SCIENCE AND TECHNOLOGY OF GLASS AND CERAMICS

A CSIR STORY

GENESIS OF EFFORTS THAT MADE A
DIFFERENCE AND CREATED AN ISLAND OF EXCELLENCE

A CSIR - CGCRI Publication


Welcome
to
A Centre of Excellence

SCIENCE AND TECHNOLOGY OF GLASS AND CERAMICS

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Genesis of efforts that made a difference
and created an island of excellence

CSIR – Central Glass & Ceramic Research Institute
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Foreword

Sixty years in an individual's life usually signals that it is time for retirement from active duty. However, sixty years in an organization's life is the time for retrospection, re-evaluation, and re-dedication. It is a time to both look back and to plan ahead. It is a time to celebrate the achievements of yesterday and to steel the resolve for an even more brilliant tomorrow.

This Commemorative being brought out by CSIR–Central Glass & Ceramic Research Institute, Kolkata, provides a historical documentation of the Institute's journey over the last six decades and a look at future prospects with a proactive vision that anticipates, and prepares for future needs.

Based on the narrations of several former Directors who steered the Institute through many difficult junctures, overcame challenges and provided visionary leadership; the publication provides an interesting and authentic account of the decisive moments which were encountered along the sixty years of Institute's journey.

As is well-known, CSIR-CGCRI is engaged in the innovative R&D activity in glass & ceramics and allied materials and has contributed significantly to social development and the inclusive growth of the nation.

The history of CSIR-CGCRI since it was set up in pre-Independence India (1945) is a gripping story of the pursuit of excellence; transformation and growth. Its role in the development of glass and ceramic industry has been phenomenal although the Institute had to pass through a critical phase of transformation in choosing its priorities from traditional ceramics to advanced ceramics in line with the changing scenario of globalized R&D.

In due course of time, the Institute successfully created several niche areas such as Optical fibre, Sol-gel processing, Glass fibre-based composites, High temperature materials and Electro-ceramics. Advanced in-house laboratories with world class infrastructure were set up and major research programmes were initiated. These initiatives have catapulted the Institute to an enviable position among global peers.

For over a decade, the Institute has collaborated with and contributed to several overseas-programmes in the areas of communication, health, energy and nano-materials which demand collective international intervention. Notwithstanding these developments in the global arena, the Institute has never lost sight of local needs and remains attuned with the societal and industrial sectors of India.

The two outreach centres at Naroda (Gujarat) and Khurja (UP) continue to serve the small-scale sector as well as rural pottery clusters. The contributions of these centres have immensely benefitted the local industries. This speaks volumes about the Institute's initiatives to ensure synergetic growth and development of research and industry.

CSIR-CGCRI has done well and lived up to its firm resolution of serving the nation despite radical changes in the prevailing scientific and industrial climate of the country and abroad. I am pleased to note that the Institute could successfully stand the test of times and earn appreciation and due recognition. I am hopeful that CSIR-CGCRI will continue to correctly interpret future trends and pro-actively position itself to benefit the nation. In past couple of decades, CSIR-CGCRI has been able to reorient its innovative R&D to champion the cause of the unprivileged who occupy the bottom of country's social and economic pyramid. Some of the successful innovations have been in the areas of affordable healthcare, water purification, low cost pottery and waste utilization. Besides these innovations, notable results have been achieved in high-tech areas of optical fibre communication, multi functional coatings, strategic glasses, fuel cell and batteries, high temperature materials, etc. It is commendable that research in these areas is progressing very well and holds enormous promise for the future.

I am happy to note that from a modest inception, the Institute could advance steadily to address the concerns of industry, government and society despite the upheavals that marred its progress.

This Commemorative Volume is therefore a vehicle that would enable the present and future generations of readers to not only get a glimpse of CSIR-CGCRI's journey through time but to also appreciate its manifold contributions and assess its glorious achievements.

I sincerely thank the editors and the associated staff for their perseverance and efforts to bring out this volume in time. I congratulate Team CSIR-CGRI for their contributions towards making the Institute India's premier organization in the field.

Prof. Samir K Brahmachari

Director General, CSIR

& Secretary, DSIR, Government of India

Date: 20.08.12

Place: New Delhi

Preface

Mirror mirror on the wall
Who is the fairest of them all?

[Grimms' Kinder- und Hausmärchen (Berlin 1857), English translation by D. L. Ashliman]

The proverbial 'glass mirror' always gave an honest answer to the vain queen who would not accept that Princess Snow White could be fairer than her.

Glass, an amorphous (or non-crystalline) and transparent solid of ionic, covalent or metallic origin, still tells the truth. It still finds use ranging from the absolute mundane (window pane, bottles) to the most sophisticated (optical communication, laser) applications even today. Like the prophetic mirror, glass can serve as a measure of technological progress and economic growth of a nation. On the other hand, ceramics, an inorganic, non-metallic and partly or completely crystalline solid made by and for high temperature processing with phenomenal strength and stability, is an absolutely necessary component, almost alike a Siamese twin, when it comes to making or melting glass.

Arguably glass and ceramics were the first engineering materials ever used or exploited by mankind. But who made them first and when? To get an answer, one needs to delve into the history of the world, beginning with the Paleolithic Era, spread between Lower Paleolithic or Early Stone Age (2.5 million to 200,000 years ago), Middle Paleolithic or Middle Stone Age (ca 200,000 to 45,000 years ago) and Upper Paleolithic or Late Stone Age (45,000-10,000 years ago) periods, which are replete with examples of exploitation of stone implements and earthen objects for hunting, housing (in caves) and making a wide range of tools in stone, bone, ivory and antler – all naturally occurring precursors of the modern ceramic materials. Evidence also exists that silica based glassy objects, possibly produced by volcanic eruptions were used by pre-historic people for cutting or slicing.

The earliest man-made ceramics were pottery objects such as pots and figurines, made from pure or blended clay and hardened in fire. Later ceramics were improved by glazing and decorated with colour and had smooth surfaces. With time, glass, instead of just being a transparent and brittle solid, has metamorphosed into ultra-modern sophisticated applications like solar panels (functionalized for coupling the entire solar radiation by up/down conversion), transparent bullet proof glass-ceramic armours, heat resistant crockery, photo chromatic lenses, optical communication devices, Bragg grating sensors, metamaterials and white/monochromatic lasers. Similarly, ceramics through ages have now found applications in the most advanced devices, gadgets and machines as semiconductors, superconductors, sensors, magnets, multiferroics, piezoelectrics, electronics/spintronics, electrolytes, spinel-ferrites, membrane-filters, bio-medical prosthesis/implants and thin/ thick coatings.

Glass and ceramics are intimately intertwined with the progress of human civilization. The first man made glass is believed to have evolved in the erstwhile Mesopotamia (now Syria) and Egypt as early as 3rd millennium B.C. In several Egyptian cities, ceramic vessels with vitrified remains have been identified as glass crucibles. The art of glass making was known in India towards the end of 2nd millennium B.C. and the glass beads prepared in the Indus Valley were precious objects for trading. From these early developments, until the present millennium, the meandering passage of human history has witnessed myriad techniques of production and usage of both glass and ceramics in various parts of the world.

The history and evolution of glass making and ceramic fabrication in India is certainly an interesting topic to sociologists and historians. Even more interesting could be a discussion as to why the only national institute on glass and ceramics was founded in Calcutta/Kolkata at the time of independence. Without digging into history, suffice to mention that eastern India, primarily because of its strategic proximity and access to raw materials (mines and quarries), energy (coal fields), and industrial and knowledge base, emerged as the obvious venue for starting a project under the Council of Scientific and Industrial Research (CSIR), on glass and ceramics in 1945. Subsequently, thanks to the great visionaries and legends of modern India like Pandit Jawaharlal Nehru, Dr. Shanti Swarup Bhatnagar, Dr. Meghnad Saha, Professor CV Raman and many others, Central Glass and Ceramic Research Institute was formally founded as a national centre of excellence under the umbrella of Council of Scientific and Industrial Research, on 26th August, 1950, in Kolkata (with an initial grant of Rs. 12 lakhs and individual contributions of Rs 10000 apiece from Bengal Glass Manufacturer Association, Dr. I. D. Verseney and Dr. U. N. Brahmachari, the inventor of the vaccine for Kalaazar)). Initially the Institute was called Central Glass and Silicate Research Institute, which soon was renamed Central Glass and Ceramics Research Institute (CGCRI) when it was realized that quality glass cannot be produced without ceramics. Led by the first Director, Dr. Atma Ram (who eventually became the 4th Director General of

CSIR), a small group of dedicated employees, quickly carved out a niche by producing optical glass of a very high quality ostensibly for fulfilling the country's civilian and strategic needs. The first ever patent taken by Dr Atma Ram on coloured glass paved the way for manufacturing tinted glasses for signals in Indian Railways. These efforts were soon rewarded in the form of prestigious national awards – "Padma Shree" and the first Shanti Swarup Bhatnagar Award to Dr Atma Ram in 1959.

In the following three decades (1967 to 1999), under the able guidance of four successive Directors - Shri K. D. Sharma, Dr. S. Kumar, Dr. B. K. Sarkar and Dr. C. Ganguli, CGCRI made several notable achievements, such as, development of specialty shielding glass, glass to metal seals for electrical devices, chemical toughening of glass, ophthalmic glass, high strength glass fibres, initiating activities in the area of non-oxide ceramics, bio-ceramics, development of synthetic mullite and mullite-corundum refractory, establishment of Naroda (1977) and Khurja (1986) Outreach Centres, and so on.

Following the development of optical glass in early sixties, the seventies witnessed the initiation of the development of laser glass, infra-red transmitting filters, synthetic quartz single crystal, high temperature protective enamels, high alumina ceramic seals and spacers – all these efforts bear testimony to the aspiration of CGCRI to assume leadership in glass and ceramic research. Developments were also attempted in the areas of foam glass, glass bonded mica, and steel plant refractory. In eighties CGCRI initiated important activities such as optical fibre for telecommunications, sol-gel processing of glass and ceramic materials, production of glass fibre based composites and electro-ceramics. Around the same time, several of the new entrants were felicitated with Young Scientist awards by CSIR and Indian Science Congress Association.

Despite the initial inroads and achievements made in the first few decades, the situation turned difficult due to various unfortunate factors in nineties. It cannot be denied that these events tarnished CSIR-CGCRI's image to a certain extent. However, a significant transformation of this institute was achieved under the astute leadership of my predecessor, Dr. H. S. Maiti (1999-2009). Not only did the institute workforce soon transform into a disciplined and dedicated lot, but the investments in infrastructure and experimental facilities led to a significant growth in various performance indicators of the institute, such as, external cash flow, publications, patents, technology transfer and so on. In addition, the Institute resumed some major projects that had been stalled due to unavoidable circumstances and even initiated ambitious developments.

It was indeed a happy coincidence and a rare privilege that the mantle of steering CSIR-CGCRI was placed on my shoulders in the Diamond Jubilee year (2010) of its existence.

In keeping with the global vision of a new and one CSIR ushered in by our beloved Director General Professor Samir Kumar Brahmachari, this Institute pledged to make a mark not only in the frontier areas of glass and ceramics through world class research or landmark technological breakthrough, and also committed itself to catering to the welfare of the common masses through CSIR-800 programme.

In the recent years CSIR-CGCRI has made bold strides in the areas of bio-ceramics based human prosthesis implants and coatings. Ceramic Hip Joint designed and developed by CSIR-CGCRI in collaboration with Padmabibhusan Dr. K.H. Sancheti, has earned the confidence of Orthopaedic Surgeons and patients in this country due to several successful operations conducted in different parts of the country. This prosthesis costs about 1/5th of the same item imported from abroad. Similar success was also achieved with artificial eye-ball which was commercialized by IFGL, Kolkata. Considering the huge demands within and outside the country, particularly in the neighbouring states, it is absolutely essential that these exploits are commercialized and brought to the masses immediately.

However, an Institute like CSIR-CGCRI can at best develop and demonstrate a technology to the satisfaction of the customers and hope that an entrepreneur with vision and initiative will come forward to translate the scientific and technological breakthrough into a commercial success story. This Institute is in dialogue with several potential companies who have evinced interest for commercializing bio-ceramic prosthesis/implants developed by CSIR-CGCRI. The recent initiative from National Innovation Council has added a fillip to this effort. Success in transferring technology developed to Industry would be a fitting tribute to the memory of Late Dr. Debabrata Basu, the Chief Architect of the bio-ceramic prosthesis and implants, who passed away on May 10, 2012 without seeing his dream fulfilled. Among other notable scientific achievements of the Institute, the activities on manufacturing technology for glass frits, ceramic membrane based water purification technology for removal of arsenic and iron, transparent hard coating on plastic ophthalmic lenses, optical amplifier based on Erbium doped fibre, fibre Bragg grating based thermal and strain sensors, solid oxide fuel cell technology for environment friendly alternative source of energy, ceramic sensors for detection of harmful and hazardous gases, non-oxide ceramic based clutch plates and nano-clay dispersed composites have earned national/ international accolades and recognition. Several of these technologies have been successfully transferred to Indian industries and strategic sectors for implementation and field trials. Under societal missions, CSIR-CGCRI's technologies for ceramic membrane based water purification, biomedical prosthesis and implants (under CSIR-NMITLI) and modernization of ceramic clusters in villages of Bankura and Siliguri districts of West Bengal stand out as true success stories.

CSIR-CGCRI is indebted to all the industries, laboratories, strategic departments, funding agencies, and collaborating institutes and scientists for all these achievements.

As a part of the newly established CSIR Academy (AcSIR), CSIR-CGCRI will soon offer specialised and tailor made M.Tech and Ph.D degree courses in the niche areas of glass and ceramics.

A major part of CSIR-CGCRI's research endeavours are directed towards supplementing to the country's need and meeting its aspiration in strategic sectors. Many of these projects are extremely challenging, requiring sophisticated and specialized infrastructure that is both expensive and energy intensive and planned for development within a short time frame. Hurdles faced in implementing these projects are severe and manifold. Yet CSIR-CGCRI steadfastly rises to the occasion and serves the nation in areas that directly concerns it.

Technology can not be developed without firm foundation of scientific understanding. When time is a constraint and demand of performance level is steep, scientists are often frustrated at not be able to pursue a project to the extent scientific logic demands. To add to the woes, available scientific manpower is limited and at the same time engaged in multiple activities simultaneously. Quite often a scientist involved in sensor development is found busy procuring equipments, chasing recruitment files, writing letters for the release of funds and at the same time struggling to formulate a strategy to overcome a nagging hurdle. As an administrator I can only try to protect (from mundane affairs), facilitate their scientific pursuits and strengthen their hands with available infrastructure and manpower. However, challenges and imminent opportunities far out number the realistically available avenues. I am yet to solve this puzzle as to how can it can be ensured that scientists in a laboratory like CSIR-CGCRI can devote all energy and time only for scientific and technological pursuits and not waste it by becoming mired in bureaucratic steps and procedures.

Barriers and hurdles are only natural in any voyage embarked upon to explore new horizons. If the goal is justified and resolutions do not falter; success is only a matter of time and perseverance. CSIR-CGCRI is baptised and committed to the three matras of the Director General of CSIR: highest quality science, highest order of translational research from science to technology and caring for the 800 million underprivileged people of the bottom of population-pyramid of India. We aspire to design new devices based on the emerging concept of nano-glass, develop three-dimensional metamaterial and supercontinuum white laser source based on photonic crystal fibre, synthesize innovative coatings and patterns on glass surfaces for coupling the entire range of solar spectrum in solar photovoltaic or solar-thermal plants, and innovate new generation sensors based on Bragg grating, functionalized oxides and multiferroic perovskites. We are committed to translating the years of laboratory research into finished products and technologies like patient specific tailored artificial bio-medical implants with compositionally and functionally graded bulk and surfaces (including bone-scaffolds for cancer affected patients), launch indigenously built complete fibre laser system, targeted drug delivery vehicles using intercalated nano-clay and similar layered structures, metal supported solid oxide fuel cells capable of using natural gas with external/internal reformer, and elevate membrane technology to newer avenues in food processing and hot-gas separation. CSIR-CGCRI's societal mission projects will empower the rural under privileged masses with training for pottery and ceramic ware manufacturing for assured self employment, provide water purification plants to distant villages, develop cheap prosthesis and implants, and convert industrial waste to value added commercial products.

Science usually progresses with incremental contribution to existing knowledge except the occasional peaks of inventions and discoveries that trigger paradigm shifts. While we do aspire for such disruptive changes in the long run, our sustained efforts are always pursue innovations that can serve the society and nation at large. As knowledge grows by interaction, CSIR-CGCRI encourages and promotes collaboration and partnership with mutual benefits and synergy, both at national (with sister laboratories, academia and industry both within the country and abroad). Indeed CSIR-CGCRI is actively engaged in multiple network projects within CSIR, individual partnership with university professors, cooperation with industry for product and technology innovation and development and international projects with foreign universities and institutes.

Though translational research and development constitutes its core mandate CSIR has recently embarked upon a new initiative called Innovation Complex, designed to promote and house multi-institutional and multi-disciplinary projects of short duration to incubate, upscale and facilitate translation of laboratory scale innovations into commercial products and technologies with appropriate industry or financial partners. CSIR-CGCRI is proud to be an active member the first CSIR Innovation Complex in Kolkata from where several recent glass and ceramic based innovations from this Institute will soon find their way to the market.

To pursue and realize an ambition, one needs a vision, infrastructure and manpower. CSIR-CGCRI is aligned and committed to the recently formulated CSIR Vision@80 document. In the penultimate phase of 11th five year plan period, this Institute has added over Rs 40 crore worth of sophisticated and state-of-the-art equipments and facilities. CSIR-CGCRI is severely constrained in space with no room for lateral expansion. Realizing this limitation and considering our major ambitions and professed commitments in the ensuing years, a multi-storied (B+G+10) vertical complex with about 800 m2 per floor is being planned with an outlay of about Rs 36 crore. Once implemented, this project will not only alleviate the space crunch but also, usher in a new culture of multi-department (in the government) synergistic research as Department of Atomic Energy is expected to invest a substantial amount to create an inter-disciplinary research centre with support for civil construction as well as equipment. The 12th five year plan projects with unambiguous benchmark, realistic roadmap and timeframe, identified novelties, and clear targets and deliverables have been finalized. Thus the job and mandate for the next five years are now well defined. One of the biggest hurdles is limited number of scientific staff strength with imbalances in terms of non-uniform retirement matrix, lopsided age distribution, complex competence profile of scientists required, and challenges to handle emerging scientific issues beyond the reach of conventional training and education. Therefore, recruitment of scientists and technicians at all level must be a well thought of exercise with an unbiased and principled approach carried out in well planned phases. CSIR-CGCRI has taken one such bold step only recently and is poised to strengthen it further in the near future, in consonance with the overall HR policy of CSIR. To fortify the regular staff on roll, we must ensure manifold increase in the numbers of research scholars and project staff engaged in our short/long term goals. The newly launched integrated MTech and PhD programme under the Academy of Scientific and Innovative Research (AcSIR) will positively contribute to fill up the vacuum of available manpower in the area of advanced ceramics and specialty glass, which is now adequately covered in any of the existing under/post-graduate courses on Glass and Ceramics in India. Thus AcSIR programme will only complement the higher education structure of the country and not compete with university system. In this respect I fervently hope that a vibrant scheme is launched by CSIR to attract, utilize and create an untapped huge manpower resource in the post-doctoral level and bridge the gap of scientific leadership between masters/doctoral level students and staff scientists in R&D Institutes and professors Universities. This scheme should have the provision of attractive packages with multiple renewable contracts as in the United States.

CSIR-CGCRI's journey started sixty years ago. The path treaded until now has been extremely eventful and important not only for this Institute and for CSIR, but for the nation too. In order to remind posterity about these valiant efforts fraught with both success and failure but never lacking in courage and determination, we decided to compose a decade wise chronology of developments, a passionate story about how CSIR created an island of excellence with practically no prior history of research in the country in specialty glass and advanced ceramics. It is surely a fascinating story that should not only evoke interest but also intense respect for those but for whose dedication and devotion this Institute would not have reached this far. This volume is a fitting tribute to those scientists and technologists of yesteryears as much for those who would join the crusade in future and turn the unrealized aspirations and dreams into reality.

Sixty years is considered a landmark meant for superannuation in government circles. To CGCRI, sixty years offered a new opportunity to salute the past, plunge into the present commitments, and embrace the challenges of the future. CSIR-CGCRI took Diamond

Jubilee as a cause to rededicate itself to the service of the nation and humanity with as clear a heart as glass and as strong a will and soul as ceramic. As a result, there is no doubt that CSIR-CGCRI will soon emerge as the strongest centre of research in glass and ceramics in the country and occupy a prominent position in the global map. I fervently hope that this prophesy will soon turn into reality.

Indranil Manna
Director, CSIR-CGCRI

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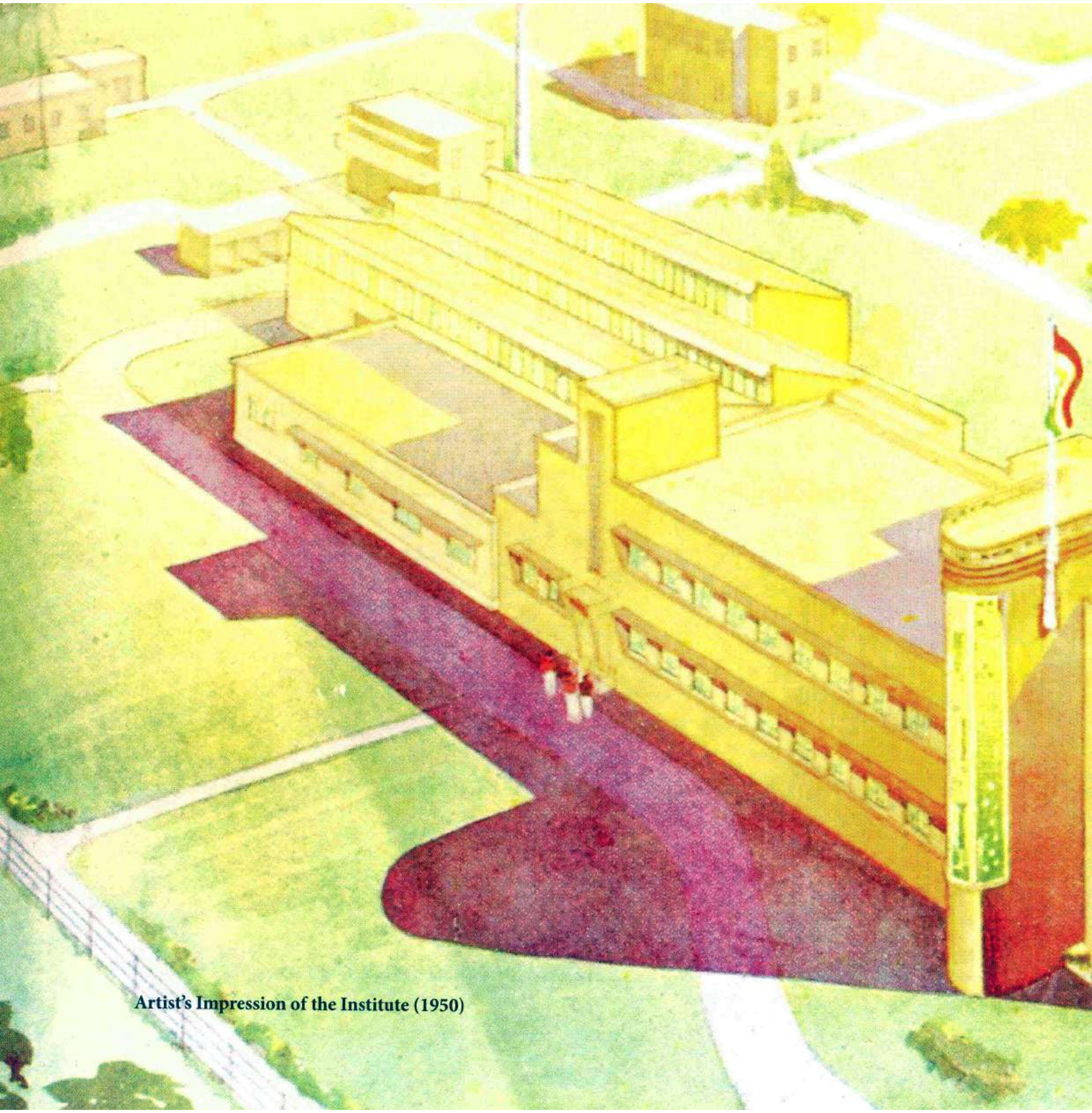
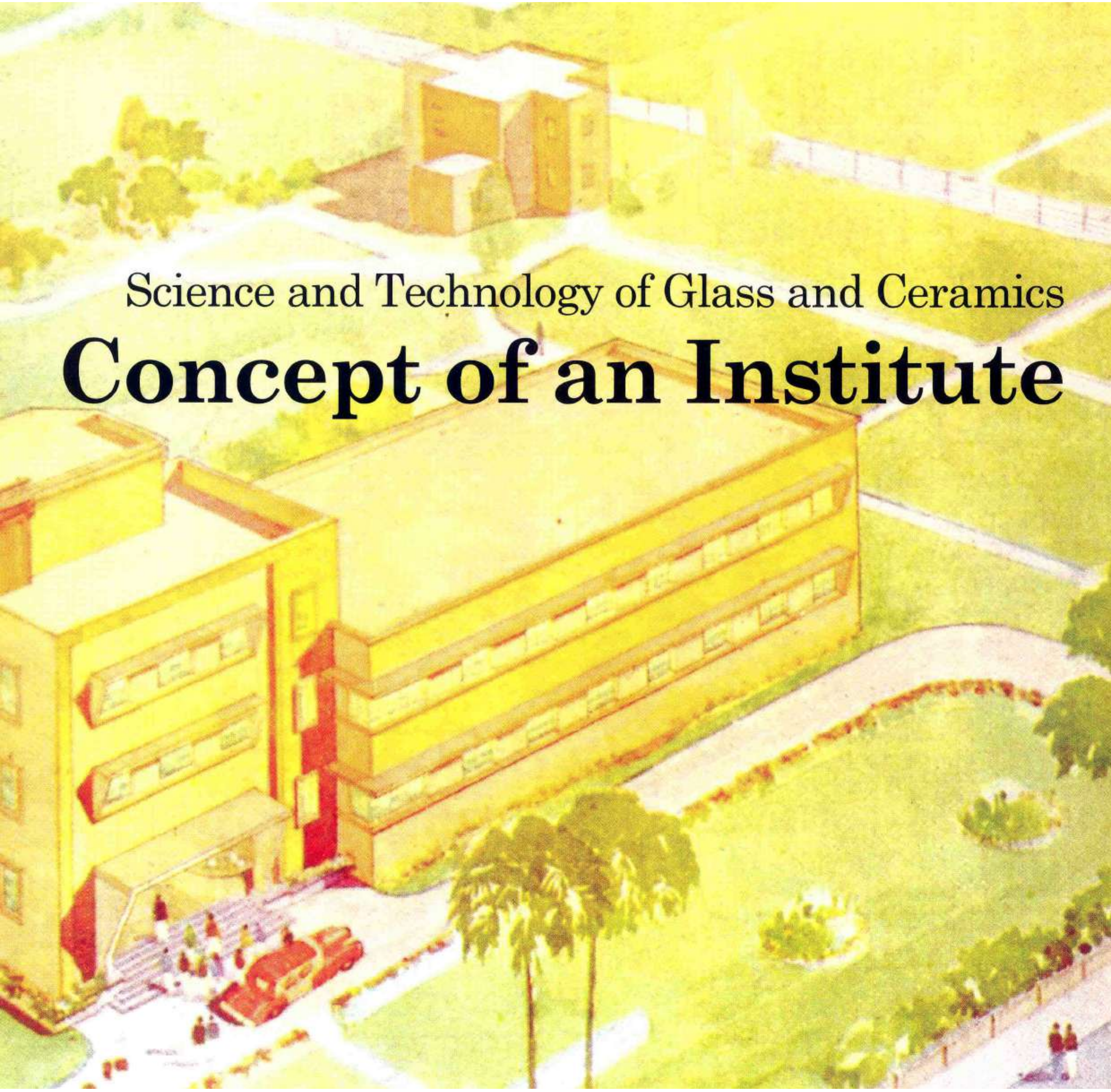


Artist's Impression of the Institute (1950)

Science and Technology of Glass and Ceramics

Concept of an Institute



Background of the **establishment** of the Institute

Indian Industrial Commission, 1916

War is an ill wind, but sometimes it blows some good. One good arising out of the First World War was that the policy of neglect, even antipathy, towards the industrial development of India was brought into sharp focus. This was highlighted by the serious situation in regard to the supply of materials in which India could have been of great assistance to the allied forces. The Government of India appointed in 1916, the Indian Industrial Commission headed by Sir Thomas Holland, an eminent Geologist, who was then a member of the Viceroy's Executive Council. The commission included amongst others, Mahamana Pandit Madan Mohan Malaviya, the great national leader and founder of the Benares Hindu University, and Sir Rajendranath Mukherjee, the celebrated engineer-industrialist of Bengal.

The Indian Industrial Commission noted, "An organisation is wanted to take up the whole industry, including men who can deal with the furnace problem, the preparation of refractory materials for furnaces, crucibles and pots, the chemistry of glass, the manipulation of the crude products and its conversion into finished forms, whether by skilled blowers or by highly complex and semiautomatic machinery.

Protective tariffs may bolster up the existing factories, but they will prove ineffective, unless they give rise to scientific enquiry and expert treatment of the many problems involved. To establish a tariff, and then to trust private effort is not likely to be productive of satisfactory results. Clearly, the State should take the lead, employ the experts, and place them in charge of practical work;

and if tariffs are employed, it should only be as far as it is necessary to protect the industry in its infancy."

On the resumption of normal trade, imports increased at a fantastic rate. Within two years (1920-21) import of glass reached a peak of Rs. 3.5 crores. Japan, a nonbelligerent country in the First World War seized the opportunity and accounted for half of the total imports.

The industry struggled without any assistance from the Government, and reached the verge of ruin. Curiously enough, it was not the British glass industry that benefited from the situation, but the Japanese and European glass industries. It is doubtful if the glass industry would have survived, had it not been for the *Swadeshi movement* of 1930. The bangle industry, in particular, owes much to the patronage of the Indian women who refused to wear imported glass bangles.

Indian Tariff Board, 1931

On continued public demand, particularly by the glass manufacturers, the Government appointed a Tariff Board in 1931 under the Chairmanship of Dr. John Matthai, one of the ablest economists of the country and later Finance Minister in independent India, to enquire into the case of the glass industry for protection.

One of the important observations of the Board was:

"The difficulties experienced by Indian manufacturers of glass are to be attributed largely to the lack of adequate provision for the investigation of scientific problems connected with the industry and for the training of managers possessing the requisite knowledge of technology and modern methods of manufacture".

Industrial Research Bureau

In 1934, the Government of India established the Industrial Intelligence and Research Bureau under the Indian Stores Department to act as a clearing house of technical information, and for undertaking some investigations to help local industries, as a follow up of the recommendations of the Industries Conference. The Bureau had its headquarters at Delhi, with a Director and an Assistant Director. It had a research branch functioning in the Government Test House, Alipore, Calcutta. The term 'Intelligence' was dropped from the name before long, and the name of the Bureau became the 'Industrial Research Bureau'. Dr. Lal C. Varman, who later became the Founder-Director and Director-General of the Indian Standards Institution, was the Research Officer-in-Charge of the research group.

The Bureau's programme included a survey of glass raw-materials, working out methods of producing some glass decorating materials particularly china glass and liquid gold, which were at that time entirely imported, and helping in the introduction of better glass melting furnaces. Its activities were limited. It had very small funds for its research programmes, glass being only a part of it.

In 1937, the Uttar Pradesh Government appointed Glass Technologist Dr. A Nadel to Government and located his establishment in the Department of Glass Technology at the Benares Hindu University. This was the first Department of Glass Technology in the country. There was a Department of Ceramics already at the University. An impression of implementing the recommendations of the Tariff Board was sought to be created by the Government. However, the establishment of a full fledged organisation for glass research was still a far cry.

Few have the gift of persuasion that Sir Ramaswamy Mudaliar had. He succeeded in persuading the Government of India to establish the Board of Scientific and Industrial Research (BSIR) which came into being in the early 1940's with Sir Ramaswamy as the President and the eminent scientist, Dr. (later Sir) S. S. Bhatnagar, Director of the University Chemical Laboratories, Lahore, as the Director, Scientific and Industrial Research.

There was no suitable Government laboratory for industrial research at that time. The research work of the Director, Scientific and Industrial Research

The Committee which recommended the location of CGCRI (initially named the Central Glass and Silicate Research Institute) at Calcutta

was temporarily organized in the laboratories and premises of the Government Test House, Alipore, Calcutta where the research branch of the Industrial Research Bureau was located. The Test House which did not have spacious laboratories and lacked the facilities of modern equipment underwent a change, both physical and functional. There was no time to grumble, no time to lose. Some sheds were hurriedly constructed. Laboratories were improvised with whatever fittings and furniture were then available. Varandahs became offices. Sitting rooms were shared. Dr. Bhatnagar himself shared the sitting room of the Superintendent of the Test House, the late Mr. N. N. Sen Gupta. The informal atmosphere was typical of a University research set up.

Plea for the establishment of national laboratories

The Indian Science Congress reflected the feelings of the scientific community when Sir Ardeshir Dalal, the General President of the 1941 Session, said at Benares: "Associated with the Department of Scientific and Industrial Research in Great Britain are the great National Physical Laboratory at Teddington and important Boards such as the Fuel Research Board, the Food Investigation Board, the Forest Products and Building Research Associations. While we must necessarily make a very modest beginning, the development of the Alipore Test House into a National Physical and Chemical Laboratory seems to be obviously and urgently required".

The Science Congress President not only made a powerful plea for the establishment of research laboratories, but also suggested the locations of two of these, Fuel and Metallurgy, which incidentally were the locations finally accepted.

Establishment of the CSIR

Difficulties in the effective functioning of a research organisation under an administrative department became apparent during the very first year of the BSIR. It was then proposed to establish an autonomous organisation for which the Government would take the responsibility of providing funds, but the management would be left in hands of a Governing Body consisting of scientists, industrialists and administrators. A Bill was introduced by Sir Ramaswamy Mudaliar in the then Central Legislative Assembly to establish an 'Industrial Research Fund'. A beginning was made with a million rupees. That is how the Council of Scientific and Industrial Research came into being on **April 1, 1942,** as an autonomous organisation under the Society's Act, with Sir .Ramaswamy Mudaliar as the Founder-President.

Plea for glass research by 'Science and Culture'

An editorial on the 'Need of a school of glass technology in India' and an article entitled 'Indian glass industry' in 'Science and Culture' (April, 1941), revived the much neglected question of establishing a central organisation for glass research. The editorial said, "If the glass industry in India has to be placed on a firm basis, it is of immediate importance that there should be a School of Glass Technology in a suitable center which will arrange for adequate and effective provisions for training and research with the objectives: (i) Training of students in glass technology including refractory and fuels; (ii) carrying out investigations for the benefit of the industry and also fundamental research; (iii) testing, and standardization of raw materials, refractories, finished glassware, etc; and (iv) giving technical advice to the industry whenever necessary".

Glass Research Institute Committee

Few writings have been so effective in influencing the thinking as was the afore mentioned. The question of glass research was again discussed. As a result, Prof. M. N. Saha, the then a member of the BSIR and Editor of 'Science and Culture', and Sir S. S. Bhatnagar paid a visit to the Benares Hindu University with the object of exploring the possibility of organizing an Institute of Glass Research using the University Department and the set up of the Glass Technologist, to Uttar Pradesh Government as the nucleus. They submitted a report to the BSIR, and the Board appointed a Central Glass Research Institute Committee in March, 1942, to advise the Board in this regard with Sir S. S. Bhatnagar as Chairman and Prof. M. N. Saha, Prof. J. N. Mukherjee, Prof. P. Ray, Mr. I. D. Varshney and Dr. A. Nadel as members.

The Committee held its first meeting on April 27, 1942, in the Forman Christian College, Lahore. Only the Chairman, Sir S. S. Bhatnagar, Mr. I. D. Varshney and Dr. A. Nadel could attend the meeting. The main recommendations made at this meeting were:

Objectives and scope: The Committee unanimously resolved that the Central Glass Institute should be devoted to research in glass and to the introduction of the industrial processes new to India using all technical and other means at its disposal.

Area of the building: 15,000 square feet.

Sections: Glass technology, glass chemistry, glass physics, furnace construction, refractories, glass engineering, labour control and statistics.

The Committee recommended, "... bringing experts under the recently initiated Indo American Cooperation in the technical and industrial matters." The Committee also suggested "... bringing the following processes, more or less secret, from the USA-Manufacture of safety glass, heat resisting glass, fiber and insulating glass, vacuum vessels, drilling, and finishing of sheet glass, mechanical stirring of optical glass".

Location of the Institute: In regard to the location of the Institute the Committee suggested: (i) Calcutta, (ii) Delhi (Delhi Polytechnique), (iii) Benares, (iv) A place in Uttar Pradesh other than Benares, and (v) Lahore.

Enlargement of the scope of the Institute

The report of the Committee was submitted to the BSIR for consideration at its meeting on July 1, 1942. The Board postponed consideration for two successive meetings and it was only on July 12, 1943, that on the recommendation of the BSIR, the Governing Body of the CSIR decided that: (i) the proposed Institute for glass research be styled as the 'Central Glass and Silicate Research Institute' as suggested by the Indian Ceramic Society; (ii) a Secretary be appointed 'who would carry out a survey of raw materials needed for the industry and find out problems in silicate and glass research'; and (iii) a Committee consisting of the following be appointed for giving guidance and advice to the Secretary: Sir S. S. Bhatnagar, Chairman, Prof. M. N. Saha, Prof. J. N. Mukherjee, Prof. P. Ray, Prof. P. Carter Speers, Dr. A. Nadel, Mr. I. D. Varshney, Dr. M. D. Qureshi, and Prof. K. S. Krishnan as members.

Rupees Two lakhs for Glass and Silicate Institute

The demand for the establishment of national laboratories which had been voiced from the highest platform of Indian scientists could not be ignored by the Government, particularly at a time when the Government was seeking their cooperation, in view of the unanimity amongst the scientists, industrialists, and men of affairs in this regard.

Site inspection for the Institute

Also, the impediments in the work of the Director, Scientific and Industrial Research (DSIR) due to the absence of laboratories convinced the Government of India about the need of concrete action.

Unlike their pre-war attitude of indifference and neglect, the Government of India was quick in setting apart a sum of rupees one crore (ten million) towards capital expenditure on the establishment of five national laboratories - National Physical Laboratory (Rs 30 lakhs), National Chemical Laboratory (Rs 25 lakhs), National Metallurgical Laboratory (Rs 30 lakhs), Fuel Research Station (Rs 6 lakhs) and Central Glass and Silicate Research Institute (Rs 2 lakhs) on March 1, 1944. Dr. Atma Ram was appointed Secretary of the Committee for setting of the Institutes.

Secretary's report

It was in this atmosphere of enthusiasm, eagerness and earnestness about the establishment of the Institute that Dr. Atma Ram completed the first phase of his visits to different places. He visited Calcutta, Bahjoi and Bombay, Kolkata, Tata Laboratory at Jamshedpur and Departments of Glass Technology and Ceremics of the Benares Hindu University. On the basis of the information and impressions gathered during the visits and after the study of publications on the development of such Institutions in other countries, specially Prof. W. E. S. Turner's extensive writings in the journal of the 'Society of Glass Technology', Germany and USA, Dr. Atma Ram prepared a report for the consideration of the Committee within two and half months of his undertaking the work.

Briefly, the report set out the position of the industry, its problems, its place in national development, and the need of a research Institute to ensure speedy post-war development of the industry. It also described briefly the standards achieved by the industry in the advanced countries. The functions of the Institute, possible locations, anticipated requirements of staff, equipment and buildings, as also estimates of expenditure, were discussed. The report was printed leaving a blank leaf in between for people to put down their suggestions and return. It is unfortunate that no copy of this report is available either at the Institute or at the CSIR head office in New Delhi.

Consideration of the report

The Committee held its meeting in June 1944 in Prof. Saha's Cyclotron Laboratory, Calcutta. The Secretary's report was the chief item for consideration. Almost all members attended the meeting. Dr. Atma Ram was overwhelmed with the words of appreciation and the unanimous acceptance of the proposals submitted.

The proceedings of this Committee were considered by the BSIR and the Governing Body of the CSIR on August 1, 1944. Initiating the discussion, Sir S. S. Bhatnagar, said - "According to the plan which the Council had in view, the Glass Research Institute and the Fuel Research Station were to be established immediately".

In regard to the Glass and Silicate Research Institute, a very detailed report had been submitted by Dr. Atma Ram. The report had been printed and circulated with the agenda. There were only three places where the Institute could be located with advantage, *viz*, Bengal, Uttar Pradesh and Bombay. Amongst these three places, the Glass and Silicate Research Institute Committee recommended Calcutta as the best place if Bengal was to be selected, and Delhi, if the vicinity of Uttar Pradesh was to be chosen. Calcutta could then be assigned as the first place of choice by the Glass Research Institute Committee who proposed to have an institute here not only for glass but also for other branches of ceramic industry. The Mayor of Calcutta and a representative of the Calcutta Corporation had held out assurances that they would help the Council in getting a suitable piece of land in the vicinity of the Government Test House. Unfortunately, it was found that this land would not be available. At their instance, however, the authorities of the Jadavpur

College in South Calcutta have offered a plot of five bighas of land at a nominal rent, say, one rupee per acre for 99 years. The Managing Committee of the College which included Dr. B. C. Roy, who was present at the meeting, had communicated in writing that as soon as another plot in the same area owned by the College becomes available they would be very willing to part with it if the Corporation had no objections. This plot had been taken over by the Labour Department, but if this was chosen as the site of the Institute it might be possible to get the release of the land. If this site was finally selected, it would be possible to start the Institute operations before April, 1945. Funds were available starting the operations straightaway.

CSIR's decisions

After discussion of the various points raised on the subject by DSIR and the Glass and Silicate Research Institute Committee in their respective reports, it was decided that the Glass and Silicate Research Institute should be located in Calcutta.

"Estimate of capital expenditure: The Governing Body sanctioned the increase in the estimate of the capital expenditure on the Institute to Rs 12 lakhs, as recommended by the Committee inclusive of Rs 2 lakhs already provided, spread over a period of 3 years".

The proposal of the DSIR for the appointment of Dr. Atma Ram as the Officer-in-charge of the Institute was approved.

Prof. M. N. Saha supporting the proposal observed that the survey made in the report should serve as a model for other surveys.

The President (Sir Muhammad Azizul Haque) observed that although he was not in favour of any particular firm, the urgency of the case in regard to the Glass and Silicate Research Institute deserved special consideration and a start could be made by entrusting the task of designing the plans of this Institute to M/s Ballardie Thompson and Matthews Ltd, while for other laboratories tenders might be invited from other firms of standing and selection made on merits when several firms might get the chance in connection with the various laboratory schemes.

The proposal of the President was approved unanimously.

Appointment of Advisory Sub-Committee: The Governing Body approved the recommendations of the Glass and Silicate Research Institute Committee for the appointment of a small subcommittee, for advising the architects, with the following personnel: DSIR (ex-officio Chairman), Mr. I.D. Varshney, Dr. A. Nadel, Dr. A.H. Pandya, Mr. K.C. Roy (Bengal Electric Lamp Works), Dr. Atma Ram (Secretary.)"

In addition to the Bengal Glass Manufacturers Association's donation of Rs 10,000.00, two personal donations of Rs 10,000.00 each from Mr. I. D. Varshney and from Sir U.N. Brahmachari of Urea Stibamine for Kalazar' fame had been announced. Thanking them for their donations, the President of CSIR, Sir Muhammad Azizul Haque observed in the meeting of the Governing Body on August 1, 1944, "It is a sure indication that our industrialists are taking an increasing interest in research and having their due share in the responsibility of organizing industrial research on an adequate scale."

Thus, it was that after nearly three decades of the Industrial Commission's emphasizing the responsibility of the State for making provision for research, and technical assistance to industry that a firm decision to establish a research Institute was taken by the Council of Scientific and Industrial Research. Coming after a series of frustrating experiences and the earnestness with which the CSIR was going about the establishment of laboratories, that its decision to establish the Central Glass and Silicate Research Institute (named later Central Glass and Ceramic Research Institute) at Calcutta was received with great satisfaction and enthusiasm.

Reminiscences of Dr. Atma Ram, First Director, CGCRI (Abridged and edited from article published in Glass and Ceramics Bulletin, Vol. 22, No. 4, 1975, p. 208-217)

Science and Technology of Glass and Ceramics

Concept to Reality- The Efforts

Establishment of the **Institute**

Choice of a site

Dr. B. C. Roy, the then Chairman of the Jadavpur College Committee, Shri K. C. Roy, Secretary, and Dr. T. Sen, Principal, (later Vice Chancellor of the Jadavpur University and subsequently Vice President of the CSIR as Union Minister of Education 1967-69), were extremely enthusiastic to provide land to the Institute adjacent to the College on the Gariahat Road. A big portion of this land, including the place where the Institute now stands, was then under the occupation of the stevedore's camp under the Department of War Transport of the Government of India. Being war time, the camp had an element of essentiality about it. The College authorities were prepared to spare some land in the campus itself along the main road, by the side of the post office and the bank building, almost opposite to the present buildings of the Indian Institute of Experimental Medicine where another CSIR Laboratory established much later. But only five bighas were available - too small even then for the requirements of the Institute, let alone to have provision for future expansion.

The land along the road had been given on a hundred years' lease to the College by the Calcutta Corporation. The quickest way to have the title to this land would have been for the CSIR to become the sublessee of the College, which the latter was very willing to allow. However, since a sublease would have its own limitations, Dr. Atma Ram felt that the CSIR should be the direct lessee of the Corporation. In order to make it possible, the College authorities agreed, to surrender the land to the Corporation provided it was leased, by the latter to the CSIR.

The surrender and release were not without hurdles. The Institute should be grateful to Mr. Abdul Rehman Siddiqui, the then Mayor of Calcutta, for the skill, tact and speed with which he got this completed. This is how the Institute got its present site on a long term lease from the Calcutta Corporation on payment of a nominal annual rent.

Setting up office at Calcutta

Dr. Atma Ram joined duties in Calcutta as Officer-in-Charge of the Institute in the first week of May 1945, when war in Europe had nearly ended. Suitable residential accommodation was difficult to obtain in Calcutta then, on account of the large number of houses requisitioned during war time. Prof. M. N. Saha gave Dr. Atma Ram shelter in his house which was not far from the site. This proved to be doubly advantageous. Dr. Atma Ram got Prof. Saha's guidance also in many matters. Their conversations during the morning and evening walks were very stimulating. Prof. Saha discussed science, scientists, and scientific developments in historical perspective, with his incisive insight.

With the rapid development of the Jadavpur College into a Technological University, the establishment of two national laboratories—the CGCRI and the Indian Institute of Experimental Medicine, and the National Instruments Limited, the expansion of then existing industries, and establishment of new ones including some glass works, and the construction of the new buildings of the celebrated Indian Association for the Cultivation of Science with which are associated the names of such eminent Indian scientists as Prof. C. V.

Raman, Prof. M. N. Saha and Prof. K. S. Krishnan, the area then soon became the. Science and Technology Square of Calcutta.

Early days

Sometime after the cessation of hostilities, CGCRI was given, with the permission of the War Transport Department, possession of a small low ceiling temporary office of the stevedore camp at the site. It had four small rooms with electric lights, fans and a telephone. What a boon the telephone was —a prized item during war time. Mr. S. Chakravarti, who was the then Under Secretary in the department, was extremely helpful.

The building was situated almost where the then lily pool was. Sir S. Radhakrishnan, the then Chairman of the Education Commission visited the site while returning from a visit to the Jadavpur College and sat for sometime in the then tiny building with Prof. M. N. Saha and Sir Hugh Duff, Vice-Chancellor of St Andrews University, both were members of the Commission. It was demolished when the main building was nearing completion in 1950. What a hammering it took! Everyone felt sad. It was 'a friend in need'. It had given them shelter when they needed it most.

Financial problems

The phenomenal pace of development called for adequate funds but there was not much. Ever since the first Institute Committee had suggested an incredibly small sum of Rs 1,71,000 for capital expenditure, one of the persistent worries had been about finance. The Government appeared liberal in making a 20 per cent higher provision of Rs 2 lakhs.

When Dr. Atma Ram was preparing his report for the Committee, an estimate of about Rs. 20 lakhs for capital expenditure was proposed. As a practical proposition, therefore, the capital estimates were kept at Rs 12 lakhs. Even this was six times the amount earmarked about a year earlier, for the Institute in the overall allocation of Rs 1 crore for laboratories. One argument put forward to justify the increase was the widening of the activities of the Institute to include pottery, refractories and, enamels in addition to glass. A demand to allocate the additional ten lakhs to the Central Glass & Ceramic Research Institute was made in the March, 1945 meeting of the Governing Body. Sir Ardeshir Dalal was the, the President of the CSIR. After a good deal of arguments and discussions, the Government agreed that the Central Glass and Silicate Research Institute be allowed to proceed on the basis of Rs 12 lakhs.

Laying the foundation stone

The name of the Institute was changed a second time from Central Glass and Silicate Research Institute (as decided in 1943) to Central Glass and Ceramic Research Institute in 1945. This came about as a result of a resolution of the Glass and Refractories Committee of the CSIR, which was accepted by the Governing Body.

Sir Ardeshir Dalal, President, CSIR, graciously accepted invitation. The foundation stone was laid on December 24, 1945 in the presence of a large gathering of scientists and a good number of administrators, and industrialists from Calcutta. Glass and Ceramic manufacturers attended in large numbers. So great was the enthusiasm that Sir U. N. Brahmachari, one of the donors came to attend the function, in spite of his poor health and failing eyesight. Sir Ardeshir Dalal visited the technological

Sir Ardeshir Dalal, Member for Planning and Development of the then Government of India

block already under construction and was obviously quite pleased.

It is worth mentioning that the foundation stone of the CGCRI was first laid by the CSIR Laboratory. Some foundation stones have the habitat of shifting from the spot where they were first laid. This was one such. It was not exactly on the spot where it was laid, but a few metres to the south. It was kept covered and protected for about four and half years.

With no possibility of early augmentation of finances, a decision was reluctantly taken early in 1946, that the building work should remain confined to the technological block and that efforts should be made to procure scientific equipments which at that time was difficult to obtain. Detailed specifications were already drawn up and had even received quotations for some. Not many equipments were then available in the country. In order to have the benefit of scrutinizing equipments in other countries and of having personal discussions, it was decided that Dr. Atma Ram should go to UK for procuring equipments.

Glass and Ceramics in post-war Germany

Hardly any glass or ceramic research laboratory was then functioning in the world. The Kaiser Wilhelm Institute for Silikatforschung, which had been shifted during the war from Berlin to an obscure place was very badly damaged. Only a few German scientists could be contacted. They were quite communicative. But since their laboratories were disorganized, not much advantage could be taken, except for having some useful personal discussions.

The productive part of Dr. Atma Ram's German visit was, however, cut short after about three months. One September night, Dr. Atma Ram's car met with an accident near Frankfurt while he was returning from Bosch's spark plug factory. He barely managed to escape death, and lost the use of the right eye for ever. He spent about three and a half months in hospitals in Frankfurt and London and was discharged in January, 1947.

Meeting British Scientists

Dr. Atma Ram met, Prof. W. E. S. Turner in London, with whom he had already been in correspondence. The meeting was quite long and very useful. Dr. Atma Ram carried the impression of having met a missionary, a combination of eminence and humility, of profundity and simplicity. Prof. Turner is one of the donors of the Institute. He was later to stay at the Institute as its guest for about two months in 1953–54. He also delivered a number of lectures at the Institute and some other important centers.

Dr. Atma Ram paid a number of visits to Sheffield, UK and met Prof. H. Moore, who had taken over from Prof. Turner on his retirement. Dr. S. N. Prasad, and Dr S. Kumar had all also worked under Prof. Moore.

Pilkington Brothers factories, famous for their sheet and plate glass, were also in St Helens. Dr. Atma Ram visited both the plants and the research laboratory. He had not till then seen a glass plant of that size. The twin grinding of plate glass—a novelty introduced by the Pilkingtons—fascinated him. Float glass which revolutionized plate glass industry had not been introduced till then. Dr. Atma Ram met the two Pilkington brothers, Mr. Harry (later Sir and became Lord Pilkington) and Mr. Lawrence Pilkington.

Coming of Independence

Soon came August 15th, 1947—the great national day. India became free. Masses and masses of people everywhere—drums, music, blowing of conch shells and all in the delirium of joy. Prof. Saha hoisted the national flag on the technological block which was then still under construction.

An event which was to exercise tremendous influence on the progress of scientific research in India was Prime Minister Jawaharlal Nehru's acceptance of the Presidentship of the CSIR. He took charge of the then newly started Department of Scientific Research. Thus, he became directly involved in the establishment of national laboratories. Panditji was a man in a hurry. As the plaque in the entrance hall of the main building of the Institute indicates, he was *'not interested in excuses for delays'; he was 'interested only in things done'.* Dr. Bhatnagar used every opportunity to invite Panditji's personal attention to as many things as possible. The establishment of several laboratories within two and a half years of independence led Prof. C. V. Raman to call that high speed work as the 'Nehru-Bhatnagar effect'. CSIR has been singularly fortunate in having successive Prime Ministers accept its Presidentship, and lend the weight of their authority to its development.

However, this was not to belittle the contribution of earlier Presidents of the CSIR right from Sir Ramaswamy Mudaliar, the Founder-President, BSIR, Mr. N. R. Sarkar, Sir Muhammad Azizul Haque, Sir Ardeshir Dalal and Rajaji, all took deep personal interest in the setting up of the laboratories.

Dr. Shyama Prasad Mukherjee became the first Industries Minister of independent India. On Panditji becoming President of the CSIR Dr. Mukherjee accepted the Vice Presidentship. Dr. Atma Ram invited him during one of his visits to Calcutta to see the Institute. In the course of the visit, he saw several packing cases of equipment which were lying in the corridor or stacked in the congested rooms. He made enquiries as to why these were lying like that. Prof. Saha who was with him explained how, in the face of financial limitations, the building work had to be kept in abeyance. Dr. Mukherjee's personal interest in the provision of more funds was sought. The hope was not belied and in September, 1948, permission was received to go ahead with the construction work.

Optical Glass—the Initiation

We may read the history that was best narrated by the first Director of the Institute, Dr. Atma Ram. "One of the problems always in my mind, ever since I had taken up duties as Secretary of the Institute Committee, was optical glass. I had known something of the efforts made by the Government of India during the War to seek collaboration of the UK manufacturing firms and also about the research schemes financed by the CSIR, without any concrete results. I had also read about the successful efforts made by the scientists in the UK and the USA during the First World War in producing optical glass.

I learnt that there was a small experimental optical glass plant attached to the National Bureau of Standards. I was anxious to see the Bureau's plant. As the plant was for the US Navy though operated under the Bureau's supervision, special permission was obtained by the Ambassador from the State Department for my visiting it. The Ambassador and the Minister took personal interest in my work and I met them several times during my stay in the USA. The optical glass plant at the Bureau used to operate only occasionally for making special glasses. It was only during the latter part of my stay that I was able to see its working as also the production of refractory pots by the slip casting process developed at the Bureau. I have given an account of this in the Shanti Swarup Bhatnagar Memorial Lecture to the National Institute of Sciences, (now Indian National Science Academy, New Delhi), 'The making of optical glass in India.....' All I would say is that the stay at the Bureau was very fruitful in every way".

Almost across the road was the Geophysical Laboratory of the Carnegie Institution of Washington. There he met Dr. George W. Morey, the phase diagram wizard. Knowing his interest in phase equilibrium studies, he showed him his equipment and method, and even invited him to work on it, which he did for sometime. Morey had done pioneering work in the production of optical glass during the First World War. Even more remarkable is his work which led to the introduction of rare earth optical glasses based on the incorporation of lanthanum, and thorium borates. Because of their high refractive index and low dispersion, these glasses revolutionized the design of camera lenses, and eventually even the technology of optical glass manufacture—the melting of optical glass in platinum lined tanks.

At the invitation of Dr. J. T. Littleton (then Vice President in charge of research, Corning Glass Works), Dr. Atma Ram spent two days at the Corning Glass Works—the makers of 'Pyrex' glass. Several glass and ceramic manufacturing firms in the USA have their R&D organisations, but that of Corning was unique for its achievements and innovations. There he met Mr. Howard R. Lillie, physicist at the laboratory, whose work on viscosity is considered a class. Lillie died in a plane accident in the prime of his life and glass science was deprived of a gifted researcher. Others whom he met were Dr. Dalton, Dr. Nordberg of 96 per cent silica glass fame, and Dr. Donald Stookey.

The pioneering work of Dr. Stookey on the controlled crystallization of glasses led to the production of photosensitive glass and to the development of a new class of materials of great promise, called 'glass-ceramics'. He did not exactly recollect how it all started during their discussion on photosensitive glass, but he remembered that he had to prepare for Dr. Stookey some colloidal gold in his laboratory. Much work was then being done at the Institute on glass-ceramics by Dr. R. L. Thakur and his associates.

Dr. Atma Ram saw the set up, till then preserved, used in casting the glass disc for making the reflector of the 200 inch telescope of the Mount Palomar observatory, weighing several tons and requiring more than a year to anneal—a fantastic under taking. One piece which had developed some defects and was unsuitable for use was housed in a specially constructed room at the entrance of the hotel near the works. It looked awe inspiring to Dr. Atma Ram. It was during the Second World War that Corning entered the field of optical glass and introduced the 'continuous process' of making it by melting in platinum lined, electrically heated tanks.

But the most interesting person Dr. Atma Ram met during his Columbus visit was Dr. Ross C. Purdy who had done much to organize the American Ceramic Society which had exercised a tremendous influence on the development of ceramic research and teaching, particularly in the USA. At the time of Dr. Atma Ram visit, Dr. Ross C. Purdy was not well, and Dr. Atma Ram could have been easily put off. But Dr. Ross C. Purdy insisted on Dr. Atma Ram meeting him and invited Dr. Atma Ram to his house one evening. Americans usually take early dinner and Dr. Ross C. Purdy insisted on Dr. Atma Ram joining them. He narrated about the work of the Society, incidents and personalities, and spoke most feelingly till it was quite late.

During his stay in the USA, Dr. Atma Ram had tried to meet almost everyone connected with the development of optical glass. He felt that the experience of the American scientists, who had developed the process of its manufacture during the First World War without any assistance even from their Allies, could be of great use to us. So he was anxious to meet Dr. John C. Hostetter, who was then in St. Louis as President of a company making wired and figured glass. He had been for sometime at Corning also. Atma Ram met Dr. John C. Hostetter in St. Louis and from the narrative of his experience, he began to have a better appreciation of the problems one would face, particularly in the availability of special machines, which he said they had failed to get from anybody. Atma Rams own experience confirmed it. He could not meet Lt. Col F. E. Wright, though he had read his fascinating book 'Manufacture of Optical Glass and Optical Systems' describing the American efforts in optical glass making. Col. Wright was in charge of coordinating the work on optical glass production during the First World War and was Chairman of the Army Commodity Committee on Optical Glass and Instruments of the US Ordnance Reserve Crops.

Lessons from foreign developments

Many of these great names in glass and ceramic technology are no more in the land of the living. Dr. Atma Ram had given his brief account to indicate how deeply interested the glass and ceramic scientists in those countries were in the development of their subject in another part of the world, and he also recalled with gratitude the assistance they gave him so willingly. Whenever any of his colleagues visited them afterwards, they were highly appreciative of the contribution of the Institute and were extremely helpful. As for himself, Dr. Atma Ram gained immensely from these visits and contacts not only in regard to the selection of equipment, of library books and journals, acquaintance with many Indian researchers; working in these laboratories, but even more in the removal of several doubts that had lingered in his mind. It became clear to him that most of the people who set up or were managing those research laboratories had begun their career as pure scientists. Much had been achieved by them, often with meagre resources and simple equipment. Whatever be the technology—glass, ceramic or any other, the same basic principles of science and engineering run through all of them. What is essential is a mastery of the basic science. The application would then be easier and more effective. The Corning laboratory, predominantly an industrial research establishment, is remarkable for having some of the very brilliant basic scientists. An industrial research laboratory with a climate of interaction between basic scientists, applied scientists, technologists, technicians, and economists has a much greater chance of success than one packed with scientists of one kind or the other, howsoever, brilliant. After a study of the developments in the field of optical glass in those countries and discussions with the persons directly involved. Dr. Atma Ram was convinced that given time and facilities, the Institute would be able to produce optical glass, whether any collaboration was obtained or not. How gratified Dr. Atma Ram must have felt when the Institute actually achieved it—and achieved it without any collaboration!

Early work

On an urgent call from Dr. Bhatnagar, Dr. Atma Ram had to cut short his stay in the USA and return to India in the first part of December 1948. With additional funds made available, the construction of the main building had begun. It continued vigorously throughout 1949.

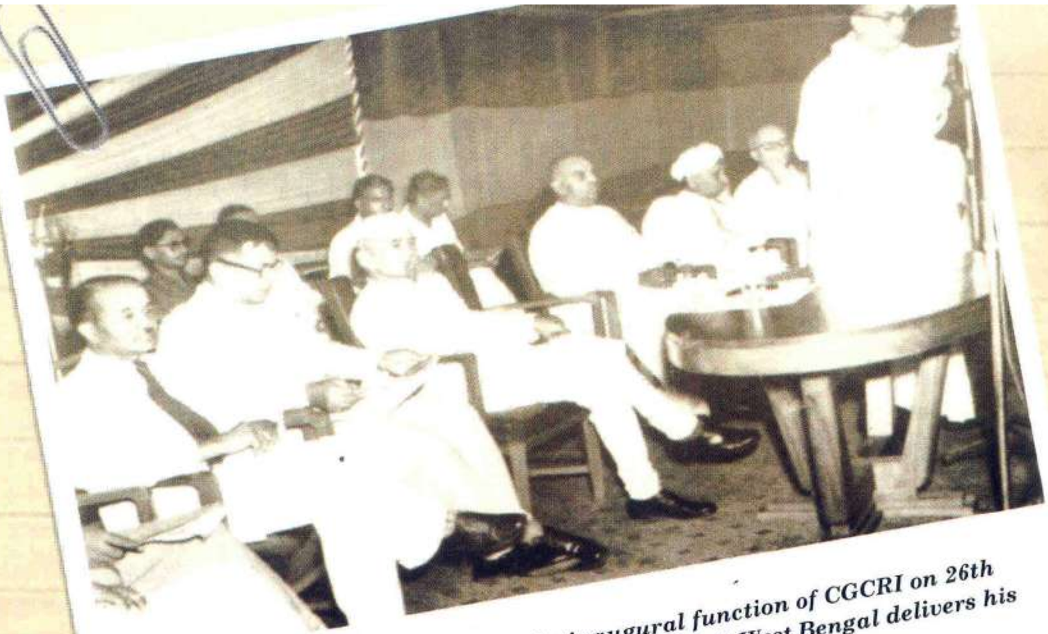
Some laboratories were improvised in the technological block which had been completed. In spite of all the inconvenience of working in the asbestos roofed technological block in the hot and sultry weather, with stores stacked, machines running and furnaces operating, his colleagues set about in right earnest. It is best described in the words of Dr. Bhatnagar himself:

"Even during the incubation period of the Institute, investigations for improving the quality of raw materials by treatment particularly washing, magnetic separation, *etc*, have been pursued since 1948, and results of great benefit to the industry have already been obtained.

Researches have been in progress on coloured glass, sintered glass and foam glass. The work on foam glass has aroused great interest since the product obtained possesses good thermal insulation and buoyancy and is expected to find wide use as a roofing material. With the limited facilities of staff and equipment so far available, the Institute has been rendering technical assistance to industry, particularly with regard to the removal of defects, suitability of raw materials, advice on plan layouts, furnace designs, *etc*."

The first part of 1950 was a difficult period for Calcutta. Conditions in the city and suburbs were often so unsettled that they did not sometimes have more than a couple of masons on the job. Dr. Atma Ram recalled the resourcefulness and the sense of responsibility of the late Mr. Arjun Dalmia, the builder, without whom the work might not had been carried out at that

Members of staff with Dr. Atma Ram and
Mr. V. Thompson, Chief Architect of the building



A host of luminaries participate in the inaugural function of CGCRI on 26th August, 1950. Dr. B.C. Roy, the then Chief Minister of West Bengal delivers his address

Doyens of Indian Science and Industry who influenced the decision to establish a separate institute for glass research pace in the face of heavy odds. He was one of the very cooperative and pleasant persons Dr. Atma Ram came in contact with during that period.

Inauguration

It was decided to have the formal opening of the building sometime in the latter half of August, 1950. Dr. Bhatnagar stayed with Dr. Atma Ram for about three days or so, perhaps the longest he ever did. He used to be very particular about every detail— the list of invitees, laboratory arrangements, the brochure, and so on. Dr. Atma Ram had seen the grand opening of the National Physical Laboratory by Prime Minister Nehru in January, 1950 and of the Fuel Research Institute by the President, Dr. Rajendra Prasad, in April. Dr. Atma Ram was not an adept in the art of inauguration but kept on nodding consent to all of Dr. Bhatnagar's suggestions in the hope of getting the best. When he came two days before the opening, he was very pleased and exclaimed - "Oh, what a pearl of a laboratory!"

And so, in the evening of August 26, 1950, Dr. B. C. Roy, Chief Minister of West Bengal inaugurated the CGCRI, in the presence of a distinguished gathering.

Some of the finest sentiments and fondest hopes were expressed on the occasion. It might be well to recall some of them.

"The Central Glass and Ceramic Research Institute deals essentially with one of the most important applications of science. It will, I hope, play an important role in developing not only the glass industry in India but many of its ramifications. Above all, I hope that this laboratory will nurture and spread the spirit of science so that we may grow out of our narrow selves and thus raise ourselves and our country to higher levels of thought and achievement. "

— *Jawaharlal Nehru, Prime Minister*

"We have got abundant raw materials for the glass and ceramic industry, so much so, that we can easily export our manufactures if we know how to develop our means of production. In spite of this, we are today importing glass and ceramic manufactures on a large scale. The position has to be reversed as quickly as possible in this field and in others as well. From that point of view this Institute is one of great national importance."

— *Shri Hare Krishna Mahatab, Union Minister of Industries and Vice President, CSIR*

"I am sure this Glass Institute will become a source of inspiration and strength to the glass industry, and processes will be developed here which will enable the industry to develop quickly and intensively in all directions. The same observations apply with full, if not, greater force to the ceramic industry."

— *Dr. K. N. Katju, Governor of West Bengal*

"I hope and trust that this Institution will have a succession of achievements to its credit. Providence helps those who help themselves."

— *Dr. B. C. Roy, Chief Minister, West Bengal -:*

"We have chosen Calcutta for the location of the Institute as it is one of the principal centers of the glass and ceramic industry. For the establishment of a successful glass and ceramic industry, we are as much dependent on science and technology as on decorative and creative art requiring delicate touches which only deft hands can impart, and as we know that Bengal possesses artistic talents which few others can equal, as well as scientific acumen of a high order, we feel we have acted rightly in locating the Institute here."

— *Dr. S. S. Bhatnagar, Director, Scientific & Industrial Research*

"I hope that this Institute will play a great part in the development of the glass industry of this country as the Sheffield School of Glass Technology and the Kaiser Wilhelm Institute for Silicate Research have played in the development of glass industries in England and Germany."

— *Prof. M. N. Saha, Chairman, Local Planning Committee*

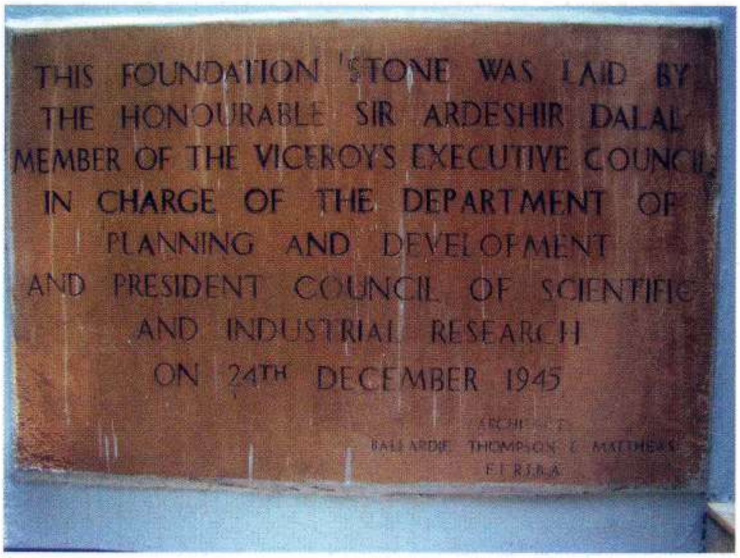
"Let us never forget that all industrial progress, economic welfare and so on are ultimately dependent on the basic and fundamental scientific knowledge that we can acquire through fundamental research. Even if such knowledge does not at the first sight appear to be of any value, economically or otherwise, I am sure it will in the long run prove to be of great value for our prosperity, economic or spiritual, as you may call it."

— Prof. C. V. Raman, Raman Research Institute, Bangalore

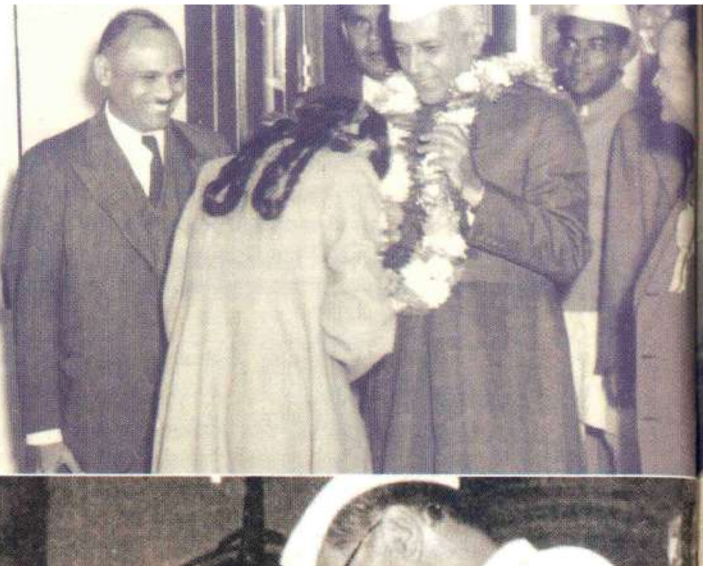
"Many people in the country and outside have doubted the desirability of setting up the several research institutes in this country and have criticized the expenditure of the large sums on their construction .... that setting up large research institutes when there is hardly any industry in the country in the modern sense is like putting the cart before the horse. I consider this as an unsympathetic and unconstructive criticism. . . . In the peculiar circumstances in which our industrial growth is placed, we have to make a start somewhere. To wait till there is a full-fledged industry before research institutes should be put up, is to my mind a wrong basis to work upon. Whatever industry exists in this country, it is definitely going to benefit from these research institutes, and I feel that these institutes will act as a great impetus to the advancement of our industries."

— Shri M. G. Bhagat, Member, Local Planning Committee, Managing Director, Bengal Potteries

How far has the Institute responded to the sentiments voiced, and fulfilled the hopes raised sixty years ago? Dr. Atma Ram had been too near the scene, and for too long a period, to speak with academic unconcern. There can, however, be little doubt that few industrial research laboratories in developing countries in the world today can stand comparison, in the quantum and calibre of contributions, at the national or international levels, with the CGCRI.



Reminiscences of Dr. Atma Ram, First Director, CGCRI (Abridged and edited from article published in Glass and Ceramics Bulletin, Vol. 23, No. 2, 1976, p. 72-85)


Science and Technology of Glass and Ceramics

The Phenomenal Beginning

The first **decade**

All round research activities were initiated in the first decade on raw materials for glass and ceramics industries. These included steatite porcelain, better glass saggars, ceramic colours, bonded mica products, cast iron enamels, foam glass, signal glasses, partial substitution of soda ash by Didwana sodium sulphate in glass manufacture, composition for glass electrodes, glass containers, standardization of glass raw materials and glassware, sand lime bricks, etc. Efforts were made to ascertain the possibility of making porcelain parts of automobile spark plugs. There were investigations on the manufacture of dental porcelain, alumina glasses, glass moulds of Indian and foreign make. A tilting furnace (250 1b capacity) had been ordered in order to try out castings of different compositions and textures suitable for glass moulds. Titania glasses were investigated with a view to improve the chemical durability of soda-lime glasses by replacing some of the alkali by titanium dioxide. Nine glasses containing up to eight per cent titania were melted and tested for chemical durability, thermal expansion and softening point. The glasses melted easily and showed improved durability.

Even with limited facilities of staff and equipments, the Institute began to render technical service to the industry. Investigations on the production of low-melting, black glass for the insulation of electric lamp caps were undertaken at the request of an industrial firm. Request for advice from private manufacturers on plant and lay-out of factories were received from private parties. A lathe useful for table-blowing of glass and manufacture of such articles as thermo flasks was designed and patented by the institute.

Green glasses developed at the institute had been subjected to rigorous tests and their suitability had been proved. Work on red signal glasses was being pursued, and it was hoped to send glasses for tests under service conditions. One dozen samples of green stepped lenses made at the institute were sent to the Government Inspector of Railways for use in railway yards. Samples of red lenses, using substitute for selenium as colourants, and samples of lunar white and colourless white stepped lenses were also prepared.

Trials on a number of electric furnaces, some of the resistance type, and one of globar type was carried out. Some of these were being assembled with suitable framework structures as permanent equipment of the Institute. One of the electric furnace units was designed specially for trials on foam glass. Corrosion on refractories due to the melting of salt cake containing glass batches was studied by using crucibles of different compositions. Testing of refractories brick was undertaken at the instance of the Inspector General of Stores (Navy), Government of India, for the determination of fusion point, refractoriness, under-load, spalling resistance, and permanent linear changes. Information in respect of refractory parts for glass furnaces, thermocouples and accessories and availability of raw materials for glass manufacturer, were supplied in response to enquiries. Work was undertaken to develop hot-face refractories from indigenous raw materials like high alumina clay and kyanite.

Eight new on-glaze colours of different shades of yellow, blue, green, red and red-brown were formulated and tested. These compared favorably with imported Blythe's colours. Colours already developed at the Institute and declared promising under plant trials by Messrs Bengal Potteries Ltd., Calcutta were produced in large quantities. Cast Iron enamels—a number of one-coat finished samples in black and green were prepared for replacement of imported enamel raw materials. Encouraging results were obtained in trial batches in which the conventional ingredients, *viz.*, cobalt oxide, cryolite and tin oxide, were replaced by easily available materials. Pressed hollow ware shapes, such as dishes, were enameled and tested for impact resistance, thermal shock resistance and acid resistance. Work on cobalt and boron free ground coat enamels were continued. Titania produced in India, though containing higher percentages of iron oxide, yielded results comparable with imported titanium oxide. A comparative study was made of imported pink enamels and the low-cost pink enamels developed at the Institute, in respect of colour characteristics, specular gloss and acid resistance.

A meeting of the Glass and Refractories Research Committee was held on February 26, 1952 at New Delhi. Dr. D N Wadia presided over the meeting. The Committee reviewed the progress of the survey of glass and ceramic raw materials undertaken by the Geological Survey of India. A large number of samples collected during the survey were selected for semi-commercial tests at the Institute. About seventy samples were found promising and investigations on them were continued. The Committee recommended that an interim report on the survey and on the results of the tests should be published. It reiterated the recommendation made by it previously that the production of optical glass should be undertaken in India for strategic reasons.

As a result of tests carried out by the Deputy Chief Engineer (Signals), East Indian Railway Calcutta, in the railway yards, and suggestions received

The Clay Laboratory

Pandit Jawaharlal Nehru with a research product

regarding the intensity of colour, light shades of red, blue and lunar white signal glasses were prepared. The possibility of using copper ruby glasses for making red bangles was explored. The Institute developed a process by which insulating bricks could be made from waste mica.

Tests for chemical durability of glasses were completed from the standpoint of screen analysis of powdered glass samples. Tests for alkali extraction on glass ampoules from neutral tubes produced by different firms in India were also carried out. A discussion on the suitability of glass containers produced in India for packing chemical, pharmaceutical, food and cosmetic preparations was held on May 5, 1952. It was suggested that imports of the bottles into the country should be stopped and the difficulties of the Indian Glass Industry should be removed so that the manufacturer of quality products could be facilitated. A Committee consisting of Dr. Atma Ram (Chairman), Shri K N Dasai, Shri Y P Varshney, Shri S P Sen, Shri Sisir Ghosh, Shri B Sircar, Shri B N Mitra, Dr. U P Basu, Dr. S N Ghosh, Dr. S Niyogi and Prof. M L Shroff (Members) – was appointed to examine the problems of glass containers and to recommend measures for improving the quality.

Glass and Refractory Research Committee of CSIR recommended a proposal for setting up of a unit pilot plant for the production of optical glass at CGCRI. The Governing Body of the Council accepted the proposal. The Institute submitted a budget to the government seeking a grant of Rs.5 lakhs towards capital outlay and Rs.2 lakhs towards recurring expenditure annually.

The Planning Commission then assigned the Institute the task of evolving necessary technology for the production of optical glass. After about eighteen months of systematic work on the choice of raw materials, design and fabrication of equipment and furnaces, a detailed study of pot making, working out different schedules of stirring and annealing, fixing up suitable compositions, the Institute was able to produce optical glass in 600 lb meltings. Prof. P. K. Kichlu, Professor of Experimental Laboratory, New Delhi and the Technical Development Establishment (TDE) of the Ministry of Defence, Dehradun examined the samples of optical glass and expressed their satisfaction. TDE, the biggest consumer of optical glass in the country certified the samples as 'A' grade.

Dental porcelain was not manufactured at that time in India and porcelain teeth, valued at Rs.10 to fifteen lakhs were annually imported. Investigation was started at the Institute on the production of dental porcelain using washed china clay, feldspar, quartz and nepheline syenite. Porcelain teeth of various shades were prepared.

Porcelain spark plugs with 95 per cent aluminium oxide body were made using calcined aluminium oxide manufactured at Muri (Bihar). The spark plugs were found to withstand a high torque value. These were fitted with metal parts fabricated in a factory of the Defence Department. Their performances were satisfactory under laboratory tests and arrangements were being made for conducting field trials.

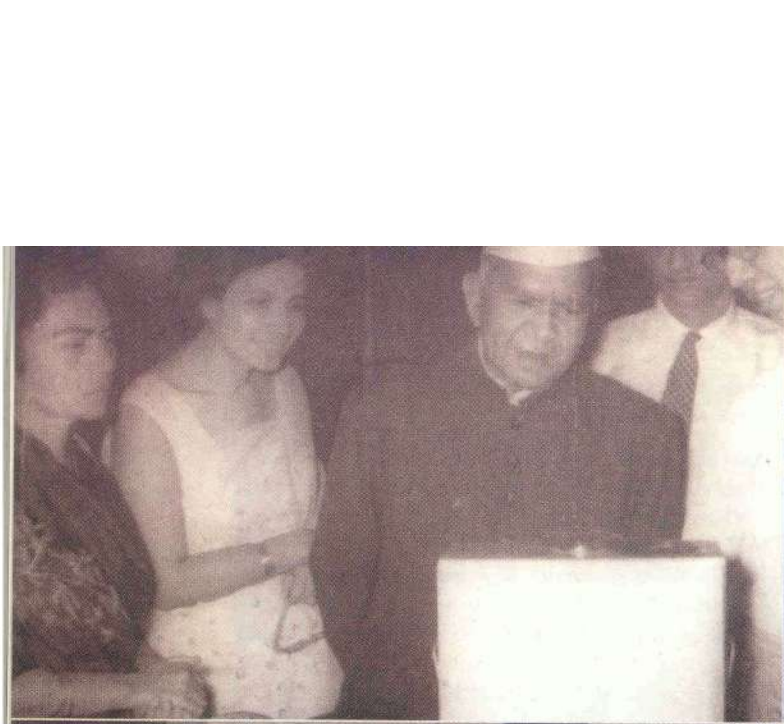
Boric oxide, in the form of borax or boric acid was hitherto considered to be an essential ingredient of commercial heat resistant glasses. As a result of the investigations carried out in the Institute, new types of glass compositions were developed, with or without boric oxide, which possessed the chemical durability expected of heat resistant glasses. These compositions could be melted within the temperature range usually employed for glasses containing boric oxide and worked to different shapes by colouring, pressing or drawing.

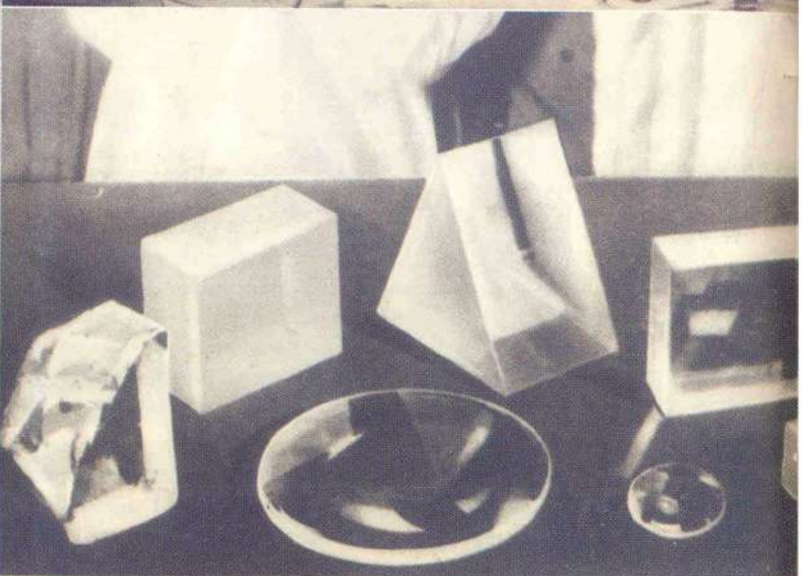
Another development concerned sun-glare glass. Tests conducted on grey sunglare glasses available in the local market proved that none of these conformed to the requirements demanded in a tropical country like India. The results of work carried out at the Institute then led to the development of a glass composition containing antimony and cerium which had better absorption characteristics than those of the best imported sun-glare glasses.

There were many more achievements. Some important dignitaries who visited the Institute highly appreciated the progress achieved. Shri Jawaharlal Nehru, the then Prime Minister of India, visited the Institute on January 2, 1952. He was accompanied by Dr. B. C. Roy, Shri C C Biswas, Dr. S. S. Bhatnagar and Prof. M. N. Saha. The Prime Minister was very much impressed by the work of the different sections. He was especially interested in the various stages in the manufacture of foam glass and signal glasses.

Maulana Abul Kalam Azad, Union Minister for Education and Natural Resources & Scientific Research and Vice-President, CSIR accompanied by Dr. S S Bhatnagar visited the Institute, on February 3, 1953. He was taken around the laboratory by Dr. Atma Ram, and shown the work in progress on glass bangles, substitutions of borax in the enamel industry, utilization of mica waste, foam glass and production of signal glasses for the railways. In a brief speech, the Minister observed that in pursuing scientific research for developing the resources of the country, the Institute was laying the foundation of a new India. He hoped that the Institute would bring new developments and added prosperity to the industry and the nation.

The Institute felt that generation of information is incomplete without proper dissemination and decided to publish a journal named the "Central Glass & Ceramic Research Institute Bulletin" which evolved into a globally esteemed journal in the latter years. Contributions came from all over the world.






Science and Technology of Glass and Ceramics

Reaching Out

The second **decade**

Some of the important achievements of the Institute were as follows. The Central Glass and Ceramic Research Institute conducted application-oriented and objective basic research on problems connected with glass, pottery, vitreous enamels, refractories and mica. Evaluation and beneficiation of indigenous ceramic raw materials, improving quality of glass and ceramic products, finding substitutes for imported raw materials and products, and developing indigenous know- remained the principal objectives. Special emphasis was laid on projects relating to import substitution and Defence requirements.

In regard to selection of problems, the policy of the Institute was to concentrate on a few items on priority basis rather than to spread its limited resources over a wide field. The modus operandi of selecting and tackling industrial problems was as follows:

- To invite suggestions from and to hold discussions with Industrialists, Manufacturers' Associations, Technologists and consumers regarding problems of the industry.
- To organise visits by members of the staff to factories and to invite factory technicians to the Institute.
- To arrange extensive factory trials on processes developed, (using as far as possible plant personnel), before these are passed on for adoption in manufacturing operations.

Achievements of the Institute

Some of the then important achievements of the Institute are as follows:

Development of processes and products of strategic and Defence use

Optical glass: A special assignment given to the Institute by the Planning Commission was to work out processes for the production of optical glass with a view to making the country independent of imports in respect of this vitally important strategic material. Optical glass was produced in only about half a dozen countries in the world and its technology of production was a carefully preserved secret. The Institute succeeded in establishing the details of manufacturing operations without assistance from any foreign manufacturing firm. All equipments and furnaces were designed and fabricated at the Institute, since the foreign manufacturers, for reasons of secrecy, did not sell such equipment or supply the designs.

The Institute's plant went into production in early 1961 and since then it has been meeting the entire requirements of defence establishments and optical instruments industry. In all, 25 varieties of optical glass have been developed on the basis of demand indicated by the principal consumers. The quality of glass is comparable to the best produced anywhere in the world.

Optical glass was supplied in the form of random slabs and moulded blanks and was used in the manufacture of microscopes, telescopes, interferometers, theodolites, cameras, binoculars, range finders, gun sights, directors, etc. The Institute's plant then supplied optical glass then worth over Rs. 20 lakhs to consumers. The successful completion of the project had not only relieved the country of continued dependence on imports in respect of such a strategic material but had also opened up new avenues for the development of optical instruments industry in the country.

Tank periscope prisms

An armoured tank is fitted with large-size periscopes to enable the commander, the gunner and the driver to observe the outside from inside the vehicle. The essential parts of a periscope are glass prisms whose demand increased severalfold since the establishment of indigenous production of armoured tanks after the foreign aggressions. A substantial portion of the current requirement of such prisms was supplied and steps were taken to increase production for meeting the growing demand.

Atomic radiation shielding windows: Polished and transparent glass slabs made from a special glass of very high lead content, capable of cutting off harmful atomic radiations, were used inflows in hot cells. Several dozen of such windows of up to 1 sqft area, which were previously imported, had been supplied to Bhabha Atomic Research Center, Trombay. For nuclear reactors, very large slabs of about 4 ft x 4 ft size were required. The technique of casting and annealing such slabs was worked out and a few slabs were made. A separate pilot plant for their production was set-up.

Special infra-red transmitting glass: This special type of glass cuts off visible light but allows invisible heat radiations to pass through it. It is required by the Defence Sector for use in vehicle headlamps and searchlights to locate enemy positions in darkness without being exposed to the enemy. The glass was developed at the Institute and being supplied to the Defence in the form of rolled discs and other shapes.

Synthetic quartz single crystals: Quartz is a vitally important material for the electronic industry. Quartz oscillators or resonators are extensively used in quick communication systems, radars, sonars, radio and television transmitters, *etc.* Single crystals of quartz required for these purposes should be free from twinning and other flaws. Natural resources of such crystals are confined to only a few countries like Brazil, Madagascar and USSR, there being no known workable deposit in India. In view of the strategic nature of the material, synthetic quartz crystals of fairly large size were developed at the Institute by using hydro-thermal technique. These were tested at Bharat Electronics Ltd and found satisfactory for electronic usage. The work was extended to pilot plant scale.

Glasses for glass-to-metal seals used in the electronic industry: Glasses for sealing to metals are required in large quantities for making electronic valves and other devices and were entirely imported. The problem was referred to the Institute by the Electronics Committee of the Government of India. Glasses suitable for sealing with Kovar alloy and Tungsten metal and for making compression seals were developed at the Institute. The glasses were found to be satisfactory on being tested at the Tata Institute of Fundamental Research and at the Central Electronics Research Institute and were being supplied to users.

High temperature protective enamels for aeroengine parts: At the instance of the Gas Turbine Research Establishment, Bangalore, investigations were undertaken to develop protective enamels for nimonic alloy parts of the jet exhaust system and for heat resistant steel parts (stator blades) of aircrafts. A few suitable vitreous enamel compositions were developed and some proved successful.

Import substitution The Institute worked out several substitutes for imported materials and chemicals, such as selenium-free red glass for bangles, boron-free enamels, antimony-free white enamels, lead and boron-free ceramic glazes for pottery, *etc.* Some of the important achievements relating to import substitution were as follows:

Heat insulating bricks from waste mica: An illustration of how, by proper utilization of science and technology, waste could be converted to wealth was provided by the work of the Institute on the development of mica bricks. During mining of mica, about 80 to 85 per cent of mica goes waste and disposal was a problem. The Institute developed a process for making heat insulating bricks from this waste material, leading to the establishment of an entirely new industry in the country. Three Indian firms took up the process developed at the Institute and are began manufacturing heat insulating mica bricks and shapes for steel plants, industrial furnaces, oil refineries, textile and paper mills, etc., as substitute for imported vermiculite bricks. By March 1967, Mica bricks worth Rs. 1.14 crores were manufactured and sold by these firms. Mica bricks of very low density and possessing good mechanical strength were developed. These were expected to replace imported diatomite bricks to be used in Bokaro Steel Plant and other industrial projects.

Opacifiers from indigenous zircon sand: Opacifiers for ceramic glazes used by the pottery industry were either imported or made from very costly and scarce tin oxide. The Institute developed similar opacifiers from indigenous zircon sand which were tried in two large pottery works and were found to be comparable in quality with the opacifiers made from imported materials. Factories then stopped using imported opacifiers and tin oxide.

Grinding wheels for safety razor blades: A process for the manufacture of grinding wheels for sharpening safety razor blades was developed at the Institute and was leased out to a firm which went into production. These grinding wheels were entirely imported and their indigenous production resulted in a saving of foreign exchange of about Rs. 3 lakhs per annum.

Glass enamels: These enamels were for marking glass apparatus, syringes and containers and for decorating tumblers and other glassware. Their demand, estimated at about Rs. 5 lakhs per annum, was so far then met mostly from imports.

The Institute developed suitable white and coloured compositions and the enamels were supplied to a number of parties including manufacturers of scientific glass apparatus and decorated glassware.

High-alumina refractories: Refractory bricks and shapes, containing 70 to 95 per cent alumina, were essential requirements of the steel industry. These were not manufactured in the country and the entire requirement was met from imports. A process was developed at the Institute for production of such bricks from entirely indigenous raw materials. Utilization of the process resulted in saving valuable foreign exchange and eliminating dependence on imports.

Autoclave plaster of Paris: The Institute developed a method for making hard, dense plaster of paris, which could be used as a substitute for the imported cementing material employed in high-tension switchgear industry and for the plaster used for making models and case moulds in the pottery industry. Bulk samples sent to the Heavy Electricals Ltd. Bhopal, were found to be satisfactory. The process was sent to the National Research Development (NRDC) Corporation for commercial utilization.

Glass and ceramic articles of special use: The' Institute has developed processes for the production of several special glass and ceramic articles hitherto imported, such as glass electrodes for *pH* meters, combustion boats, pure oxide refractories, pyrometer sheaths, refractory tubes and plates, glass melting crucibles, enamel stains, glass and ceramic colours, etc. Though of limited demand, these were indispensable, either as parts of essential equipment or as necessary ingredients, for certain industrial operations. For want of their ready availability within the country, serious difficulties were being experienced by the users, leading occasionally even to disruption of industrial production. With a view to rendering assistance in this regard, a special production cell was set up at the Institute in 1960 for production of these items.

The service was in the form of assistance to industry and processes were assigned to parties as soon as they come forward to undertake production. Some of the items were assigned to the industry for commercial production. The annual sale of such special items to steel plants, defence establishments, research laboratories and industry during 1967-68 was Rs. 1.548 lakhs, the total sales amounted to Rs. 7.863 lakhs.

New processes and products of special use

The Institute developed several new processes and specialized products *viz.* chemical porcelain, signal glasses, hot face insulation refractories, wet ground mica, glass electrodes for *pH* meters, enamel-coated resistors, etc, which were assigned to industry for commercial utilization. A few important developments are given below:

Foam glass: The Institute developed a novel heat insulating material from glass which was as light as cork and had the capability to float on water. Called 'Foam Glass' or 'Multicellular Glass', it is an efficient low-temperature thermal insulating material with the added advantage that it does not absorb moisture. It was rigid, fire-proof and rot-proof. It also remained unaffected by common acids and acid fumes. Because of these properties, it retained its insulating properties almost indefinitely and was, therefore, much superior to most insulating materials on the market. Foam glass finds extensive application in petrochemical and fertilizer industries, cold storage, air-conditioning of buildings as well as for thermal insulation of hot and cold pipes, storage tanks, *etc.*

The process of its production, was kept secret by the few countries in which it was produced. It was successfully worked out at CGCRI utilizing indigenous raw materials. The party to whom the process was assigned failed to organise efficient production in time, and so N.R.D.C. made arrangements for a fresh assignment of the process for commercial production.

Developed at the Institute which, after being given certain thermo-chemical surface treatment, develops high resistance towards thermal shock and chemical attack. The treated glass compares favourably with conventional boro-silicate glasses (Pyrex type) which require a temperature of 1600° to melt and are very expensive. The process was found to be suitable for making laboratory glassware, ovenware, lantern chimneys and other articles which were subjected to chemical attack as well as mechanical and thermal shocks during use. The technique of chemical toughening is fairly simple and could be adopted by the existing units producing common soda-lime glassware.

Chemically toughened glass: A special boron-free alumino-silicate glass, melting at around 1450°, developed at the Institute which, after being given certain thermo-chemical surface treatment, develops high resistance towards thermal shock and chemical attack. The treated glass compares favourably with conventional boro-silicate glasses (Pyrex type) which require a temperature of 1600° to melt and were very expensive. The process was found to be suitable for making laboratory glassware, ovenware, lantern chimneys and other articles which are subjected to chemical attack as well as mechanical and thermal shocks during use. The technique of chemical toughening was fairly simple and could be adopted by the existing units producing common soda-lime glassware.

Ceramized glasses as cutting tools: Ceramized glasses made by controlled crystallization of glass possess unusual mechanical and thermal properties. Some glass-ceramic compositions studied at the Institute were found to have very high strength and hardness. To explore the possibility of their use in making tungsten carbide type cutting tools, samples in the form of tool bits were being studied.

Standard strain discs: Standard main discs used for determining the quartz annealing in glassware were so far entirely imported. The discs then developed at the Institute and were made available to Indian glass industry. This helped the industry in improving the quality of glassware besides saving foreign exchange of Rs. 1000/- per set of discs.

Mica grading apparatus: Mica is a sizeable export earner for the country. It is usually graded arbitrarily on the basis of colour and other visual characteristics. Researches carried out at the CGCRI have established the advisability of grading mica on the basis of electrical properties. A handy apparatus for rapid evaluation of the quality of mica on the basis of electrical properties was developed at the Institute. Mica, rejected or downgraded on visual examination, proved on many occasions with the help of this instrument to be actually of superior quality. The use of the apparatus has resulted in saving of considerable amount of foreign exchange by minimizing rejection or downgrading of exportable mica. The utility of the apparatus, now being produced at the Institute, was appreciated by mica producers and exporters.

Evaluation, beneficiation and utilization of glass and ceramic raw materials

Systematic and comprehensive work on the availability and evaluation of raw materials for glass and ceramic industries are continuing activities of the Institute. Under this programme, clays, glass sands, quartz, limestones, magne-sites, chrome ores, kyanite, diaspore, *etc.* were evaluated with a view to determining their suitability for use in the industry. Methods of evaluating and upgrading the raw materials were also worked out.

Decolourisation of clays: Good quality white china clays required by the pottery, paper, rubber, textile and cosmetics industries are scarce in India and considerable quantity of such clays have to be imported, CGCRI developed a process for decolourisation of off-coloured clays, abundantly available in the country. The decolourised clays were used as substitutes for imported white china clays. An Indian firm took up the process for commercial utilization.

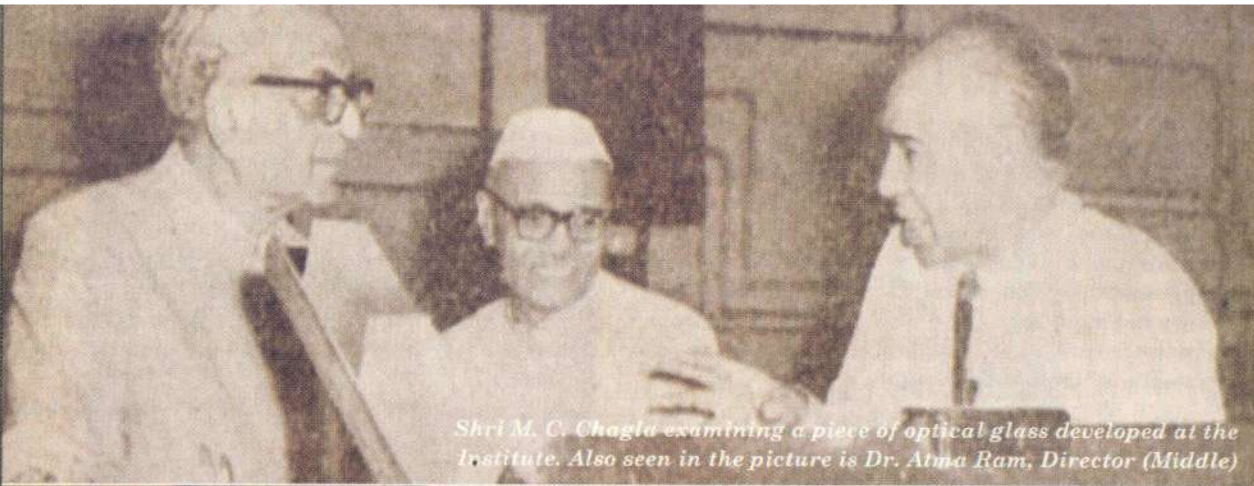
Improvement in quality

For several years the CGCRI did, on priority basis, considerable amount of work on improvement of indigenous glass and ceramic products.

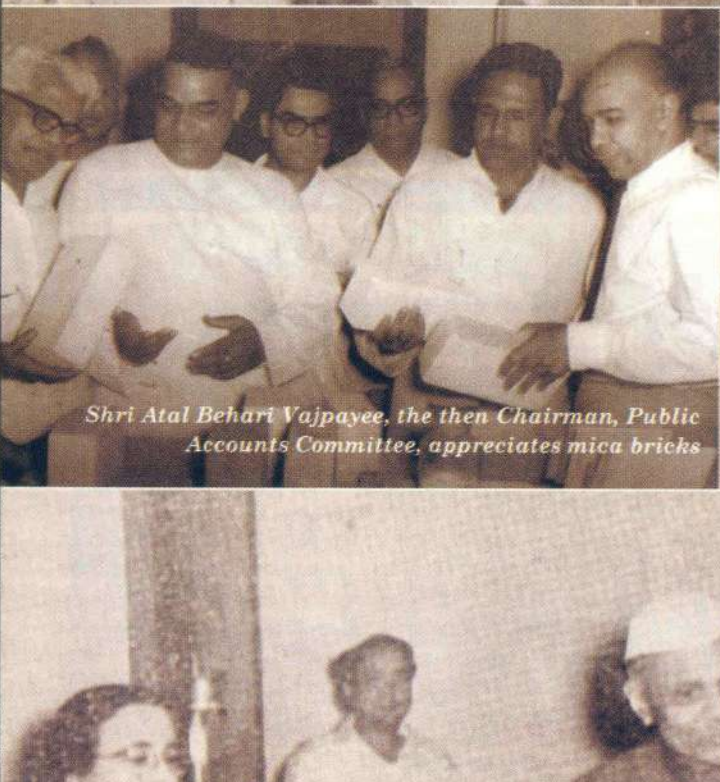
Some of the important investigations of direct use to the industry were on (i)working out suitable glass compositions and specifications for containers required for pharmaceutical preparations, inks, distilled water, mineral water and aerated beverages, preserved fruits, milk, beer, etc. (ii) saggars and plaster of paris for pottery industry (iii) improving the quality of sanitaryware and tiles, and (iv) steel plant refractories.

Project for BARC to develop vitreous matrices suitable for containment of high level nuclear wastes

At the instance of the Bhabha Atomic Research Center, the Institute undertook a project in 1965 to develop vitreous matrices suitable for containment of high level nuclear wastes Generated at Tarapur and Ranapratapsagar fuel reprocessing wastes, to find solutions to the volatilization of ruthenium and caesium which occurs in the form of gases during the melting of glass and contaminates the atmosphere, as well as to find out the effect of heat on glasses during storage. Several vitreous matrices developed at the Institute could be processed at temperatures varying from 900^{0}C to 1100^{0}C in stainless steel pots. When boiling water was allowed to flow on the glasses, toxic fission products like 90Sr released from the glass to the water was of the order of 10–12 g/cm2/ml water. If the water was at ambient temperature then the

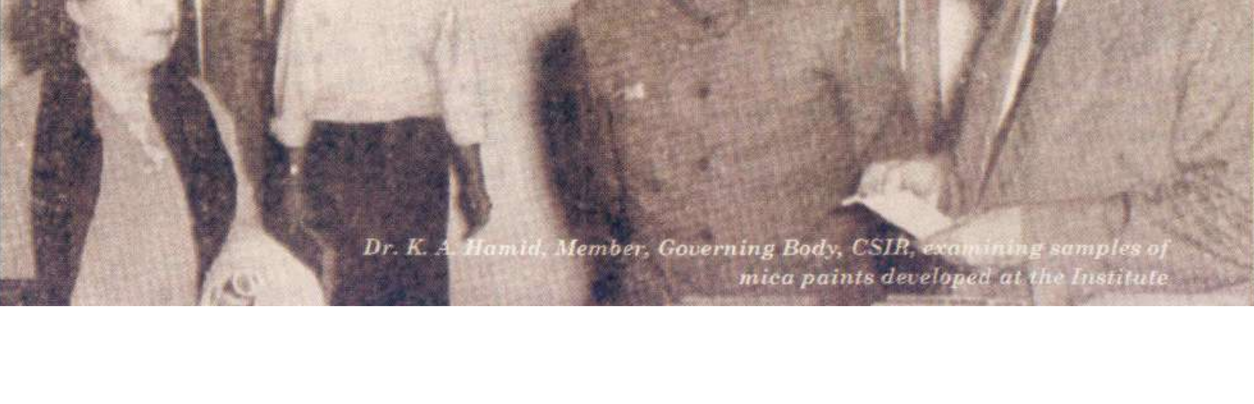


Shri M. C. Chagla examining a piece of optical glass developed at the Institute. Also seen in the picture is Dr. Atma Ram, Director (Middle)



Shri Atal Behari Vajpayee, the then Chairman, Public Accounts Committee, appreciates mica bricks

Dr. Atma Ram with Prof. W. E. S. Turner, F. R. S., Department of Glass Technology, Sheffeld

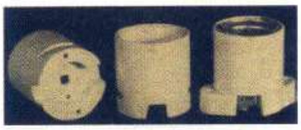


Dr. K. A. Hamid, Member, Governing Body, CSIR, examining samples of mica paints developed at the Institute release of the isotope was decreased by another factor of 100. These glasses were also stable under heat and radiation. Some of the vitreous matrices developed at Institute were tried at BARC in pot melting trials and were found to be suitable as far as their processing characteristics, corrosion towards melter pot and durabilities were concerned. BARC set up a waste immobilization plant at Tarapur on the basis of results achieved at the Institute.

Although several countries were working on fixation of nuclear wastes in glass, India was the first country that successfully planned a full-scale plant for this purpose. This achievement became possible because of the very close collaboration between BARC and CGCRI.

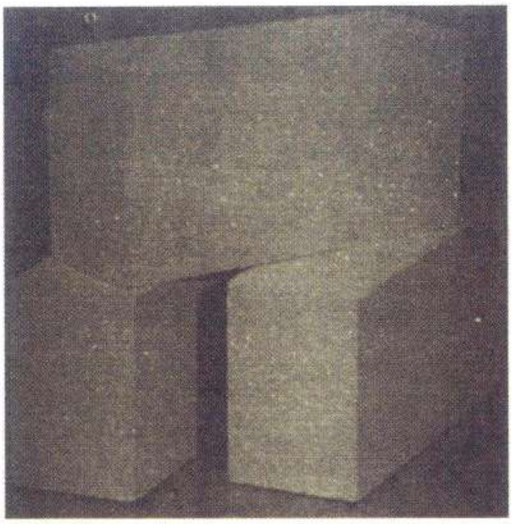
Fundamental research

Among the fields of fundamental research pursued at the Institute, special mention may be made of: the origin of colour in copper-red glass, mineralogical studies on clays, nucleation and crystalisation of glasses, fixation of high level atomic wastes in glass, introduction of polarographic technique in the analysis of silicates, reactivity of inorganic materials, thermal conductivity of low conductive materials, and phase equilibrium studies in systems containing beryllia, alumina, silica and water.



Porcelain bulb sockets

Ceramic spacers for use in electronic equipment. Top and bottom rows show metallized spacers



Low density heat insulating mica bricks

Visit of Dignitaries

Shri M. C. Chagla, Minister of Education and Vice-President, CSIR visited the Institute on July 11, 1966 and addressed the staff.

He expressed his happiness on meeting the scientists of the Institute and referred in eulogistic terms to the Institute as being unique in that it had produced optical glass using indigenous technology through collaboration of Indian scientists. On this occasion the Vice-President announced the appointment of Dr. Atma Ram as Director-General to lead the scientists in all CSIR laboratories across India.

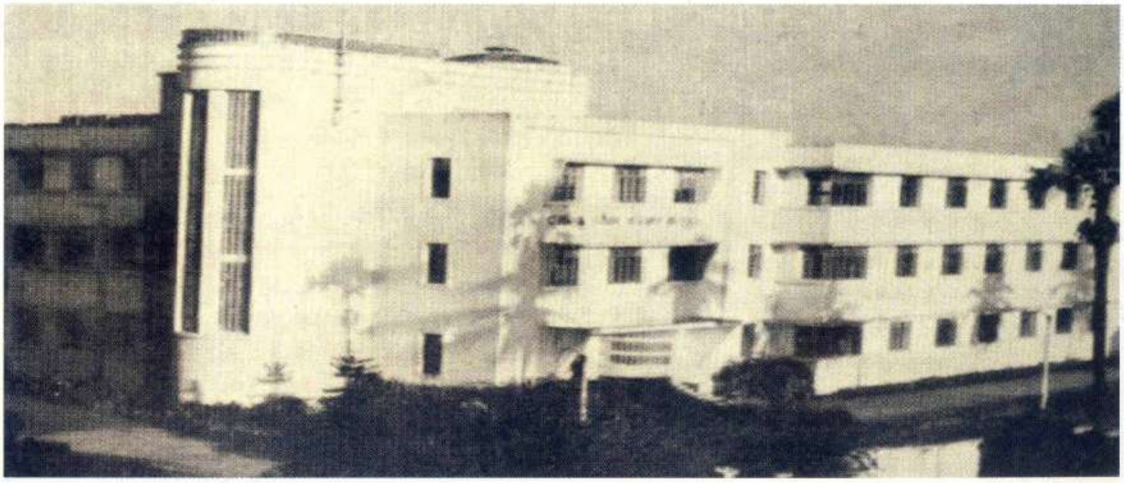
The Vice-President, CSIR, Shri Fakhruddin Ali Ahmed visited the Institute on February 24, 1967 and addressed the staff.

Prof. W. E. S. Turner, F. R. S., Department of Glass Technology, Sheffeld, UK had commended the work of the CGCRI, Calcutta, in an article published in Glass Technology (Vol. 2 No. 2, April 1961). He wrote - "This Research Institute has achieved an outstanding reputation for the quality and variety of its work amongst the industrial research institutes established by the Government of India. Its annual reports for several years past have disclosed activities in various field of glass and ceramics, which have greatly stimulated these industries."

Special mention had been made in the article about the success achieved by the Institute in the production of optical glass, development of laboratory porcelain, and surveys of sands suitable for glass making and Indian clays for refractory materials.

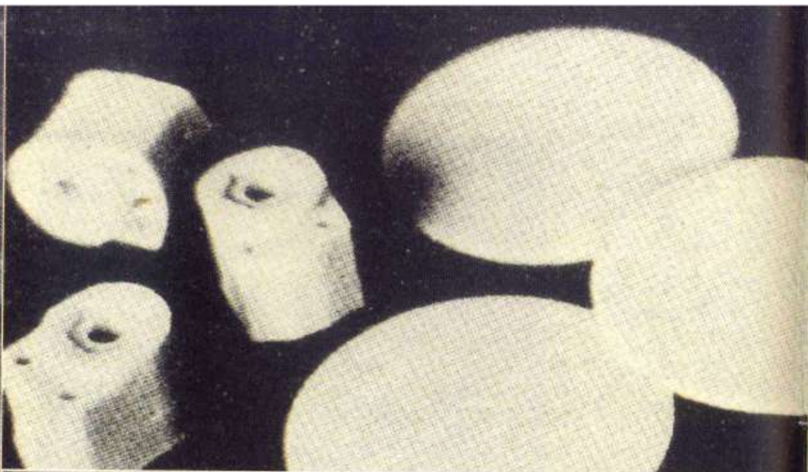
Shri K. D. Sharma was appointed as Director of the Institute on May 1, 1967

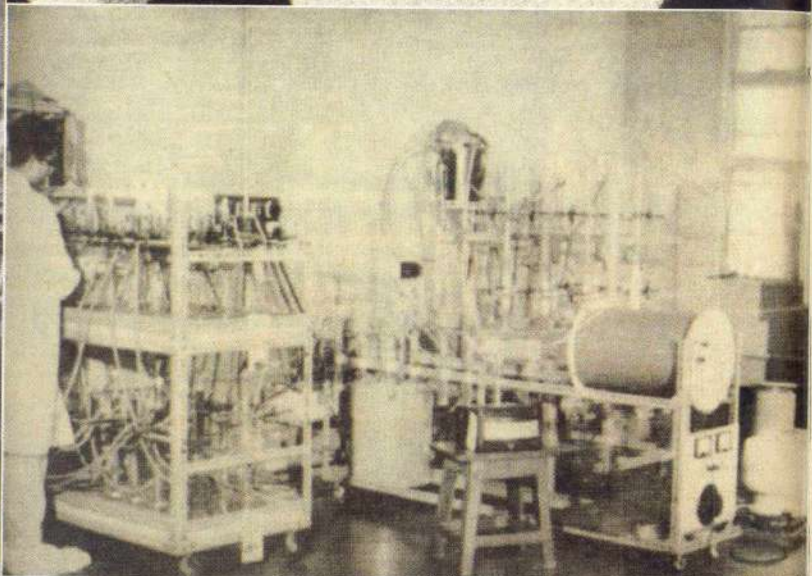
Shri Kapil Dev Sharma
Director, CGCRI
(May 1, 1967 - July 31, 1980)

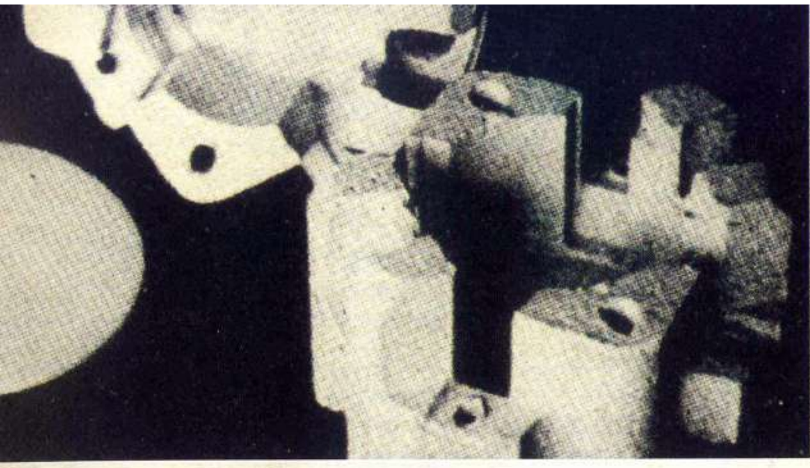


CGCRI Building in 1960's


OPTICAL G

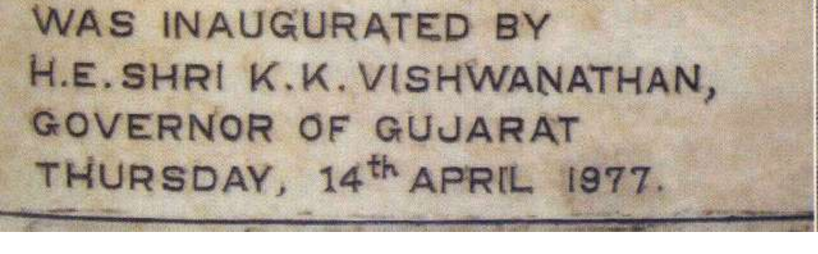






Science and Technology of Glass and Ceramics

Coming of Age



The third **decade**

This was the decade that celebrated Silver Jubilee of the Institute. Silver Jubilee celebration was held not only to mark the 25th anniversary of the Institute, but also to signify the coming of age and maturity of the Institute and to pass the torch to another generation. Shri Siddartha Shankar Roy, Chief Minister of West Bengal, inaugurated the event held from March 12-15, 1976. The then Prime Minister of India and the President of CSIR, Smt. Indira Gandhi, in her message of felicitation to the Institute stated "Glass has a multitude of uses ranging from the kitchen to the most sophisticated of scientific instruments. Deeper know-how of glass and ceramic technology is indispensable for progress. The career of the Central Glass and Ceramic Research Institute in Calcutta has been useful. The Institute has several achievements to its credit, especially the development of optical glass and of laser glass. The Institute's work has saved us resources which would have otherwise gone into imports.----"

Here is the details of the activities and progress of the Institute in the words of the then Director, Shri K. D. Sharma.

"At the time of the establishment of the Institute, the modern glass and ceramic industry was still in its infancy in India. The industry, which had prospered during the war years due to absence of competition from Japan and the European countries, consisted mostly of a large number of small units employing semi-automatic or manual methods' of production. In fact, the first fully automatic container glass plant had been set up only in 1949 and there were only two or three medium scale modern pottery units. The refractories industry was better established, mostly near the coalfields of Bihar and Bengal, to cater to the requirements of steel plants and. other industries, like cement and glass.

Survey and evaluation of raw materials

With the commencement of the five-year development plans in early fifties, the industry started expanding on modern lines and several new glass and ceramic units came up in different regions of the country. However, paucity of information regarding the occurrence and quality of raw materials - an essential prerequisite for the location of new factories - proved a great handicap. The Institute, therefore, took upon itself the task of collecting authentic information about locally occurring glass and ceramic raw materials and, in collaboration with Geological Survey of India; Directorates of Mining and Geology of various States and the industry, evaluated more than 1500 samples of clays, sands, quartz, quartzite, bentonite, diaspore, kyanite, magnesite and other raw materials for their quality and amenability to beneficiation. Of particular importance is the extensive survey carried out on glass sands and clays occurring in the various States, beneficiation of plastic clays as substitute for imported ball clay, decolourisation of offcoloured clays, utilisation of diaspore in making high alumina refractories and detailed evaluation of Almora magnesite.

Import substitution and development of sear, new products and processes

In the field of import substitution, the Institute developed boron-free enamels, signal glasses for railways, chemical porcelain, ceramic components of automobile spark plugs, hot-face insulation bricks, selenium-free red glass for bangles, lead and boron-free glazes, glasses for glass-to- metal seals, glass electrodes for *pH* meters, partial substitution of cobalt oxide in making blue coloured bottles, autoclave plaster of Paris and lithium chemicals from indigenous lepidolite.

Of major economic importance is the work on the development of heat insulating bricks from waste mica as a substitute for imported diatomite product. Mica bricks and shapes worth about Rs 2 crores have so far been marketed by Bhupal Mining Works and Bajrang Mica Company, licensees of the process. Foam glass, another thermal insulating material, particularly suitable for low temperature usage, was also developed, for which a commercial plant of one lakh cubic feet capacity is being set up in Kerala. A noteworthy achievement has been the development of opacifiers for ceramic glazes in from indigenous zircon sand. These opacifiers have now been adopted by almost all ceramic factories, resulting in a saving of about Rs 10 lakhs annually in foreign exchange. The cost of opaque glazes used by village potters for red clay pottery was also reduced to less than one third by using indigenous opacifier and reducing' the lead content of glaze. The results have been successfully utilized by the All India Handicrafts Board.

Ceramic water filter candles suitable for obtaining bacteria-free drinking water, developed at the Institute, have recently gone into commercial production. These will replace 'Sterasyl' and 'Katadyn' type candles imported at a cost of Rs 10 to 15 lakhs annually. In the last few years, the Institute also manufactured several hitherto imported ceramic items, valued at over Rs 12 lakhs, and supplied these to defence establishments, research institutes, steel plants and other consumers.

Glass-bonded mica is an inorganic insulating material particularly suitable for service conditions requiring high dielectric strength, close, dimensional tolerance and intricate shapes. The important applications of the material are for insulating metallic supports of traction motors, for which investigations are in progress in collaboration with Chittaranjan Locomotive Works, and for making lightning arrestor gap Plates. Processes for the manufacture of glass-bonded mica; low impedance glass electrodes for use in *pH* meters, suitable for the entire *pH* range of 0 to 14; sodium and potassium ion electrodes; inorganic-bonded commutator type micanite, and glass-ceramic material for industrial jewels and thread guides have recently been assigned to NRDC for commercial utilisation.

A process for the manufacture of highly abrasion resistant glass-ceramic tiles for lining chutes of coke ovens has been released to Garden Reach Workshops Ltd and a process for the production of bloating type refractories from ordinary clays for use as ladle bricks, nozzles and stopper heads in casting pits of steel plants has recently been assigned to Kumardhubi Fireclay and Silica Works Ltd. Casting pit refractories constitute about 40 per cent of the total fireclay refratories consumed in an integrated steel plant and their value runs into several crores of rupees.

A significant achievement of the Institute is the development of a process for fixing high level atomic wastes in a chemically durable low -temperature melting glass. The project, taken up at the instance of BARC, has been successfully completed for containment of atomic wastes from Tarapur and Maharana Pratapsagar nuclear power plants. Based on the results achieved, a plant for the ultimate disposal of such wastes is being set up by BARC at an estimated cost of about Rs 4 crores.

CGCRI in the service of Defense

The Institute has played a significant role in attaining self-sufficiency in several strategic materials required by defence, particularly optical glass, laser glass, infra-red transmitting filters, synthetic quartz single crystals, 'Katadyn' type water filter candles, and high temperature protective enamels for aeroengine and rocket motor components.

Optical glass is produced in only a few countries of the world and its technology of production is kept a closely guarded secret. The Institute succeeded in establishing all details of the manufacturing operations without any foreign collaboration and has so far supplied optical glass in 30 varieties, valued at nearly Rs 70 lakhs, to defence establishments and optical instrument manufacturers. The process has recently been released to Bharat Ophthalmic Glass Limited - a Government of India undertaking, which has already commenced commercial production of optical glass and tank periscope prisms. With this development there is now adequate indigenous production capacity to meet the country's entire demand for optical glass.

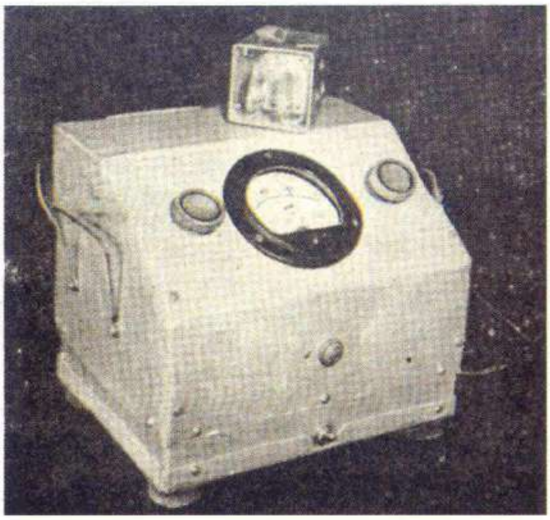
The Institute has also developed special infrared transmitting glass and arsenic trisulphide filters to meet defence requirements. It has also supplied radiation shielding windows worth over Rs 10 lakhs to BARC for use in hot cells. A recent outstanding achievement is the development of neodymium-doped laser glass rods required for making the latest types of range finders of 5 to 10 km range. The annual requirement is estimated at 500 laser rods valued at over Rs 10 lakhs.

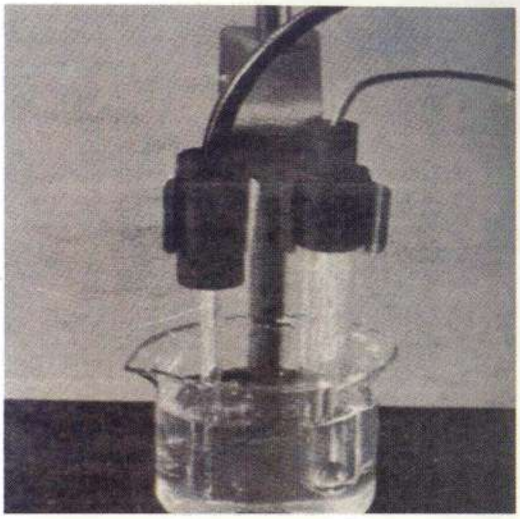
To meet strategic need of the electronic industry, flawless quartz single crystals of 15 to 20 cm size have been successfully developed using the hydrothermal technique employing 150 cm long autoclaves. It is now proposed to scale up the process to 300 cm long autoclaves with the financial participation of NRDC and Kerala State Electronic Development Corporation. The Institute is also working on the development of single crystals of yttrium iron garnet and mixed rare earth garnets, glass ceramic printed circuit boards, high purity electronic grade alumina, and inks and pastes for thick films.

The above describes very briefly some of the important achievements of the Institute in the field of applied research. Individual papers giving details of some of the processes developed and their socio-economic importance are being published. A paper highlighting the fundamental research carried out at the Institute is presented separately. In the selection of problems for fundamental study, care has been taken to see for that they have a bearing on the subjects of study at the Institute, *ie*, what one might call objective basic research".

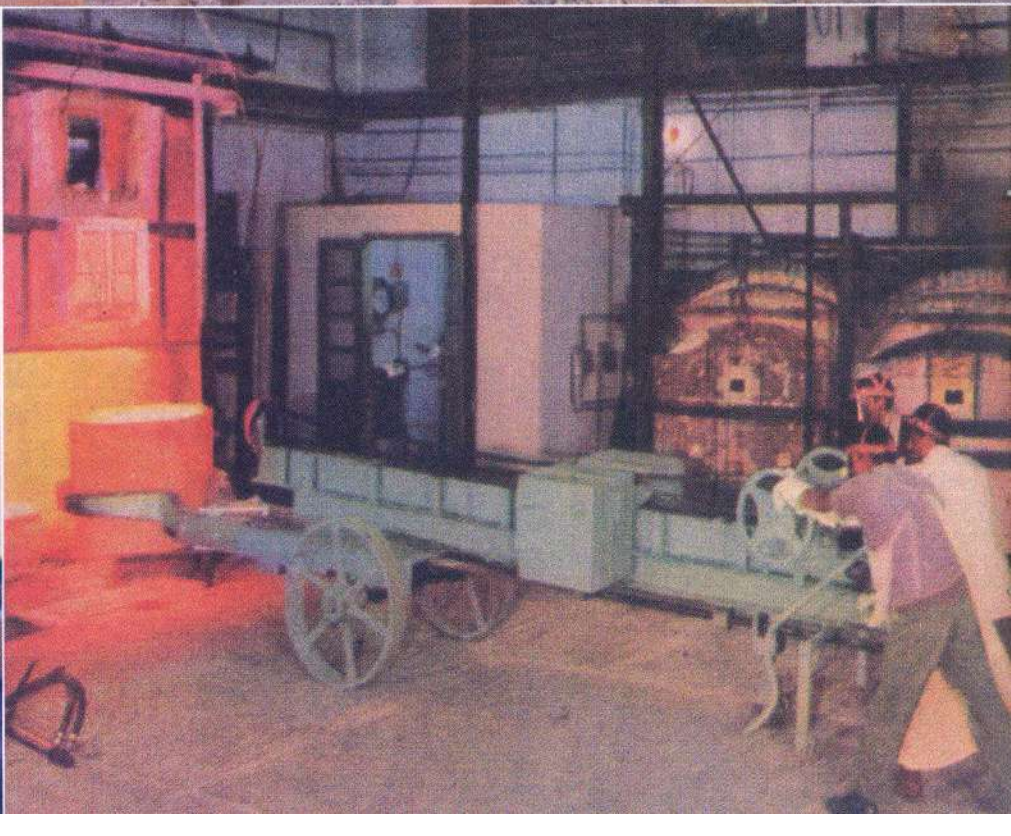
Establishment of Naroda Center, CGCRI

The Extension Center of the Central Glass & Ceramic Research Institute, Kolkata was established at Naroda, Ahmedabad by the Council of Scientific and Industrial Research (CSIR), New Delhi, on the behest of Govt of Gujarat with a view to make available R&D for product development, testing and characterisation facilities, conducting training & demonstration activities in traditional ceramics for the benefit of ceramic industries in Gujarat and elsewhere in the country.


Dryness tester


Sodium ion glass electrodes


Testing of abrasion resistance of mica paints



Science and Technology of Glass and Ceramics

Emerging Years

The fourth **decade**

By this time, the Institute had blossomed and its R&D efforts were geared towards meeting the national needs and priorities. Due emphasis was given to developing technologies in the emerging areas as well as for development of the rural areas through utilization of local skills and other resources.

Dr. S. Kumar took over as Director

Dr. Sachchidananda Kumar took over the charge of the Institute as Director on October 29, 1981.

The Institute's R&D programme continued to place emphasis on meeting the identified needs of the country mainly through evaluation and utilization of natural resources, development of special materials for steel, engineering and electronic industries, defence and atomic energy, development of new process, improvement in quality and reduction in cost of production, import substitution, technical assistance to industry and public sector undertakings and economizing the fuel consumption. The needs of the small scale glass and ceramic industries were given special attention. Special emphasis was also laid conservation of energy through an integrated, multi-disciplinary approach.

Dr. Sachchidananda Kumar

Director, CGCRI (Oct 29, 1981 - Aug 31, 1988)

A magnet levitating over a ceramic superconductor

The Institute started vigorous work in many more areas: synthetic mullite and mullite corundum refractories (Pilot scale production), high temperature protective enamels for jet-aeroengine components, appropriate technology for production of fiber glass in small scale sector, sol-gel processing, fiber optics, bioglasses/glass-ceramics for prosthetic application and hip joint prosthesis.

Some of the notable work carried out during the decade are mentioned below

Ceramic superconductor wire and foil was fabricated at the Institute using electrophoretic deposition technique that formed good adherent coatings of superconductor over metal wires and foils. The coating thickness was 50-100 μm and Tc was around 90 K. Though the current density was not too high, there was considerable scope for its improvement.

Sol-gel Processing

By the end of the decade, the Institute built up expertise in the use of sol-gel processing technique in the area of glass and ceramics. The sol-gel route successfully employed in producing antireflective coatings on radiation shielding window (RSW) glass blocks as well as a near neutral optical coatings on glass for anti-glare applications. The technology that was quite new in the country then.

Optical Communication Fibers

Several runs were carried out during the period for making multi-mode graded index performs as well as single mode performs for producing communication fibers. Fibers were drawn from the performs through arrangements with research laboratories abroad and some characterization data were also obtained from them. The communication fibers drawing system was also installed. Facilities for optical characterization of communication fibers were organized.

Laser Glass

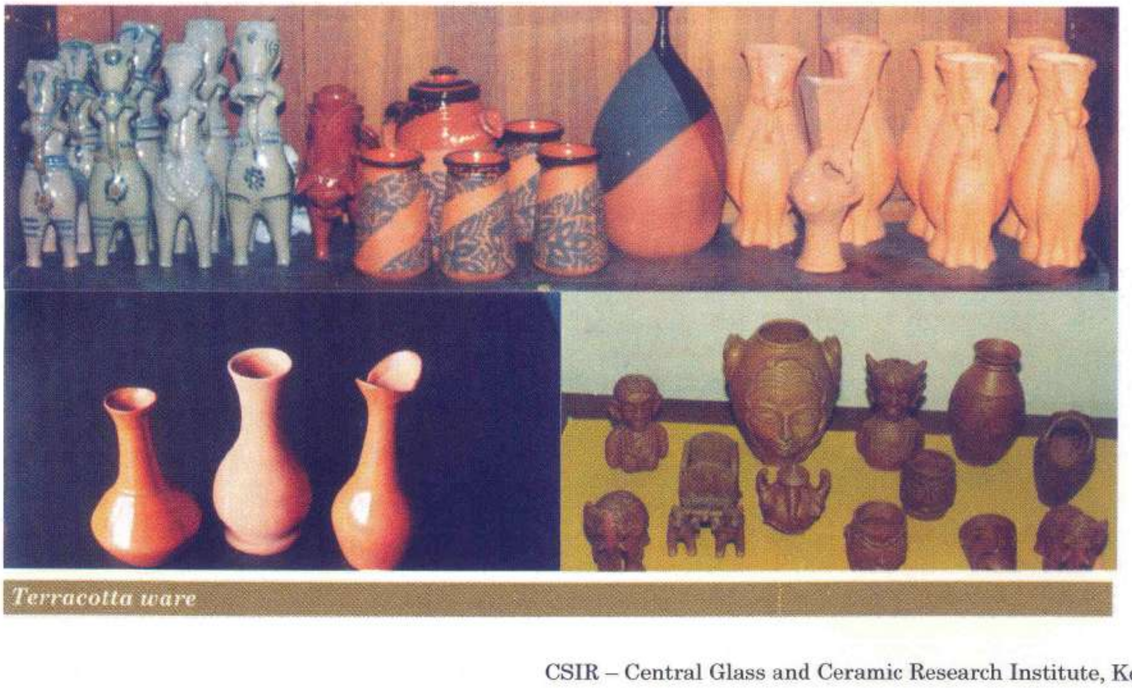
Two types of laser glasses (Neodymium doped) developed by the Institute and were supplied to the Defence Sector. The Institute was also then engaged in the development and trial production of large laser glass discs and rods required by the Department of Atomic Energy (DAE) for their high power laser system.

Alumina Ceramics

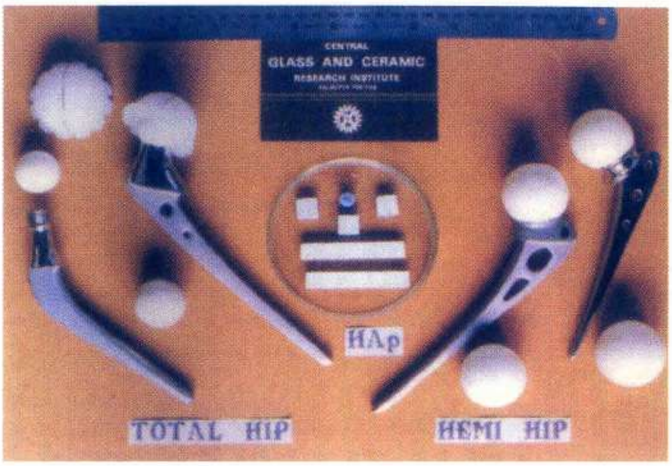
Alumina ceramics find a number of applications in the fields of engineering and electronics because of high mechanical strength, refractoriness, chemical resistance and excellent electrical properties. The Institute developed four compositions of alumina ceramics to cover the entire range of applications, in engineering and electronics industries as well as in nuclear technology.

Non-oxide Ceramics

Non-oxide ceramics like reaction bonded silicon nitride and nitride bonded silicon carbide are used as refractory materials in non-ferrous and ferrous metallurgy as well as for producing various items for engineering applications. The Institute developed reaction bonded silicon nitride for use in non-ferrous



Terracotta ware



Bioceramic prostheses

Raw materials for making GRG boards, finished and unfinished products

metallurgy and also for producing various engineering items like welding nozzles, pump seals, etc.

Bioglasses/Glass-Ceramics

In 1986, the Institute initiated research activities on Bioglasses/Glass-ceramics for Prosthetic application. The societal impact of the activities went very far. Though a new division to start activities exclusively for development of different types of innovative biomaterials, implants, devices ,etc. for innumerable number of ailing population in the country within a limited budget had started from the dawn of the New Millenium, most of the state of art prostheses and devices were out of reach because of exorbitant cost. Further, these items developed in the advanced countries did not suit our purpose due to the anatomical diversity and the difference in lifestyle between the patients of third world and the first world. In addition, some diseases that commonly occur in Indian patients do not show up in the western worlds and therefore specific innovative biomaterials/implants/devices were needed to be developed in our country.

Glass Reinforced Gypsum

The Institute developed Glass Reinforced Gypsum (GRG), a low cost composite material, which could be used as a substitute of wood. The material was particularly suitable for cheap housing schemes. The material was made by uniform spraying of gypsum and chopped glass fiber on a flat-bottomed mould of suitable dimension. The sprayed mass remained till it formed a solid board. Then, it was demoulded, dried and trimmed to requisite sizes.

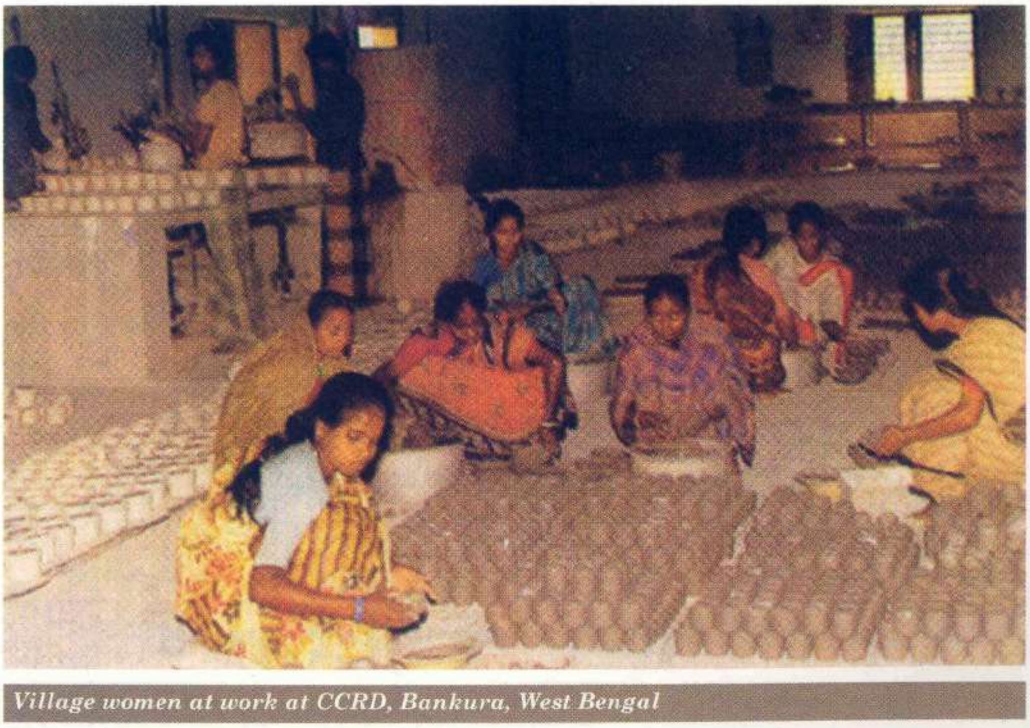
Besides, activities like consultancy, planning, transfer of technology, dissemination of information, training, reprographic services, analysis and testing of raw materials and finished products were also carried out.

Establishment of Khurja Center, CGCRI and Its activities

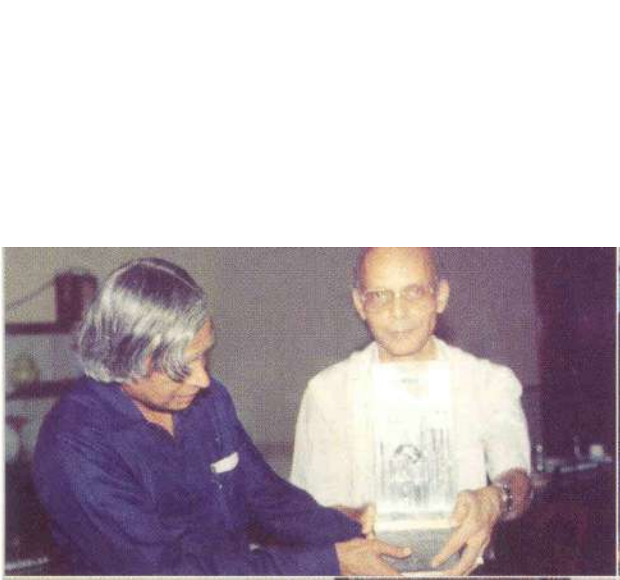
Khurja having a 600 year old tradition of pottery manufacturing was a center of Ceramic Industry having more than 494 units in the small-scale sector

Prof. Nurul Hasan, the then Governor of West Bengal at CCRD

Shri Jyoti Basu, Chief Minister of West Bengal inaugurates the CCRD



Village women at work at CCRD, Bankura, West Bengal












A. P. J. Abdul Kalam Chairman, Research Council (1988 - 1992) and is still one of the largest whiteware clusters in India. A second outreach center at Khurja, near Delhi, a small Town in the Bulandshahar District of Western Uttar Pradesh, was formally inaugurated by Shri N. D. Tiwari, Union Minister of Industry on May 3, 1986, though the Center had started functioning from 1982. Technical Back-up Support Unit was set up at Khurja Center under the National Programme on Improved Chulha. The programme was launched in December 1983 by the Department of Non-Conventional Energy Sources to introduce improved smokeless chulhas in the rural areas with a view to achieving forest and energy conservation and an overall improvement in the quality of life in the rural areas. The objective of the Unit was to carry out R&D work on ceramic liners as well as for imparting training and arranging demonstration programmes on the improved materials.

Optical communication fiber in use at Malkera Colliery, Dhanbad

(Sitting from left: Dr. B. K. Sarkar, Former-Director, CGCRI; President, Universal Cable Limited; Dr. P. K. Sengupta, Vice President, Universal Cable Limited and Dr. P. Saha, Former-Head, Fiber Optics Division, CGCRI)

This Center of CGCRI contributed to a great extent in the modernization and all round Development of Ceramic Industries in Khurja on energy efficiency & cluster development. In this decade, the Center worked on Low Temperature Maturing Glazed Potterywares, Sanitaryware for rural sanitation, Unglazed flooring tiles for housing, Unglazed facing tiles for housing; Single fired fatt glazed ceramic tiles for flooring/facing

Ceramic Center for Rural Development

One of the most important progresses happened in this decade in respect of societal mission that Institute took up for development of low cost ceramic products for housing, sanitation and drinking water

cgcri newsletter

CENTRAL GLASS AND CERAMIC RESEARCH INSTITUTE CALCUTTA-700 032

Vol. 1, No. 1 April-June 1988

Director's Message :

Dear Colleague,

It is with great pleasure that I place the first issue of the CGCRI Newsletter before you.

The Central Glass and Ceramic Research Institute is India's premier research institution in the field of glass and ceramics. It is concerned with the development of technologies relevant to the country's needs, optimum utilisation of indigenous resources, recycling of wastes as well as basic research in the related fields.

In recent times, phenomenal advances have been made in the field of ceramics and an entirely new range of products is coming up. Keeping these in view and also the needs of the country, the Institute formulates its activities accordingly. Needless to say that communication plays a vital role in achieving our goals. This newsletter will serve the useful purpose of keeping people informed about these and also about other activities and achievements of the Institute. It will thus fulfil the long felt need for communication both within and outside the CGCRI.

I wish the new venture all success.

Yours sincerely,
S. Kumar
Director

First Issue of CGCRI Newsletter

supply. In this connection a model Ceramic Center for Rural Development was set up at Panchmura, Bankura, West Bengal in collaboration with the Government of West Bengal and CAPART (Council for Advancement of People's Action and Rural Technology), New Delhi. The Center was expected to help the rural potters in diversification of their products. Thirty-three artisans were trained for a period of six months.

Prof. Nurul Hassan, Hon'ble Governor, West Bengal visited the Ceramic Center for Rural Development (CCRD) on January 11, 1988 before its formal inauguration. The Center was handed over to Zilla Parishad, Bankura with effect from September 1, 1988. Late Shri Jyoti Basu, then Chief Minister of West Bengal inaugurated the Center on 31st December, 1989.

Two more sponsored projects on utilization of Low thermal mass furnace for energy saving in pottery were completed. The projects were sponsored by Government Pottery Center, Chunar, U.P. and SISI, Baranagar, Calcutta, respectively.

Use of optical fiber in communication

The Institute along with CMRS successfully installed an optical fiber communication system through 225 metres of indigenous optic fiber cable in Malkera Colliery, Dhanbad. The system had following elements: optical communication fiber developed by CGCRI cable at Hindustan cables Ltd., terminal equipment component supplied/ developed by CSIO/CMRS. M/s. Universal Cables Ltd. supplied the connectors and the connecting kit. The cable laid from pit head to 16th seam pit bottom had been connected to an audio transmission system (a two-way telephone link) which became fully operational in December, 1988.

CGCRI Newsletter

In 1988, it was decided to publish news of important events of the Institute as also various honours and awards received by the members of the staff. It was also felt that the large community of our colleagues and their family members should be acquainted about the professional activities in which the members of the staff of the Institute were involved. With this aim, the Institute started publishing "CGCRI Newsletter" that was later renamed as "Glance", a bimonthly house bulletin (Newsletter) in 1990.

Dr. Bijit Kumar Sarkar
Director, CGCRI (Sept 1, 1988 - Oct 31, 1995)

Dr. B. K. Sarkar took over as Director

Dr. Bijit Kumar Sarkar took charge as Director, Central Glass & Ceramic Research Institute in September 01, 1988

MOU

The Institute signed an agreement with M/s Universal Cable Limited, Satna, Madhya Pradesh, India for manufacturing multimode graded index optical fiber in 1989.

ANNUAL REPORT 1998-99

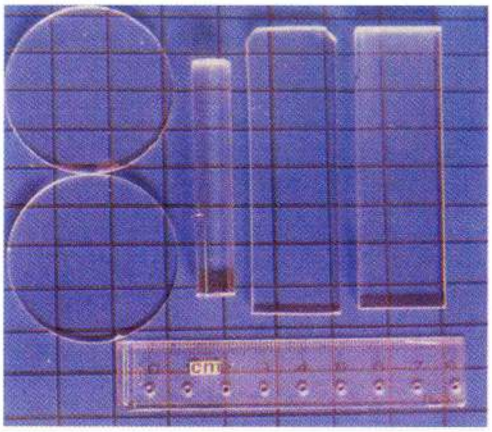
Science and Technology of Glass and Ceramics

New Horizon

The fifth decade
Towards the Golden Jubilee

R&D activities

R&D activities were continued towards meeting the national needs and priorities in consonance with the achievements made and capabilities built up. By this time, the Institute over four decades of existence, had served the nation very competently and met its original objectives in generating a wealth of information and technology upgradation in a sustained manner towards self sufficiency. Development of optical glasses, laser glass, optical communication fiber, ceramic hip joint, ceramized glass coatings for corrosion, wear and erosion protection, cutting tools, steel plant refractories, sol-gel based coatings on glass, ceramic honeycomb structures, non-oxide ceramics, electronic ceramics, superconducting ceramics, pottery products, low cost building materials utilizing industrial waste, fiber reinforced gypsum as wood substitute were noteworthy achievements. Many of these products were produced by private entrepreneurs through technology transfer. With the advent of advanced glass and ceramics being utilized in every walk of life, the Institute also reoriented its priorities to meet the changed environments. Much attention was focused on pollution control whether it was automobile exhaust or chimney outlet in a coal fired down-draft kiln. Upgradation of rural potteries attracted much importance. With another ceramic age around the



Silica glass

Dense silicon nitride and sialon

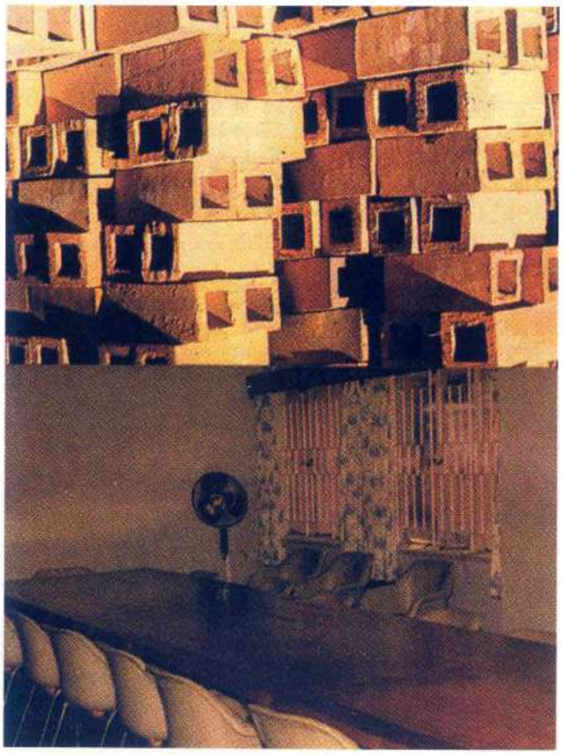
corner globally, the Institute remained conscious of its obligation to the nation.

The Institute also developed hollow building blocks that were made of mixture containing only 50 per cent common clay and the remaining half comprising waste materials such as fly ash, rice husk ash, binders, etc. Nearly 40 per cent of the volume of the block was void. The blocks were 5 to 10 times stronger than common bricks and could be used for construction of thin yet strong and thermally insulated walls supported on a light foundation. The blocks could also be used for fabrication of precast columns and beams and for construction of prefabricated roof structures.

Laser Glass

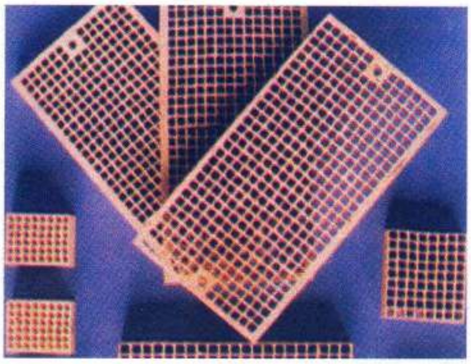
A planned effort was maintained for more than a decade on the basic research in glass as laser host, as well as on the development of technology in the making of laser glass in the form of rods and discs of different dimensions. Laser glass rods find application in range finder, target designator and both rods and discs are employed as amplifying medium in high power laser system.

Two types of laser glasses *viz.* Silicate and Phosphate were developed. The active element used in both types of glasses was neodymium.



Glass reinforced gypsum furniture and hollow bricks

Reaction bonded silicon nitride



Cordierite based ceramic honeycomb structure

Sol-gel Processing

Anti-reflective and anti-glare coatings on radiation shielding glass windows, ophthalmic lens and sheet glass were developed. A technology on antiglare coatings on ophthalmic lens was transferred to industry. Zirconia doped microspheres for plasma spray applications were also developed.

Engineering Ceramics

The Institute was a pioneer in the development of non-oxide advanced engineering ceramics. Process for making reaction bonded silicon nitride and dense silicon nitride were developed. Know-how for a material known as Sialon (a solid solution between silicon nitride and alumina) was also developed.

Pollution Control

Cordierite based honeycomb was developed for the catalytic control of automobile emissions.

In this decade new works were initiated on Ceramic Membrane and Solid oxide fuel cell.

Award Received

The scientist of the Institute received various awards from time to time from various organisations. One of the most honorable awards is Young Scientist Awards. The achievements of the staff members of the Institute were very remarkable in this decade in respect of receiving Young Scientists awards that brought laurels to the Institute. First, Dr. Mithilesh Chakraborty, Senior Scientist received Republic Day Award for invention of "Heat wheel - an efficient air heater" in 1990. Then several young scientists received Young Scientists Award. Dr. Amitava. Kumar received CSIR Young Scientists Award in 1991, Dr. Debtosh. Kundu in 1994 and Dr. Siddhartha Bandopadhyay in 1995.

Other activities

While the R&D activities play a pioneering role in projecting the image of the Institute, the non-R&D activities are no less important. Keeping this idea in view, greater stress had been put on marketing the products/processes of the Institute.Wide connections were also made with industries through several Institute-Industry Meets.

Remarkable improvements had been made in the area of international collaboration in training of personnel, deputation of scientists abroad, and presentation of papers at international seminars, *etc.*

Laying the foundation stone of a new building for the Demonstration-cum-training unit on building materials by Shri K.V. Raghunatha Reddy, the Hon'ble Governor of West Bengal, was another feather on the cap of the Institute. Visits of several distinguished scientists from within the country and abroad and the lectures delivered by them continued to inspire the scientists of the Institute. Negotiation were initiated with the Department of Atomic Energy for production and supply of optical glass slabs for radiation shielding window (RSW) for use in the hot cell of atomic reactors.

A landmark MoU was signed with Bharat Opthalmic Glass Ltd (BOGL), Durgapur for production of larger sized RSW glass slabs

Activities of Naroda and Khurja Center, CGCRI

The Institute's centers at Naroda and Khurja progressed well, in their societal mission. The use of locally available raw materials of different regions was demonstrated for production of ceramic wares at lower cost, especially in the small and rural sectors. The suitability of Rajpardi clay as a substitute for Bikaner and Thane clays was established. Production of bone china ware from local raw materials was taken up successfully in Gujarat region based on the

The CSIR Young Scientist Award-winners for the year 1991 (second from the left) Dr. Amitava Kumar

The CSIR Young Scientist Award-winners for the year 1994 Dr. D. Kundu (second from the left)

The CSIR Young Scientist Award-winners for the year 1995 Dr. Siddhartha Bandopadhyay

Institute's know-how. The know-how for production of pottery and ceramic ware was widely disseminated all over the country under a programme for rural development sponsored by DST. Entrepreneurial development programmes were organized for potential entrepreneurs, both rural and urban. The Naroda and Khurja made significant contribution in these areas.

These centers also solved problems of local industries. They had concentrated their efforts to explore possibilities of creating new products out of the locally available raw materials. The efforts of the centers to educate the local people and village artisans to adopt the processes developed were highly successful because of training and demonstration programmes.

Dr. C. Ganguly took over as Director

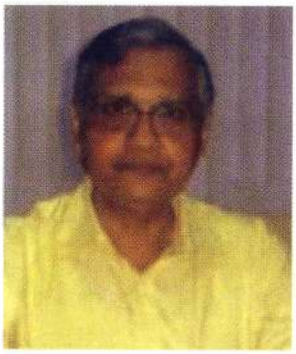
Dr. Chaitanyamoy Ganguly took over the charge of the Institute as Director on November 1, 1995.

Dr. Chaitanyamoy Ganguly

Director, CGCRI (Nov 1, 1995 - Jan 28, 1998)

Dr. H. S. Maiti took over as Director

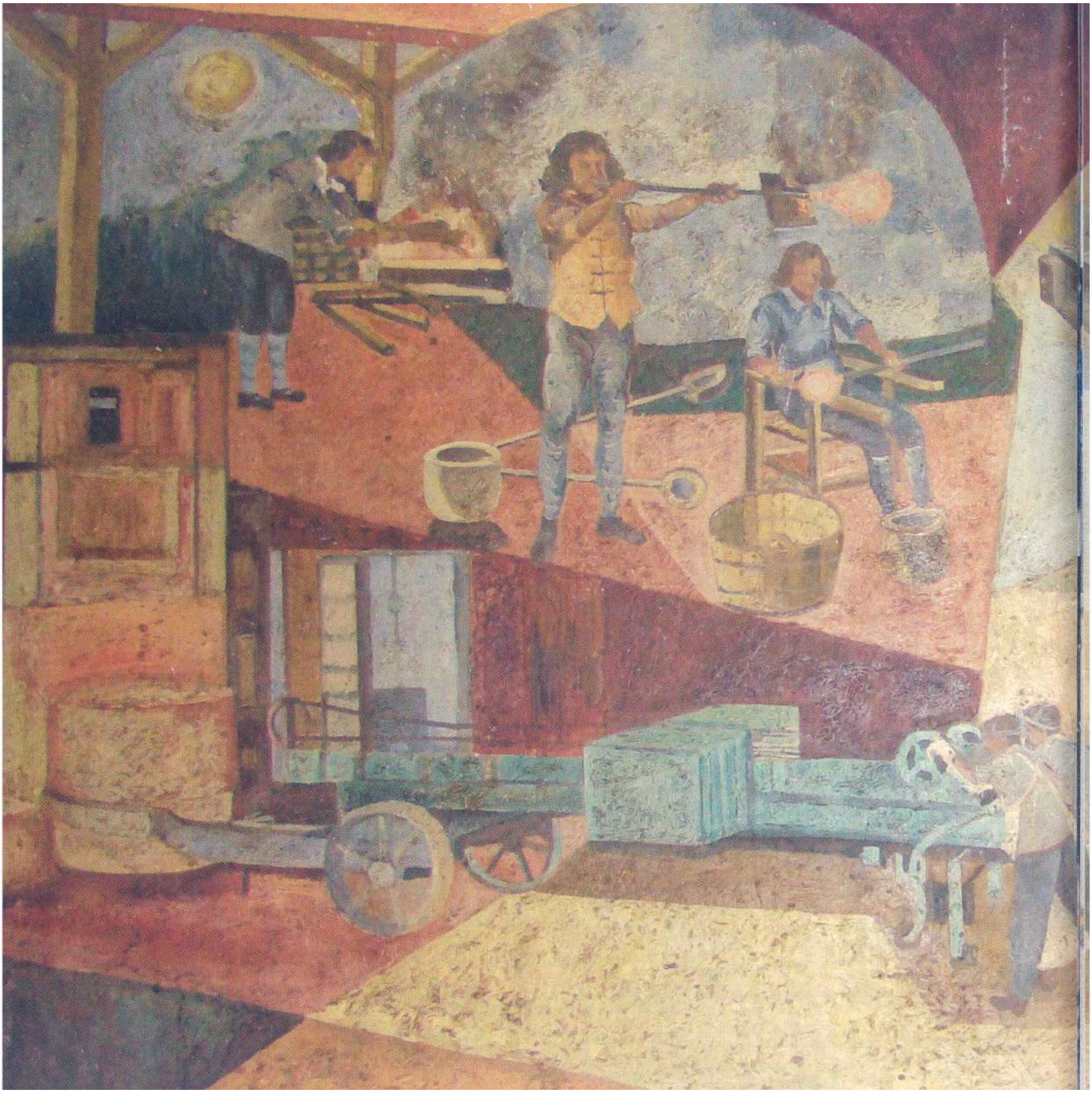
Dr. Himadri Sekhar Maiti took over the charge of the Institute as Director on January 25, 1999.

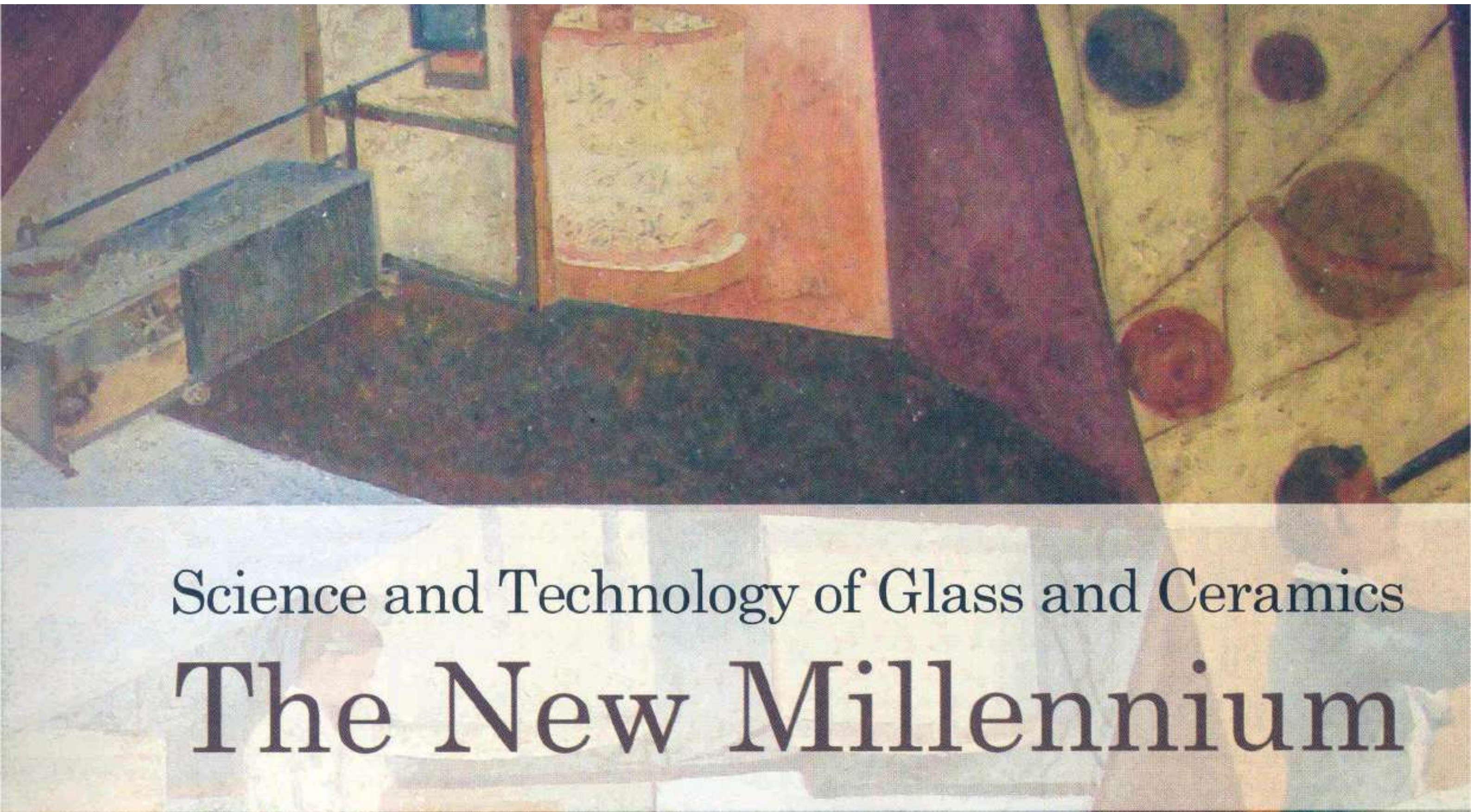


Dr. Himadri Sekhar Maiti

Director, CGCRI (Jan 25, 1999 - Oct 31, 2009)

New Innovation and Facilitation Unit of CGCRI, Naroda Centre





Science and Technology of Glass and Ceramics

The New Millennium

The sixth decade
A New Millennium

The Golden Jubilee Celebration

In its sixth decade, starting in the year 2000, there was a profound change, both physical and intellectual, in the life history of the Institute. Many, many milestones were achieved. This decade is characterised for various achievements in the field of traditional ceramics, advance ceramics and specialty glasses with additional emphasis on Societal Mission programme, Rural Development and Small scale sectors.

At the turn of the new millennium, the Institute entered into its Golden Jubilee year. Dr. R. A. Mashelkar, the then DG, CSIR, inaugurated the Golden Jubilee Celebrations on February 26, 2000. In his inaugural speech, Dr. Mashelkar lauded the achievements of CGCRI and pointed out that with the rapidly changing technological scenario, challenges are being thrown to all CSIR laboratories, including CGCRI. He hoped that scientists and staff members of CGCRI would vow to build the laboratory as one of the leading institutes in the world.

As a part of the celebration, CGCRI instituted the "Atma Ram Memorial Lecture" in fond memory of its Founder-Director. Dr. R.A. Mashelkar delivered the first Memorial Lecture on a frontline topic "Intelligent Gels". A number of national and international seminars/conferences/workshops as listed below were also organized as a part of the commemoration of the Golden Jubilee Celebrations:

- National seminar on Zircon and Zirconia - Technological Possibilities in the New Millennium
- National Seminar on Engineering Ceramics - Prospects in the New Millennium
- National Seminar on Refractories and Furnaces - New Options and New Values
- Indo-German Workshop on Special Glasses and ceramics
- Future Courses of Optical Fiber Development in India
- National Seminar on Sol-gel Science and Technology

During the closing ceremony of the Golden Jubilee Celebration on August 26, 2000, the Institute was graced by His Excellency, Shri Viren J Shah, the then Hon'ble Governor of West Bengal. Prof. Satya Sadhan Chakraborty, the then Minister for Higher Education, Govt. of West Bengal was the Guest of Honour. Dr. T Mukherjee, the then Chairman, CGCRI Research Council presided over the function. A photo chronicle, entitled "Looking through the Glass", commemorating 50 years of research activities at the Institute was released by the Governor on the occasion.

R&D activities

On the R&D front, again activities were continued towards meeting the national needs and priorities in consonance with the achievements made and capabilities built up. In tune with the new realities of the open market economy and national priorities, thrusts were given specially to niche areas, *viz.* Photonics & Optoelectronics, Bio-ceramics, Ceramic Membranes, Solid Oxide Fuel Cell, Sensor & Actuators and Nanostructured materials in addition to Traditional and Advanced Engineering Ceramics. In all these areas, CGCRI made a mark in the national scenario and many landmark achievements were made in all the areas of research that were initiated. The significant achievements in these areas are depicted:

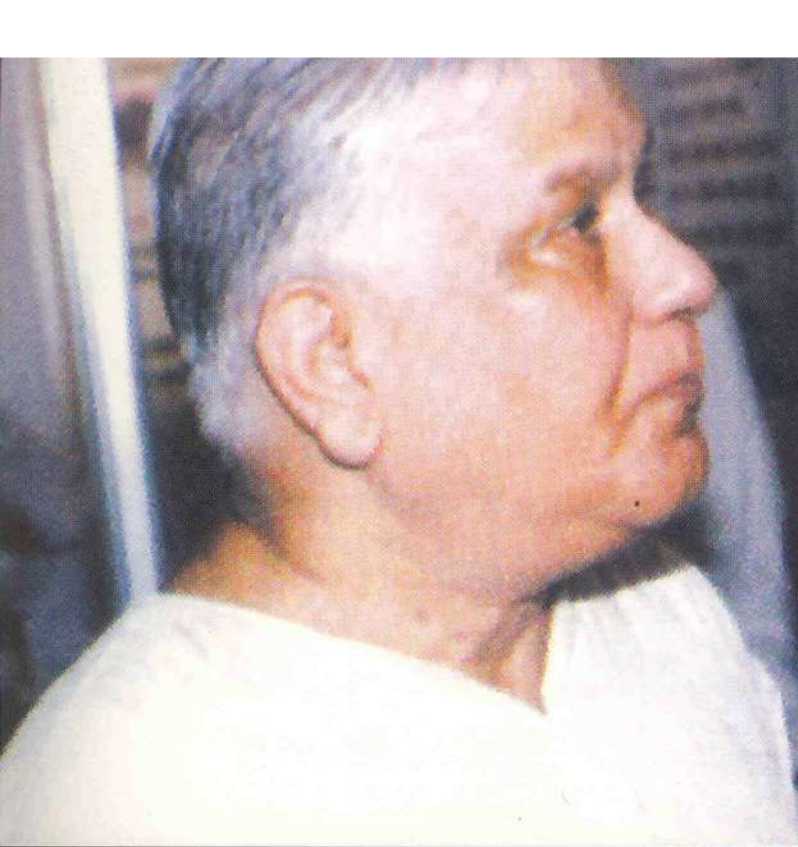
Inauguration Ceremony of Golden Jubilee Celebration

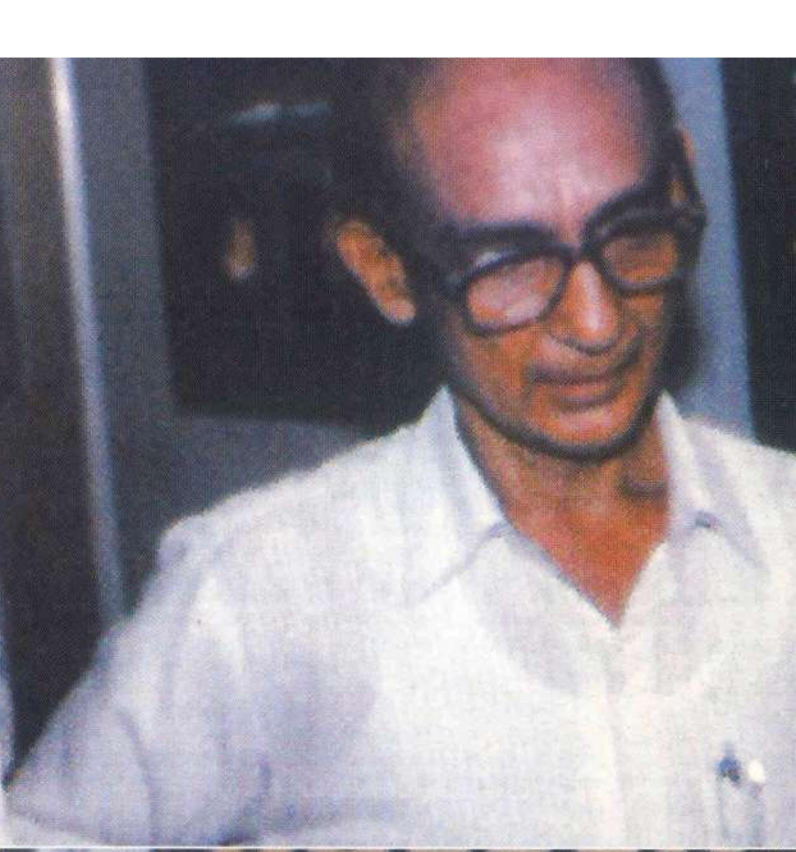
Dr. R. A. Mashelkar along with Dr. S. Kumar, Dr. B.K. Sarkar and Dr. H.S. Maiti


50 YEARS OF SERVICE TO THE NATION


NATIONAL SEMINAR
SOL-GEL
AUGUST 17-18, 2000
CENTRAL GLASS
Jubilee Year 1950-2000


GLASS & CERAMIC RESEARCH INSTITUTE CALCUTTA
50 Years of Service to the Nation






CENTRAL GLAS
GOLDEN

Optical Communication Fiber

Fiber optics is one of the areas in which CGCRI has developed world class expertise and facilities. One of the major areas of research during this decade was on Erbium (Er) doped fiber (EDF) particularly for telecommunication application . The expertise generated has led to the development of key technologies in this area. Thus, CGCRI has developed packaged C-band optical amplifier using EDF for cable TV (CATV) application jointly with industrial partner NeST Photonics, Cochin. The commercial product was launched on August 28, 2005. Similarly, packaged C-band WDM telecom optical amplifier was developed in collaboration with NeST R&D Center, Cochin using EDF and fiber grating gain flattening filter (GFF) fabricated at CGCRI and its commercial viability was proved.

During the 10th Five Year Plan, CGCRI envisioned initiating a comprehensive R&D programme in the field of Fiber Bragg grating (FBG) and its application, particularly for sensor development. Some of the major achievements in this area are discussed:

Bragg grating based temperature sensing system for online temperature monitoring of high voltage power transmission lines. (Fig 1) FBG based sensors suitably packaged for the application of monitoring of health of civil engineering structures showing excellent correlation with standard gauges. (Fig 2) FBG sensor arrays were also developed for health monitoring of aerospace structures and about 140 sensors have been supplied to NAL. The sensors have been embedded in the test box of CFRP based wing structure of SARAS. (Fig 3)

Erbium (Er) doped fiber amplifiers (EDFA) exhibiting broad gain spectra centered around 1550nm wavelength of light provide a versatile platform to revamp attenuated (weakened) signals at intermediate locations in an optical network before they become too weak to recover at the receiver end. The key component in an EDFA is a few meters of Er doped fiber in which optical amplification is achieved by creating population inversion through optical pumping.

Efficient inscription of Bragg grating in silica optical fiber requires the fiber to possess some special features that are absent in conventional silica fibers used for optical communication. Since the inherent grating writing mechanism needs precise photo-induced local refractive index change in the fiber, the later should have appreciable photosensitivity (around 244 – 248 nm). Secondly, Bragg gratings apart from few special applications, is predominantly a reflective device. It generates undesirable wavelength dependent loss due to core mode to counter propagating clad mode coupling if written in a conventional fiber. The removal of this phenomenon necessitates a very special waveguide structure with judicious control of radial refractive index and photosensitivity. This special variety of fiber is known as intrinsically photosensitive cladding mode suppressed fiber. CGCRI has mastered the technique for fabrication of such specialty fibers and utilized the same for development of FBG based sensors for various applications.

Photonic Crystal Fiber (PCF) or Microstructured Optical Fiber (MOF) consists of a central silica core surrounded by a hexagonal; array of air holes running along the fiber length. The number, size and position of the air holes around the core provide additional degrees of freedom not present in conventional optical fibers and can be manipulated to yield novel confinement and dispersion characteristics. The advent of nonlinear MOFs provided a breakthrough in the field of Supercontinuum (SC) generation as it allowed the use of much lower powers to use the SC effect. The laser generation of white light is quite interesting physical phenomenon and the developed devices are gaining practical importance for solving problems of nonlinear spectroscopy, coherent microscopy and biomedicine. During the last decade, CGCRI has initiated a number of R&D programmes in this emerging area.

Photonic Crystal Fiber (PCF) having very high nonlinearity has been developed successfully for the first time in India. Using the highly nonlinear Microstructured Optical Fiber (MOF), thus developed, it has been possible to produce a picosecond fiber MOPA pumped supercontinuum source with 39W output spanning a wavelength range of at least 0.4 - 2.25μm, generating a dense visible spectrum. Thulium-doped fiber lasers are presently attracting global attention because of their potential for generation of coherent emission in the near-IR wavelength range for a variety of medical and biosensor applications. Air-cladded doped core (LMA-PCFs) with different Yb and Tm ratios were fabricated for the first time in India at CGCRI. The LMA-PCFs were tested at Heriot-Watt University, UK for laser application in the near-IR wavelength range. Depending on the Yb:Tm ratio, lasing was obtained at wavelengths of about 1980nm to 2000nm. (Fig 4)

Work has also been initiated for development of fiber optic dosimeter for wide range gamma radiation environment, Bragg-grating sensor for health monitoring of satellite structure, acoustic wave detection through FBG sensor for damage detection of civil structure and fabrication of index guided photonic crystal fiber.

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Glass Science

The expertise generated over the past couple of decades, helped the Institute earn a distinguished position in the country in the area of specialty glasses. Some of the notable contributions during the decade are mentioned below.

A Plasma Display Panel (PDP) consists of two glass plates separated by a gap of about 130 μm filled with inert gas mixture (generally Xe-Ne) which can emit UV photons. PDP requires low-melting glass powders and pastes of some specific properties for its construction comprising (i) upper dielectric layer (transparent dielectric, TD), (ii) partition (barrier rib, BR) and (iii) lower layer dielectric (white black, WB). Usually, all these glass powders and pastes contain huge amount (60 – 80 wt%) of lead oxide (PbO). However, lead is toxic and hazardous to health and environment and has been banned by European Commission Directorate General for its use in electrical and electronic equipment since July, 2006.

One of the major achievements was the development of environmental-friendly cost effective lead-free transparent dielectric glass powders and pastes for PDP. Continuous improvement of glass composition and process technology followed by evaluation at CGCRI and the industry collaborations M/s Samtel

Fig.-1: Installed FBG

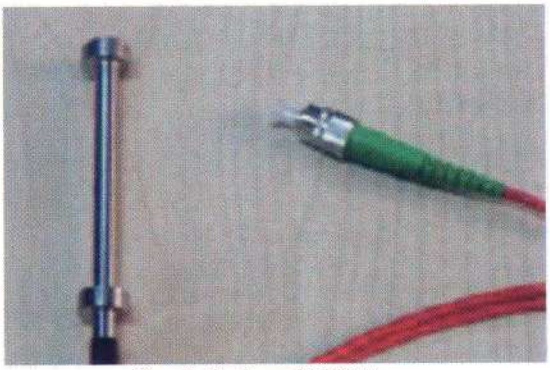


Fig.-2: Packaged FBG Sensor

Fig.-3: Embedding of FBG array sensors supplied to NAL in a CFRP test box of an aircraft wing.

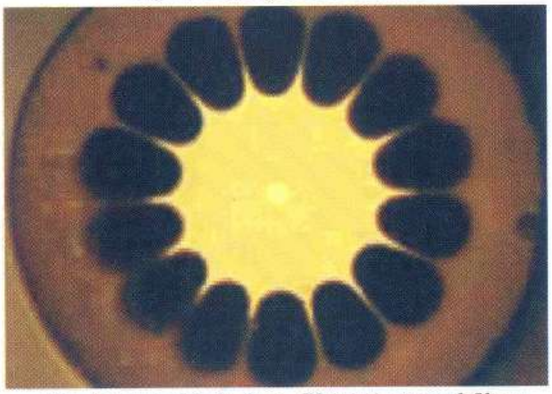


Fig.-4: Large Mode Area- Photonic crystal fibers

Colour Ltd., Ghaziabad, UP led to the development of three lead-free glass systems which were standardized for Transparent Dielectric (TD), Partition (Barrier Rib, BR) and Rear Glass Dielectric (White Black, WB) components of PDP. Standardized compositions were found to be property-wise equivalent to the existing lead-containing materials and were acceptable to the industry.

During the last decade CGCRI has mastered the technology for production of high density (3.2 – 5.9 g/cc) RSW glass blocks of different sizes and remains the only indegenous source of RSW glass blocks with sustained maintenance of stringent optical and physical properties.

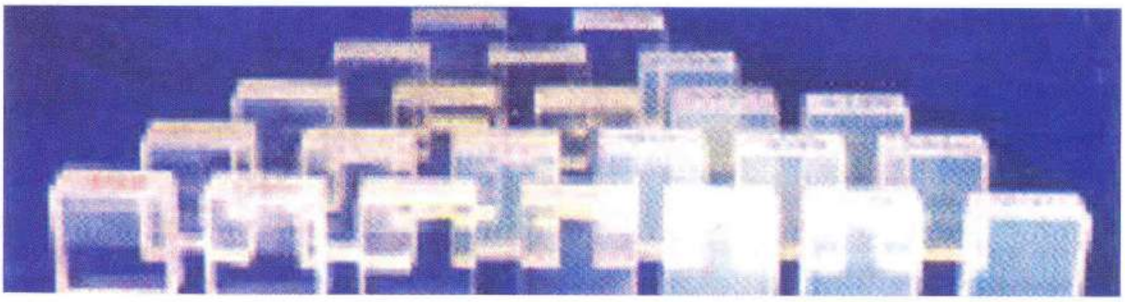
Another key achievement of CGCRI during the decade was the development of process technology for ultra low expansion transparent (ULET) glass ceramic blocks having superior thermal shock resistance. Several blocks of such materials of dimension 90 mm x 90 mm x 40 mm were supplied to Electro Optical Instrument Research Academy, Hyderabad, and were found to be acceptable with respect to various properties.

Work has also been initiated for the development of rare earth doped nanocrystalline nonlinear optical glass ceramics for self frequency doubled laser devices and glass and glass-ceramics for photonic and solar applications.

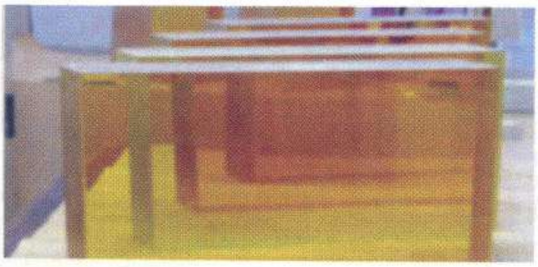
Radiation Shielding Window (RSW) glasses cut off nuclear radiations that are hazardous to health. The RSW glass blocks are essential items for remote handling of radioactive materials within thick concrete/ lead brick walled crucibles. The RSWs provide the visual passage through which operators monitor the operations going on inside such crucibles.

Ultra low expansion transparent (ULET) glasses show almost zero thermal expansion over a wide thermal range and have superior thermal shock resistance. These properties are achieved by having a suitable combination of glass and ceramic phase in the microstructure.

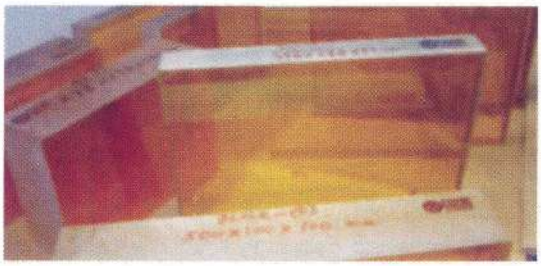
Lead-free TD coated PDP glass substrates (PD200) fired at 560-590°C



Ultra low expansion transparent (ULET) glass ceramic blocks of dimension 90mm × 90mm × 40mm



RSW glass blocks (Size: 400mm × 200mm × 100mm)



RSW glass blocks of larger size

Sensors

The advent of smart materials, structures and systems on the one hand, and the fear of burgeoning terrorism across the globe on the other, have led to an extensive demand of sensors and actuators having tailor-made properties. Amongst different sensors, gas and vapour sensors are increasingly needed for safety, environmental monitoring and process control and find applications in diverse areas. Consequently, a major initiative was taken up during the decade to carry out focused research in the area of ceramic sensors and actuators. One of the major achievements in this regard was the development of the technology for fabrication and packaging of LPG/CNG leakage alarms based on semiconducting SnO_2 sensors. The specifications of the developed sensors are at par with those of the imported ones available in the global market. The know-how has been transferred to a Hyderabad based private entrepreneur, M/s Indigen Technologies Pvt. Ltd. A Multi-position semi-automatic spot welding station, an instrument essential for sensor device production was also developed by CGCRI. Another important achievement was the development of nano-sized semiconducting Fe_2O_3-based sensors for detection of acetone in human breath that has opened up the possibility for noninvasive diabetes detection in human in an inexpensive manner. SO_2 leak detection sensor using nano-sized ceria was also demonstrated.

Humidity is considered to be one of the most effective indicators of water vapour leakage. A programme was undertaken to develop ceramic-based humidity sensors for leak-before-break (LBB) applications in nuclear installations. Thus, $MgCr_2O_4$-TiO_2 based sensors have been developed as a new leak detection method for LBB application with adequate sensitivity over the temperature range of 25°C – 300°C. Thirty such humidity sensors with associated electronics were supplied to Refractory Safety Division, BARC and were tested with satisfactory performance. In addition, M/s P.H. Scientific (UK) purchased six such moisture sensors from CGCRI to check its market acceptability in UK. Thin film mesoporous γ-alumina capacitive sensors fabricated through sol-gel technique were also developed. The sensors were found to detect moisture satisfactorily in transformer oil as the oil is vaporized in a controlled manner. The detection level of moisture was found to be up to 6 ppm. Attempts were made to detect moisture content down to 1 ppm. Actuators are used as mechanisms to introduce controlled motion. Amongst different types of actuators, ceramic actuators show fast response and depending on the design, the blocking force can be very high. Such ceramic actuators are based on piezoelectric effect, where an electric field generates strain (and in the converse effect, stress generates an electric field).

Ceramic gas sensors are primarily based on n-type semiconducting oxides like SnO_2, ZnO and TiO_2. Their resistance values drop drastically in the presence of reducing gases owing to the reaction of the latter with the metastable adsorbed oxygen species on the surface of the semiconductor. Semiconductor sensors show very good sensitivity, though it needs engineering of the composition to get the desired selectivity. They are also quite cheap, rugged and can last up to ten years.

Ceramic moisture sensors can be of resistive or capacitive type. In resistive type sensors a material like $MgCr_2O_4$ + TiO_2 is used, where the moisture adsorbed on it is ionized and the sensor resistance decreases with the increase in humidity. In capacitive sensors, where mesoporous Al_2O_3 is the material of choice, the condensation of moisture in the pores leads to a change in the capacitance value of the material.

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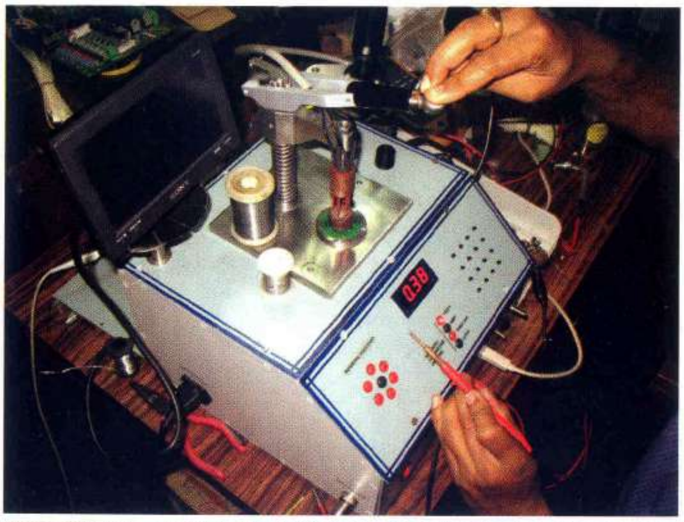
Another key development during the decade was on piezoelectric actuators. These have immense applications for vibration control in aircrafts, submarines, shape control of aerofoil, structural health monitoring (SHM) etc. The multilayered structure configuration of these actuators is preferred primarily because of numerous advantages such as low driving voltage, quick response and high generating force. CGCRI has successfully developed such multilayer actuators using the state-of-the-art piezoelectric materials *viz.* lead zirconate titanate. Since lead is a toxic material, CGCRI has also developed non-lead based piezoelectric materials, primarily alkali niobate based compositions (KNN = $K0.5Na0.5NbO_3$), having comparable piezoelectric properties to that of lead based materials. The KNN ceramics were fabricated in the forms of bulk, wafers and multilayers.

As a consequence of the achievements made in this emerging area, a 'Sensor Hub' has been formed at CGCRI under the patronage of DST and CSIR. Other Institutes in and around Kolkata, *viz.*, Jadavpur University, Calcutta University, Bengal Engineering & Science University and Center for Development of Advanced Computing (C-DAC), Kolkata have joined hands to develop, fabricate and test electronic nose for tea aroma, MEMS-based battery operated methane and carbon monoxide sensors and arsenic detection kits.



Multi-position semi-automatic spot welding station

Gas Leakage Alarm (inset: Sensor Head)

Humidity Sensor

Fuel Cell and Battery

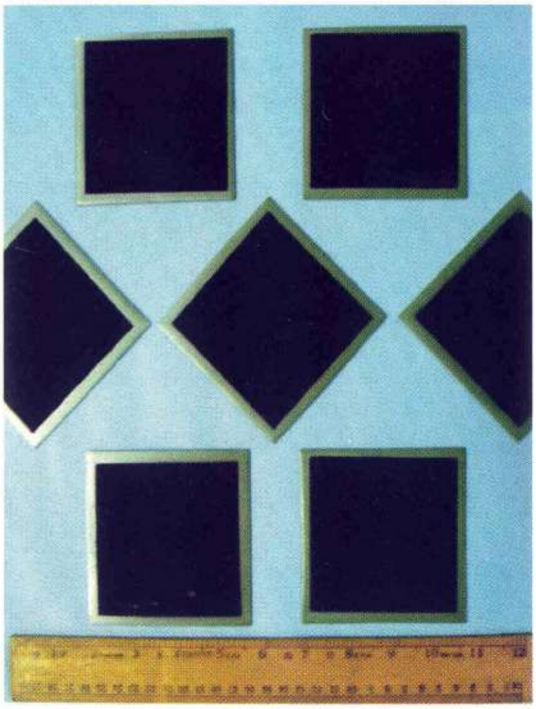
With the knowledge-base generated and expertise developed in the area of Solid Oxide Fuel Cell (SOFC) research, which was initiated during the previous decade, CGCRI had established itself as the leading Institute in SOFC research in the country. During the decade a major initiative was taken to develop an indigenous SOFC technology based on the planar anode-supported design. Accordingly, the process technology for fabrication of planar anode-supported SOFC single cells of dimensions upto 10 cm x 10 cm x 1.5 mm were developed. The cells exhibit excellent electrochemical performance (current drawing capability of ~ 2 A/cm2 at 800°C and 0.7 V) which is on par with international standard. Appropriate Glass-based sealants, a key component of SOFC stack (for making gas-tight seals between metal-metal and metal-ceramic during SOFC stack operation), were developed. Using the indigenously developed 10 cm x 10 cm x 1.5 mm single cells, glass-based sealants, and metallic (Crofer 22APU) stack components, working SOFC stacks (upto 10-cell level) were demonstrated for the first time in India.

Another key achievement in the area of SOFC research is the development of functional anode (Ni-YSZ) having a novel core-shell microstructure wherein the YSZ core is coated with a thin layer of discrete metallic Ni particles. For such anodes, the required amount of Ni is much less (only ~ 25 vol %) compared to that of conventional anode (with ~ 40 vol% Ni) for having similar electrical conductivity.

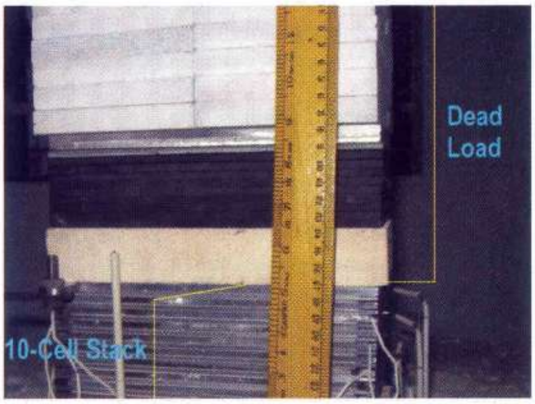
Focused research on LiB has been initiated during the decade with emphasis on developing new cathode & anode materials. Lithium manganese oxide ($LiMn_2O_4$) is a promising cheaper alternative cathode to $LiCoO_2$ but capacity fading restricts its commercial use in high power batteries. CGCRI has successfully stabilized the crystallographic structure of $LiMn_2O_4$ by controlled amount of Ni and S co-doping. Electrochemical results on 2032 coin type cells, fabricated with the synthesized powders as cathode and Li metal as anode, revealed that the substitution of S for O and Ni for Mn in $LiMn_2O_4$ enhanced the structural integrity thereby increasing the electrochemical cycleability. The Institute has also been successful in developing conventional LiCoO2 cathode into a nanocrystalline material with high rate capability (up to 5C) by doping with lanthanum. An excellent cycling performance with capacity retention by a factor of ~10 in comparison to the pristine LiCoO2 was achieved for the composite cathode containing 5.0 mol% La. Owing to the poor Li+ intercalation kinetics of conventional carbon (graphite) anodes, the power density of LiB is restricted. CGCRI developed a novel composite material, *viz.* $Li4Ti_5O_{12}/Li_3SbO_4/C$ as alternate anode for LiB application. Electrochemical results on 2032 type coin cells show retention of 78% of its initial capacity value with no significant fading upto 100 cycles.

Fuel cell is an energy conversion device that converts the chemical energy of a fuel directly into electricity through its electrochemical combination with an oxidant. In principle, a fuel cell operates like a battery: both have an ion-conducting material called an electrolyte, sandwiched between a positively charged anode and a negatively charged cathode. Unlike a battery however, a fuel cell does not run down or require recharging. It produces electricity and heat as long as fuel and the oxidant are supplied. Due to the direct electrochemical reaction, fuel cells have the very high energy conversion efficiency (~ 50%) and low level of pollutant gas (e.g., NOx. SOx etc.) emissions. Fuel cells are of different types and are classified by their electrolyte material. As its name implicates, the Solid Oxide Fuel Cell (SOFC) uses a ceramic (solid oxide) electrolyte and operates at high temperatures (650OC to 1000OC). The component materials that are generally used for making an SOFC are:

- Electrolyte: Yttria-stabilized Zirconia (YSZ)
- Anode: Ni-YSZ cermet (Ni-YSZ)
- Cathode: Sr-doped lanthanum manganite (LSM)



Planar anode-supported SOFC single cells (10 cm x 10 cm x 1.5 mm)



10-cell SOFC stack and its demonstration

Lithium-ion batteries (LiB) perform in the 'Rocking-Chair' mode by alternate charging and discharging cycles during which the lithium ions de-intercalate from the cathode and intercalate into the anode showing a back-and-forth motion. A typical commercial LiB uses $LiCoO_2$ as the cathode, LiC_6 as the anode and $LiPF_6$ as the electrolyte.

Work was also initiated on the development of mixed ionic and electronic conducting (MIEC)-based dense ceramic membrane for separation of gases (hydrogen and/or oxygen) from a mixture of gases at elevated temperature (~600°C). Nanocrystalline $La_{1-x}Ca_xZr_2O_7$ (LCZ) having higher protonic conductivity and better stability compared to the conventional perovskite-based materials were developed. The cermet containing 40 vol% of Ni and 60 vol% of LCZ forms the MIEC-based structure. Research was also initiated to develop a complete assembly comprising of a thin layer of such MIEC membrane supported on porous ceramic structure and to test the assembly for H_2 permeation.

The ambipolar diffusion and transportation of oxygen/hydrogen through a dense MIEC membrane, as a consequence of simultaneous transport of both ionic and electronic charge carriers under the influence of a high partial pressure gradient can be used for oxygen and/or hydrogen separation. The advantage of such dense membrane based separation is that the selectivity of the gas so separated is more than 99% and secondary purification that is required for other membrane separation technology, is not needed

Fabricated 2032 type Li-ion coin cells using oxide cathode and anode

Bioceramics

With the expertise developed and success achieved in the area of bioceramic materials and their application in ceramic hip joints during the 90's, CGCRI has initiated several activities during the decade in this upcoming area of extreme societal importance.

The major areas covered were bioceramic implants for medical applications, dental ceramics, bio-mimetic synthesis & near net shape manufacturing of implants, ceramic-based implantable delivery system for sustained release of the drugs and new insight in cancer biology through ceramic-based drug delivery system.

One of the major achievements was the development of a system of total hip prosthesis with alumina based ceramic heads (ball & cup) and hydroxyapatite (Hap)-coated Ti-6Al-4V stem for cement-less fixation. After successful in-vitro and in-vivo evaluation, they are being implanted to human patients through many major hospitals of India which are net-worked with the Institute. The post operative results of all these patients have confirmed their superiority over the conventional metallic ones.

Initiatives were also taken to develop different patient specific Hip and other joints by adapting rapid prototyping technique. Using this technique, CGCRI has developed porous or hollow stems that reduce elastic modulus of the load bearing implants. Clinical trials of these items are being carried out in different reputed hospitals in India.

CGCRI has also developed a process for synthesis of calcium hydroxyapatite ceramic in the form of porous granules/ blocks for application as bone graft material. After in-vitro and in-vivo tests in animals, porous granule was implanted to human patients. The post operative studies in these patients and also in the test animals showed complete tissue integration and wound healing within 12 weeks of the surgery.

Another key achievement of the decade was the development of ceramic coated implants for various applications. Thus, in collaboration with IIT, Kharagpur and M/s INOR Orthopaedic Ltd., Mumbai, the Institute has developed plasma sprayed bio-active coating on different implant materials for their cement-less fixation.

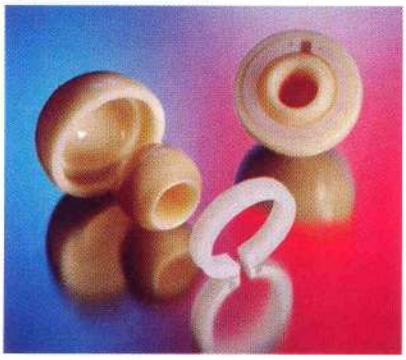
Considering the fact that the mineral portion of the bone (~ 60% by weight) is made of phosphate-based ceramics, it is believed that ceramics can play a big role in repair and substitution of skeletal parts of our body. Ceramics used for the repair and reconstruction of diseased or damaged parts of the musculo-skeletal system, termed bio-ceramics, may be bio-inert (e.g., alumina and zirconia), resorbable (e.g., tricalcium phosphate), bioactive (e.g., hydroxyapatite, bioactive glasses, and glass-ceramics), or porous for tissue in-growth (e.g., hydroxyapatite-coated metals). Clinical success of bio-ceramics has led to a remarkable advancement in the quality of life for millions of people.

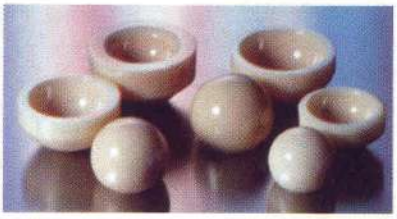
Initiatives were also taken to develop ceramic coated knee-joints with particular emphasis on using Titanium Nitride (TiN) and Diamondlike-Nanocomposite (DLN) as the coating material.

One of the most significant achievements during the decade was the development of porous hydroxyapatite ocular implants for application in the field of ophthalmology. The artificial eye ball designed and fabricated at the Institute has been characterized thoroughly before their implantation in human patients. It has been found that in all the patients the artificial eye had adequate motility and mimicked the other eye for both horizontal and vertical movements.

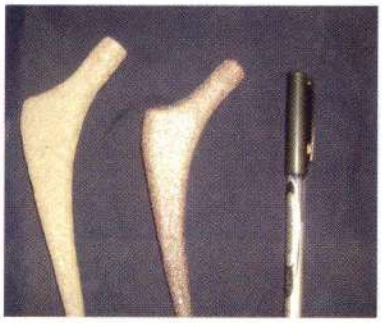
Technology for manufacturing of such ocular implants has been transferred to M/s IFGL Bio-ceramics Ltd., Kolkata and since January, 2005, the products are available in the Indian market.

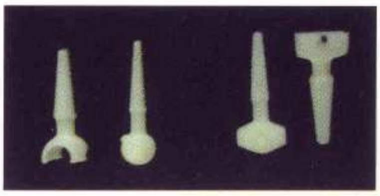
During the decade the Institute also undertook an initiative to develop porous hydroxyapatite coating (100-300 µm thickness) on metal (Ti-6Al-4V, SS 316 L/Co-Cr alloys) substrates for cement-less fixation of orthopedic prostheses in the osseous surrounding by biomimetic route. The results of both in vitro and *in vivo* trials were promising. The *in vitro* results exhibited excellent cellular response while the *in vivo* study showed neovasularization (formation of new blood vessels). Among a variety of biocompatible and bioresorbable inorganic materials, layered double hydroxides (LDHs) are endowed with great potential as a drug or biomolecule carrier because of its ability to host functional molecules in anionic form in interlayer space. A new drug delivery system was invented based on the preparation of nano sized hydroxyapatite (HAp)-DOX conjugate to target the cancerous liver cell passively without any adverse side effects. The formulation was well-accepted as drug





Newer types of all ceramic hip-joints which are under clinical trial





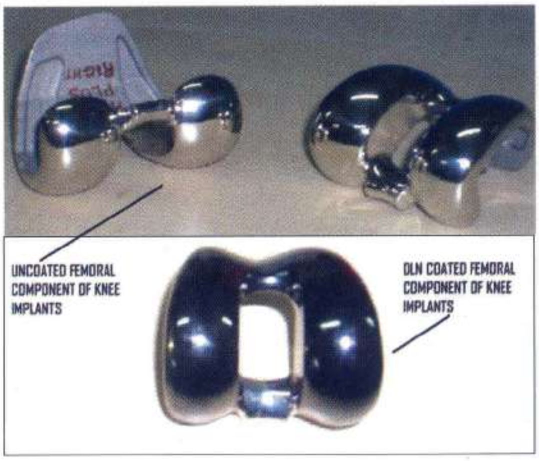
Newer types of all ceramic hip-joints which are under clinical trial

The rapid prototyping process is a modern fabrication technique which can mimic three dimensional structures and fabricate the same. It can be used to fabricate a hollow lightweight femoral stem introducing graded structure, porous and other modifications in the fabricated stem. In this technique the prosthesis can be directly produced from the CT-scan data of a specific patient and thus would be flexible enough to cater to the need of that particular patient.

Orbital (eyeball) implants

Among a variety of biocompatible and bioresorbable inorganic materials, layered double hydroxides (LDHs) are endowed with great potential as a drug or biomolecule carrier because of its ability to host functional molecules in anionic form in interlayer space. They have general formula $[M2+1-xM3+x(OH)2]x+(An-) x/n \cdot mH2O]$ with molar ratio of $M2+/(M2+ + M3+)$ varying from 0.2 to 0.33. Drugs or bio-molecules that are intercalated in the interlayer space of LDH would have higher resistance to enzymatic degradation during its circulation in the body.

Hepatocellular carcinoma (HCC) (or the liver cancer) is the fourth leading cause of cancer related death worldwide. Doxorubicin (DOX) is a drug commonly used for this type of cancer therapy with a very limited success but with serious side effects like cardiotoxicity, killing healthy/normal cells, etc.



Knee join

carriers because these vesicles are biocompatible, non-immunogenic, reduce toxicity of entrapped agents in the biological systems. 'High dose' HAp-DOX formulation was investigated and found to be very effective in combating diethylnitrosamine (DEN) induced hepatocellular carcinoma in rat model.

Non-Oxide Ceramic & Composites

By the turn of the new millennium, CGCRI had developed enough expertise in the area of Non-oxide ceramics & Composites. During this decade the Institute ventured into newer applications and / or novel synthetic techniques of production/ utilisation of these materials. Thus, the institute, in collaboration with industry partner, Ms. Clutch Auto Limited, Pune, developed carbon fiber reinforced silicon carbide ceramic clutch friction plate for advanced automotive applications. Both friction co-efficient and wear of the ceramic composite material were as desired, and acceptable for field trials. The new generation material was passed to the industry partner for a real life experiment.

The success of the use of naturally grown plant precursor in ceramic making depends on their compositional and morphological homogeneity which is sometimes difficult to attain on a regular basis. One of the ways to achieve this is to use technically manufactured bio-structures of suitable morphology as precursor.

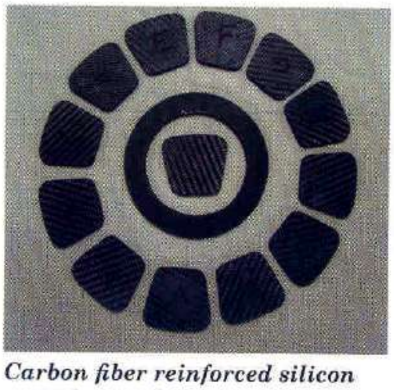
During the decade CGCRI developed the process for making dense silicon nitride balls for use in hybrid bearing with ceramic balls and steel races. The bearings have passed all the stringent qualifying tests as per ASTM specifications.

Another key achievement was the transformation of hierarchically designed cellular morphology of plant bio-structures in ceramics for the development of biomorphic silicon carbide ceramics for application as structural material. Thus, cylindrical SiC blanks for ceramic seals were prepared with complete preservation of shape and morphology of the plant precursor and the properties were found to be close to those of commercial SiC seals.

A novel method for making macro-porous SiC material in tubular configuration was also developed during the decade using paper/wood pulp followed by subsequent bio-templating and ceramization. The networking of converted SiC filaments results in the formation of void space (pores) in the final material, while fibrous structure contributes to strength to be useful for hot gas filtration application in IGCC technology.

CGCRI developed and fabricated prototype of silicon nitride radome with dimensions of 183 mm diameter and 385 mm height. Both the material and the radome qualified the test requirements for actual application.

Dense silicon nitride balls in jigs



Carbon fiber reinforced silicon carbide clutch plates

The track of some of the guided missiles is determined by the processed micro-wave signals which the airborne system receives from the target. The radome or the nose cone of the missile is required to be transparent to the micro-wave signal for easy transmission of the electromagnretic waves without aberration. Reaction Bonded Silicon Nitride (RBSN) is transparent in the range 6-14 micro-meters to such waves.

Wood in cylindrical configuration as precursor (left) and the prepared biomorphic SiC from the same (right)

Porous reaction bonded silicon nitride tubes were also developed for diaphragm application.

Boron nitride – silica composite machinable ceramic components and dense SiAlON cutting tools were developed during this decade. Another important achievement was the development of AlN ceramics based advanced structural materials for application. Impact behaviour of AlN tiles developed by CGCRI was also studied and found to be superior to that of Al_2O_3.

Porous tubular SiC using cellulosic material: (a) as-cast pulp fiber tubes and (b) porous SiC tube made thereof

Reaction bonded silicon nitride radome

Reaction bonded silicon nitride porous tubes

Refractory

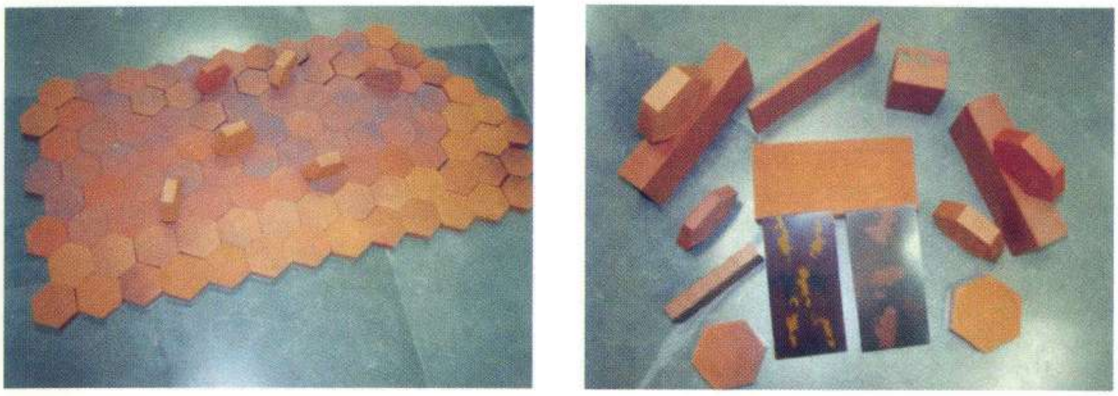
In the area of refractory ceramics, several projects were handled during the decade with leading refractory industries of the country including Engineering consultants through MOU. The R&D efforts in this area led to the development of the process for utilizing waste of iron ore from mining industries for the fabrication of low cost construction materials. Thus, a good number of construction materials such as solid and hollow bricks, pavement blocks of different designs and vitrified ceramic tiles were developed using the process. The main features of the CGCRI developed process included lower firing temperature and superior product properties leading to energy efficiency.

In a major breakthrough of a tripartite agreement between CGCRI, OCL and DSIR, hydration resistant sintered lime was developed for the first time in India using a double calcination process. Up scaling of lime refractory was initiated.

Another key achievement in this area during the decade was the development of value added refractory aggregates from low grade Indian bauxite through a novel technique of structural modification. The high temperature properties achieved were encouraging and comparable to foreign raw material imported in bulk quantity. The technology underwent plant trial at Tata Refractories Ltd.

Due to rapid developments during steel making process, the refractory should precisely match with the process condition. CGCRI developed Al_2O_3–$MgAl_2O_4$–C refractory in collaboration with an industrial partner. The developed refractory was up-scaled at the partner refractory industry and applied in ladle furnace of a steel plant. The campaign life was 85 Heats, which was found to be better compared to the existing refractory used in the plant.

> Lime (CaO) is considered to be a thermodynamically stable excellent basic refractory material, particularly for secondary steel making processes using vacuum or reducing atmosphere. However, the atmospheric hydration of CaO limits its application.

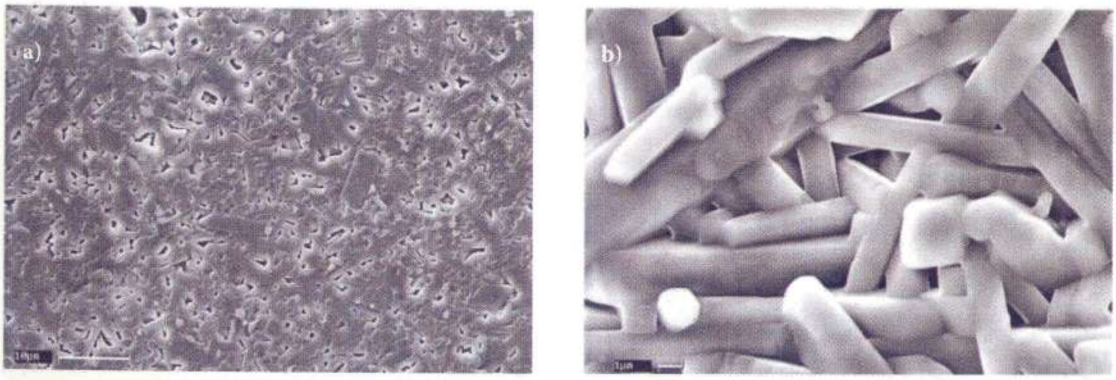


Construction/building products utilizing iron ore tailings

Other significant achievements include the following:

- A full process technology on Dolomite refractory was transferred to one a major refractory company, ACC Ltd.
- Successful commercialization of Mag-Chrome refractory from friable Chrome Ore by Burn Standard Co. Ltd., Salem.
- Successful technology transfer on low cement castables (LCC), ultra-low cement castables (ULCC) and No-cement self flow castables to leading industries.

Carbon containing refractories such as MgO–C and Al2O3–C have been widely used for steel ladle lining. High alumina bricks give a lower life of steel ladle due to structural spalling. MgO–C and Al2O3–C bricks have negative or insufficient residual expansion causing joint erosion and corrosion of the lining.



SEM photo micrographs of mullite aggregate formed at 16000°C from: (a) Bauxite-1 and (b) Bauxite-2

Sol-gel Science & Nano Structured Materials

One of the major areas of research during the decade was on Nanostructured materials primarily based on sol-gel and/or soft chemical processing for which CGCRI had developed considerable expertise during the previous decades. The emphasis was both on scientific and technological aspects.

Infiltration of a ceramic perform by an inorganic sol is an effective method for the fabrication of near-net-shape (NNS) ceramic matrix composites (CMC). The ceramic sol after calcinations, forms the matrix and the discontinuous fibers in the form of porous performs act as the reinforcement agent.CGCRI developed an effective infiltration technique for the fabrication of alumina and mullite fiber reinforced CMCs using the respective discontinuous fiber performs as the reinforcement agents. Also, a custom made sol infiltration apparatus has been fabricated for the preparation of NNS CMCs.

Applying inorganic-organic hybrid sol-gel process, several nanocomposite sols were developed for applications in the area of functional coatings. The final coatings were composed of covalently bonded organic such as. PEO, PMMA, acrylate and inorganic such as SiO_2, TiO_2, AlOOH in the form of nanoparticles or network components.

The process of thermally curable hard coatings on CR-39 ophthalmic lenses (developed earlier) was transferred during the decade to two companies in the country. One of the licensees M/s. Advanced Surface Technologies, New Delhi built up capacity to produce hard-coatings @1000 lenses per day.

An optical limiter differs from the ordinary light-filters in the sense that they transmit light when the latter is at low intensity but limits the transmission at its higher intensity, i.e. the efficiency of limiting light transmission of such material, increases with the increase of intensity of the incident light; and hence can function as a protector of laser sensor.

Infiltration of a ceramic perform by an inorganic sol is an effective method for the fabrication of near-net-shape (NNS) ceramic matrix composites (CMC). The ceramic sol after calcinations, forms the matrix and the discontinuous fibers in the form of porous performs act as the reinforcement agent.

Sols having long shelf lives suitable for application as transparent hard coatings on polycarbonate (PC), polymethyl methacrylate (PMMA), polypropylene (PP), polyethylene terephthelate (PET) were also developed. Using these sols, coatings of variable refractive index values (1.48 – 1.65) could be produced without sacrificing the optical clarity, adhesion and abrasion quality of the coatings.

Hard (pencil hardness >6H) and protective coatings on steel substrates were also developed. 3 Incorporation of Ag and Au nanoparticles made the coatings golden-

Hard coatings on plastic (CR-39®) ophthalmic lenses

The uncoated or hard-coated plastics suffer from reflection losses >10% (>5% per surface) or depend more on the refractive index of the plastics. As a result, these materials show 90% or less transmission.

yellow and pinkish-purple in colour respectively. The colours originated from the surface plasmon resonance of the embedded metal nanoparticles.

Anti-reflective (AR) coatings having reflection minima at desirable wavelengths were also developed on plastic lenses and sheets for better viewing purpose. The AR coatings were based on a two-layer optical design comprising high and low index inorganic. The uncoated or hard-coated plastics suffer from reflection losses >10% (>5% per surface) or depend more on the refractive index of the plastics. As a result, these materials show 90% or less transmission. As the reflection minima can be tuned at different wavelengths, different reflecting colours can be generated which has cosmetic appeal.

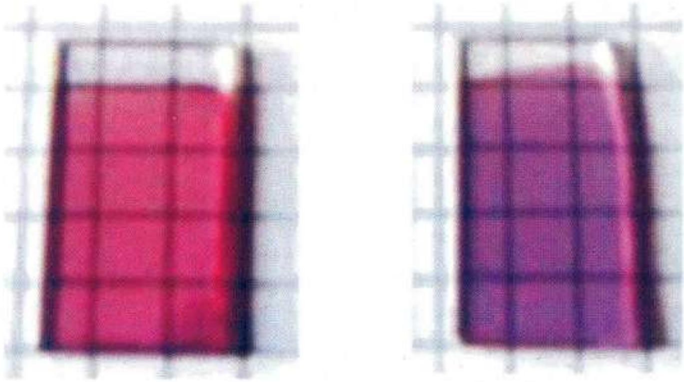
In another development, the colour of the Au doped hybrid films deposited on glass substrates were modified by plasmon coupling of the embedded Au nanoparticles. Photos

reveal colour change in coating. The plasmon coupling of the embedded Au nanoparticles with respect to the UV-treatment energies was found to be mainly responsible for colour change.

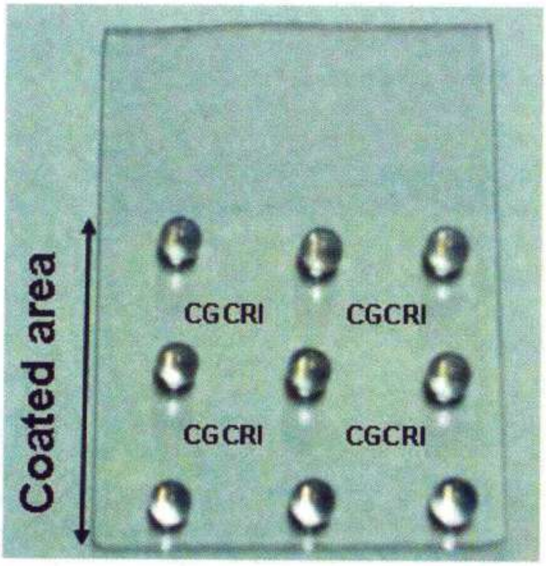
Another achievement was the development of nanorod assemblies of mesoporous boehmite (γ-AlOOH) films having thickness ~2 μm with a preferential crystallographic growth along <020> on glass substrates. For the first time it was observed that these nanorods assembly of boehmite thin films could act as an excellent catalyst for the reduction of harmful $KMnO_4$ into MnO_2 nanoparticles (30–40 nm) in aqueous solution (pH ~7.0) at room temperature. Hence, this film catalyst can find unique application in the purification of KMnO contaminated waste water.

Heat reflecting ITO coatings on glass of dimensions of about 130mm x 120mm window glass was developed by utilizing cost effective sol-gel technique. The coatings were transparent in the visible (~75% T) and electrically conducting (~20 to

Ag-doped hard-coating (coated area~10x10cm2) on stainless steel substrates



Photographs showing the colour change of the Au nanoparticle doped hybrid (SiO_2-TiO_2-PEO) films deposited on EDF glass substrates after UV-treatments with energies (a) 5.3+0.1 J cm-2 and (b) 53.0+0.5 J cm-2



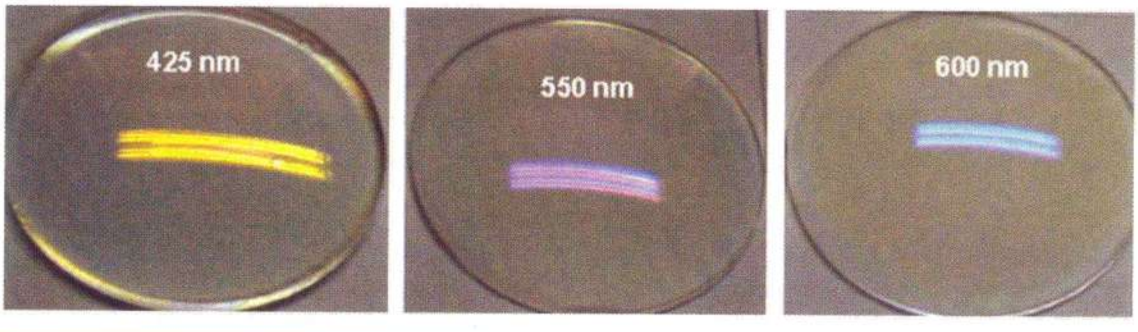
Water droplets on the hydrophobic coatings applied on glass surface

~700 ohm/square-1 according to physical thickness, *i.e.* number of layers).These may also be used as the antistatic glass as well as transparent electrode for various optoelectronic applications. Total thermal emissivity of the coatings was found to decrease with increase in number of layers and the four layer system generated relatively low emissivity (~0.40) which was a very encouraging result for heat reflector applications.

Capillary Force Lithography (CFL) technique was utilized to pattern dip coated silica films. A gel film in the liquid state can be imprinted with a soft stamp (Sylgard 184) also called elastomeric mold. The subsequent controlled annealing produced transparent oxide based grating structure in the waveguide of thin film. By curing the sol-gel films in the temperature range of 350–450°C, patterns of different oxide systems were obtained. Formation of planar waveguides by embossing oxide films of said kind can be used as optical sensors.

The demand potential of hydrophobic, hydrophilic, corrosion resistant, photocatalytic, dust repellant and coloured coatings are very high in several areas such as aerospace, automobiles, window panes in building, art gallery, etc. Several hydrophobic coating sols were prepared and applied on ordinary glass slides. The application of such coatings on glass surface made the surface super-hydrophobic and as a result, water drops assumed spherical shape.

Nanoscale BiFe03 offers scope for improving the magnetic property as well as coupling. Nanoscale BiFe03 particles were prepared by both combustion synthesis (combustion of glycine-nitrate mixture) and sonochemical processes. The particle size varied within 4–40 nm. The nanosized particles exhibited a remarkable improvement (~0.4u,j/Fe) with strong ferromagnetism even at room temperature.



AR-coated CR-39® lenses showing different reflection colours

Ceramic Membrane

As a part of its mission of Societal service, CGCRI initiated several major programmes, during the decade for safe drinking water using Ceramic Membrane based technology. Thus, a technology package was developed by CGCRI for arsenic removal from contaminated ground water. The technology was based on the development of the following major components:

i. Know-how for fabrication of low cost clay-alumina based ceramic membranes in mono and multichannel configuration.

ii. Know-how for preparation of adsorbent media in colloidal form.

iii. Ceramic membrane based hybrid technology for simultaneous removal of Arsenic and Iron from groundwater. It is a completely new concept of combining the basic principles of adsorption and micro filtration for simultaneous removal of relatively high concentration of arsenic (~1.5 ppm) and iron (~ 15 ppm) in a single step down to levels of < 10 ppb for arsenic and < 0.3 ppm of iron for producing safe drinking water as per WHO recommended limits for these contaminants. The technology was transferred to M/s Entech Metals Pvt. Ltd., Kolkata on 23 April, 2003.

iv. System design and fabrication of equipment containing ceramic membrane module fitted to ground water source.

Different types of ceramic membrane

The salient features of the developed technology are:

a) Simultaneous removal of Arsenic and Iron from highly contaminated groundwater

b) Excellent adsorption capacity of the media (about 7–8 times higher than the conventionally used granular ferric hydroxide).

c) No leaching of media leading to recontamination

d) Modular design with flexible production capacity (2500 – 10000 LPD)

e) Semi-automatic, user friendly operating procedure.

Since the development of the technology package, a total of 28 Ceramic Membrane based Community Model Plants (2500 - 10, 000 LPD) for Iron and Arsenic removal have been installed and are in operation in several districts of West Bengal and North Eastern Region (covering 8 States).

A total of 12 Iron Removal plants have been installed by Private Entrepreneurs (with self / bank financing) under SSI sector with employment generation.

While pilot scale demonstration of iron removal plants (5000 LPD capacity) made out of 2 SS modules each with 7 numbers of 19 channel ceramic elements was being pursued for propagation of the ceramic membrane technology for production of quality drinking water, an initiative was taken up for enhancing the capacity of ceramic membrane modules in order to demonstrate the effectiveness of ceramic Micro Filtration (MF) membranes for

Installation of a few Community Models at Barasat 24 Parganas (N) which are in successful operation right from the day of installation

Arsenic & Iron Removal Plants of Capacity 2500 LpD

A. Bamanmura, Ward No. 16

a. Entrance of Ramkrishna Sevashram, Bamanmura where the Community Model installed

b. The Community Model installed at Bamanmura for community application

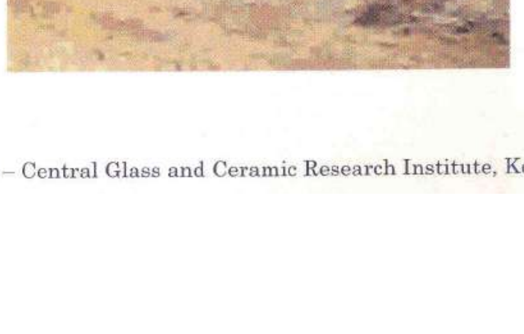
B. Barasat Municipality

C. Pilot Plant Unit for Arsenic Removal using Ceramic Filter Module

D. Nibedita Pally Local Committee, Word No. 19

E. Chakehaturia Local Committee, Word No. 21 pretreatment of Reverse Osmosis (RO) feed water and development of ceramic MF-RO plants for purification of iron contaminated brackish ground water. The plant consisting of 2 PVC modules with 19 and 37ceramic elements was designed for supply of 10000 LPD quality drinking water after removal of iron and brackishness of ground water from a deep tube well. The plant was inaugurated on August 10, 2008 by the Hon'ble Minister for Food Processing and Horticulture, Govt of West Bengal for supply of iron free potable water to people of the area. The plant was handed over to Nischinda gram Panchayat for day to day operation and production of drinking water.

Another key achievement in this area was the purification of rice bran oil miscella using ceramic membrane technology. While bench scale experiments were performed using 20–30 litres of Rice Bran Oil Miscella (RBOM), the pilot plant trial was carried out with 200 – 500 litre samples in 1000 litres feed tanks. Pilot plant unit with two types of modules fitted with 7 mono and 19 channel ceramic elements was designed, fabricated and installed in the premises of an industry called M/s Navyug Agro Industries Pvt. Ltd., Nabagram, Burdwan, West Bengal for purification of rice bran oil hexane miscella.



Advanced Clay & Traditional Ceramics

In the area of clay and traditional ceramics, the institute has continuously been catering to the need of small and medium industries and local potters dealing with ceramic products. Development of appropriate technology for diversification of rural pottery products and traditional ceramics is under societal mission. Here are the details of the activities:

Synthesis and characterisation of organophyllic nano clays

Nano clays have received much attention over the last decade because of their potential application areas like automotive, aerospace and packaging industries as nanofillers in polymer-clay nanocomposites. It is one of the promising materials for the twenty first century.

CGCRI is developing organophyllic nanoclay under a project sponsored by ISRO for space application at VSSC. Nanoclay is an important class of inorganic – organic hybrid which can be prepared by surface modification or intercalation of Montmorillonite (MMT) is a clay mineral with long chain organic cations such as alkylammonium, alkylphosphonium and alkylimidazolium. It is a 2:1 layered silicate mineral with high cation exchange property and very high aspect ratio. Cation exchange property of MMT is exploited to implant organic cations, rendering the hydrophilic clay surface to organophilic. The intergallery chemistry plays a dominant role to control the property of the surface-modified nanoclay as a pre-engineered nanostructure. When these modified nanoclays are dispersed in polymer matrix, clay platelets get delaminated or disaggregated which improves the property of the composites.

The objective is to prepare nano clay of higher thermal stability, intergallery height and organic loading so that the clay becomes more compatible with polymer matrix and enhances the properties of the composite much more effectively. As an input to the applied R&D technology, the achievements so far have been the improvements in basal spacing upto 27°A as intergallery height, thermal stability of 330°C an organic loading upto 33 mass % could be obtained.

In recent years, montmorillonite (MMT) has been regarded as an industrially important material because its layered structure is uilized to prepare polymer layered silicate clay nanocomposites. The MMT is intercalated by various organic cations to increase the basal spacing between layers so as to facilitate the separation of individual platelets into polymer matrix by chemical and mechanical means. MMT is obtained from bentonites. A large number of deposits of bentonitic clay minerals is available in India but the same is not utilized for commercial production of organo clay or intercalated nanoclay as the reserves contain impurities. Total amount of bentonite in India is about 531 mllion tonnes. Presently the required variety of pure MMT is procured from abroad.

In the present investigation one variety of Indian clay, commercially available under a brand name was selected for intercalation and the degree of intercalation in organic surfactants were compared with similar clay available under a brand name internationally to assess the comparative usability of the Indian material.

Clay NK supplied by Neelkanth Mine Chem (India) (Bentonite powder Alka Bond Super) was taken as raw material. Imported clay: PGV supplied by Nanocor Inc (USA) was used as reference material for comparison. A variety of investigations such as Chemical analysis, Particle size analysis, DTGA were carried out for untreated clays while TG and FTIR studies were carried out for both untreated and intercalated clays.

The XRD analysis of the intercalated clays revealed that the modification of clays with cationic surfactants by cation exchange could be determined by the expansion of the MMT clay layer which is the increased basal spacing. The XRD pattern showed that the presence of peak for d001 diffraction at 16.38 Ao for intercalated NK and 17.69 Ao for intercalated

> Nano clays have received much attention over the last decade because of their potential application areas like automotive, aerospace and packaging industries as nanofillers in polymer-clay nanocomposites. It is one of the promising materials for the twenty first century.

PGV. Basal spacing reflected the proportion of the interlayer occupied by the surfactant. So basal spacing increased depending on the amount of cationic surfactant intercalated within the interlamellar space which is also dependent on the CEC of the respective clay. Intercalated PGV had higher CEC, that is, 96 meq/100 gm than intercalated NK having CEC of 59 meq/100 gm. Therefore it could be concluded that the intercalated PGV had a bilayer arrangement whereas intercalated NK had mixed monolayer bilayer arrangements.

NK had low CEC which led to its lower organic loading than PGV when intercalated. This led to slightly smaller basal spacing in intercalated NK than intercalated PGV. Inspite of the above facts intercalated clays from NK and PGV had comparable basal. Hence, NK can be used as organoclay in various applications especially in the field of clay containing polymer nanocomposites where PGV is already in use.

Further work is under progress.

Development of singular clay from various sources of WB clay by blending process

The individual clays from the sources were not suitable for incorporation in traditional ceramic body composition. A blending technique was therefore developed in this project. Two different singular clays were developed by combining five different clays in definite proportions. Selection was made judiciously after considering different physical as well as chemical properties of the clay samples.

The blended singular clay so developed was utilized in the formulation of different body compositions of stoneware type. In the composition, blended clay was incorporated to the of 30–35%. Samples were made by adopting different fabrication techniques such as jiggering, slip casting, pressing and extrusion. While maintaining high slip density, casting slip with good rheological properties could be achieved. Casting of wares posed no problem and good casting rate of 9–10mm/hour was obtained. The wares matured at a temperature of 1250°C and the fired ceramic properties were reasonably good. It is concluded that the blending technique developed may be commercially exploited for gainful utilization of the lean variety of clays.

As a part of fulfillment of the project, one workshop on Singular clay by blending process was conducted on December, 18 2008 at Shilpa Sadana, Visva-Bharati, Sriniketan. The programme was organised by CGCRI jointly with DST, Govt of West Bengal and Silpa Sadana, Visva-Bharati, Sriniketan. The workshop received good response from the students and local artisans.

Development of a technology package for manufacturing sanitaryware based on locally available low cost material

Sanitaryware is manufactured utilizing a combination of good quality kaolinitic clay in the organised industrial sector as a high value product. In the entire eastern & northeastern regions of India, nonavailability of

> Sanitaryware is manufactured utilizing a combination of good quality kaolinitic clay in the organised industrial sector as a high value product. In the entire eastern & northeastern regions of India, non-availability of quality raw materials discourages investors from ventureing to the sanitaryware industry.

quality raw materials discourage investors from venturing into the sanitaryware industry.

CGCRI has successfully made experiments in which inferior grade china clay as well as red burning illitic clays, which are abundantly available throughout the country, have been incorporated in the clay-quartz-feldspar triaxial composition to produce ceramic products with properties comparable to the conventional white clay based porcelain wares.

The encouraging results have opened up the possibility of producing sanitarywares replacing costlier ingredients like white burning china clay fully or partially by inferior quality clays. The immediate benefit from this activity will reach the rural people by reducing the cost by about 40% compared to the commercially available products and by releiving the burden of hygiene and offering hazard free sanitation and self employment.

During the period, a full size Indian pan was developed along with a prototype of a mouth basin out of locally available inferior clays.

Upgradation of clay pottery cluster at Matigara

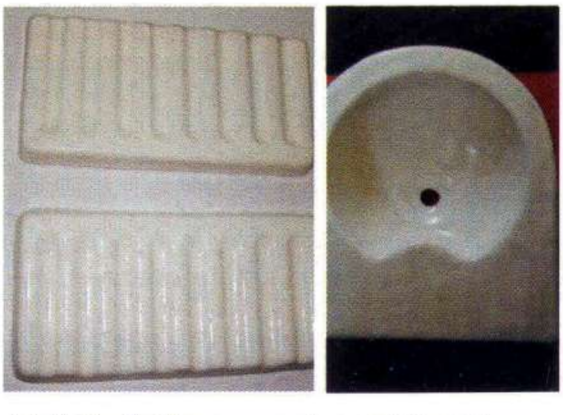
The project was sponsored by Sub-DIC of Siliguri in the Darjeeling district, under Directorate of Micro & Small Scale Enterprises, Ministry of Cottage & Small Scale Industry of the Govt of West Bengal. Preliminary interaction with the local potters was carried out by the CGCRI scientists. The interaction helped understand the pottery manufacturing process and the problems faced by the potters during practice. At the request of Sub-DIC, Siliguri two workshops on pottery making were organised at Panchmura and Matigara respectively.

The workshops were organised to discuss the results obtained by CGCRI on evaluation of raw materials which the potters of the region utilize. Based on the judicious blending, one body composition was formulated and the technique was demonstrated to the local artisans. CGCRI also provided necessary technical inputs to the sponsors for preparation of a project proposal to be submitted to the Government for financial assistance. The proposal envisaged creation of a Common Facility Center at Matigara for production of glazed crockeryware on a semi-commercial scale.

Technology upgradation of Murlu roofing tiles cluster

The project was sponsored by Sub-DIC of Bankura, under Directorate of Micro & Small Scale Enterprises, Ministry of Cottage & Small Scale Industry of the Govt of West Bengal to upgrade the technology of the Murlu roofing tiles cluster. Preliminary meetings were held by CGCRI scientists with the local potters to understand the tiles manufacturing process and also acquaint with the problems faced by the local potters. Samples of raw materials utilized by artisans of Murlu village were evaluated at CGCRI and the best composition formulated by scientists were disseminated to the potters in a couple of workshops which followed at Murlu and CGCRI respectively. Testing of finished products and their quality control were also demonstrated.

Necessary technical inputs were provided by the Institute to the sponsors for preparation of a project



A full size Indian pan and a prototype of washbasin

CGCRI scientists inspecting crockery product manufactured by artisans of Matigara

proposal to be submitted to the Government for financial assistance. The proposal envisaged creation of a Common Facility Center at Murlu for production of roofing tiles of improved quality at commercial scale.

Outreach Centers, Khurja & Naroda

The watershed- progresses during 1st decade in the New Millennium of the outreach centers were also very remarkable.

Here is the short depiction of the activities of the outreach center, Khurja:

Development of white ware ceramic cluster at Khurja: The center embarked as the nodal center for the development of white ware cluster in the region. The center's initiatives to create a strong network of the industries along with several agencies which would provide financial assistance helped the center obtain the approval for a project on 'CFC for body mix preparation and firing services for the Potteries of Khurja' from the MSME, Government of India. The center's intervention and role in an 'Exposure visit to Bikaner' of the white ware entrepreneurs of Khurja region helped the entrepreneurs transform their mindset through debate and deliberations with their counterparts.

Ambient air quality monitoring at Khurja

Several types of gases and suspended particulate matter go into the atmosphere from large number of ceramic units in Khurja. The project was taken up under the sponsorship of UPPCB to monitor the pollutant levels to spread awareness among the entrepreneurs so that corrective action through fuel efficient measures could follow. During the period, pollution levels of SPM, RSPM, SO2 and NOx were recorded by RDS equipment supplied by UPPCB.

Improvement in design of tunnel kiln for better fuel efficiency of white ware pottery industries at Khurja

The project was undertaken with financial assistance from PCRA to modify the designs of 5 tunnel kilns in Khurja. The length of the tunnel kilns were enhanced along with chimney height and diameter. Arrangements were also made for waste heat utilization from the cooling zone to the pre-heating zone through pipe lines, better insulation in the firing zone and addition of two more burners and thermocouples.

Reducing kiln car mass through better designing to improve fuel efficiency

This project was sponsored by the PCRA. Use of the Low Thermal Mass (LTM) kiln furniture has received worldwide attention. The use of recrystallised silicon carbide hollow beams with extruded cordierite batts along with ceramic fiber or vermiculite have revolutionised the kiln furniture industry.

Flue gas analysis in the oil and gas fired shuttle & tunnel kilns in Khurja

The flue gas analysis helps assess the status of combustion process in a kiln. By proper control of the excess air, parameters like CO and O_2 can be optimized so that a state is achieved where combustion is almost complete. This would not only reduce the fuel consumption considerably but also curtail the production of the green house gases into the atmosphere.

Indigenous development of roller head jigger machine for tableware industries of Khurja

Roller head jigger machine is a semi automatic machine for fabrication of flat and hollow wares such as mugs, cups, saucers and plates. The machine is imported at high prices. The Indian entrepreneurs including those in Khurja are not in a position to introduce such equipment for fabricating the ceramic wares. The equipment is very easy to operate and does not require any major skill. A unit of machine was indigenously developed by the center.

The Khurja center was progressing well achieving societal mission such as organisation of training programmes on Glass Beads and Beaded Jewelry making, as well as solving problems, such as High Alumina ferrules was supplied to Oil Refinery at Mathura. Due to high cost as well as lengthy time of delivery, they were facing problem to get the ferrules in time.

Further, the short depiction of the activities of the outreach center Naroda is as follows:

Development of glazed floor tiles utilizing low energy intensive technology for body and glaze production

The objective of this project was to utilise the locally available low grade clay through blending and levigation and utilization of scrap for body engobe and glaze development.

A novel usage of stoneware scraps dumped in the respective crockery plants was proved. The usage of scraps reduced the content of zircon opacifier, a costly raw material used in engobe manufacturing. The addition of various ceramic scraps in body composition also lowered the firing temperature. Further work on scrap addition in engobe and matt glaze showed similar properties as that of

Views of construction of LTM kiln cars at different industry sites

Indigenously developed Roller Head Jigger Machine at Outreach center, Khurja running engobe and glaze in ceramic tile industries. The uniqueness of this work was in the use of fired crockery scraps containing percentage of zirconia that could impart whiteness and thereby help reduction in the the zirconia opacifier content in the engobe. The replacement of costly zirconia opacifier by sanitaryware scraps caused no difference in whiteness and maturing property of tiles.

Technology upgradation of development of terracotta cluster in Gujarat state

This project was sponsored by the GMKB of the Government of Gujarat for the development of Wankaner cluster. In this cluster, rural artisans and manufacturers of Tawdi were given exposure to the manufacturing technology of various pottery based on terracotta bodies. The programme brought about a significant change in the attitude of rural artisans especially the woman.

State developmental studies on the energy saving low mass kiln furniture with higher life for pottery industries in Ahmedabad

The project was taken up under the sponsorship of DST, Government. of India to improve the life of kiln furniture.

Ceramic tiles engobe developed using fired crockery and sanitaryware scraps

Futuristic research work in traditional ceramics based on sol-gel technology

The objective of the project was to set up lab facilities for sol-gel technology based studies and develop low temperature maturing coatings on the traditional ceramics based products in order to improve their surface characteristics. Salient features of the research carried out were:

- Development of hydrophobic coatings on glazed ceramic tiles
- Reflective properties of glazed wall tiles
- Surface properties of sol-gel titania thin film coated ceramic glazed tiles

During the decade, the outreach center CGCRI, Naroda had a significant Project on blue pottery glaze development - augmentation of productivity and quality in the production of blue pottery in cottage scale sector in Jaipur, Rajasthan. In this project, the center associated with rural artisans of Jaipur region and with the help of RUDA(An agency of Govt. Of Rajasthan) a successful development of lead less glaze frit for blue pottery was made. Further dissemination of technology for high strength lead-free glaze for blue pottery was also been carried out.

Image of the paperweight on a) Uncoated tile and b) Sol-gel coated tile showing coatings capable of imparting colour and improving gloss of developed glazed tiles

Dr. Dipten Bhattacharya receiving CSIR's Young Scientist Award

Dr. Rabivrata Mukherjee receiving CSIR's Young Scientist Award from Shri Kapil Sibal H'onble Minister for Science &Technology and Earth Sciences

The technology package for Production of lead free blue pottery in the cottage sector in Jaipur, Rajasthan was transferred to the sponsor at a workshop organized at Yojana Bhawan, Jaipur, on 14th June, 2000.

Blue pottery of CGCRI Naroda Center

Dr. Chandra Bhan, Hon'ble Minister Min. of Industries, Govt. of Rajasthan, while launching the technology and releasing the final report stated that this technology development of lead free blue pottery by CGCRI, Naroda Center was a landmark achievement in the history of blue pottery.

This lead free high strength eco-friendly blue pottery glaze and the technology was transferred to the artisans in several clusters around Jaipur through a series of T&D programme as well as implementation at unit level by CGCRI. The blue pottery technology was also highlighted in "TURNING POINT" programme of Door Darshan several times.

Sri Suresh Chandra Mehta, Hon'ble Minister of Industries, Govt. of Gujarat inaugurated the Workshop on "New Technology Developments in Ceramic Industry" as a part of celebration of the Golden Jubilee Year (1950-2000) of CGCRI, Kolkata held at Naroda Industries Association Hall on November 10, 2000 and organised by CGCRI, Naroda Center, Ahmedabad.

The Center, Ahmedabad was awarded the prestigious Federation of Gujarat Industries (FGI) award for excellence in the field of research in Science & Technology for the year 2003. The award was conferred on CGCRI, Naroda Center, Ahmedabad in recognition of its innovative contribution in the development of "lead free frit" for application in the blue pottery of Jaipur.

Installation of Local Area Network

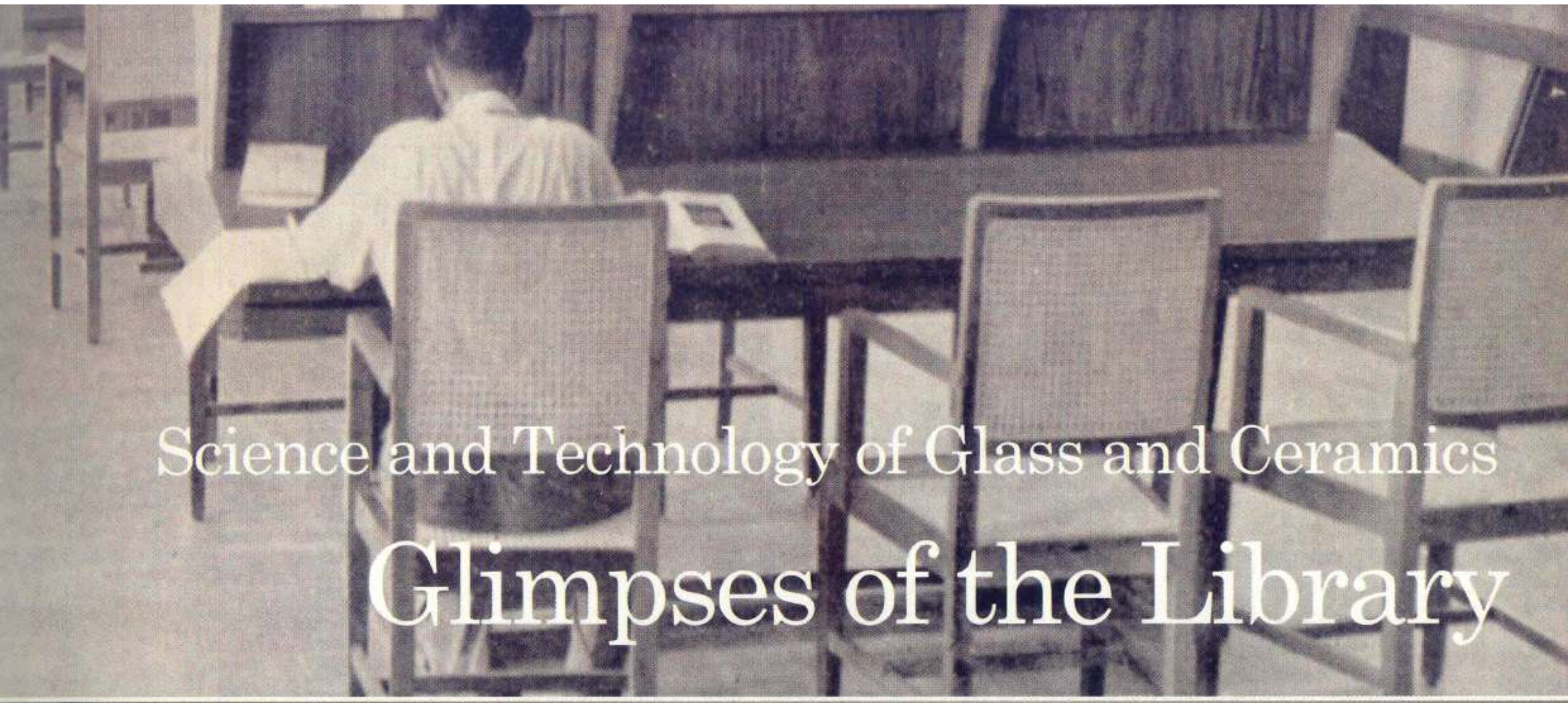
Local Area Network with 168 nodes distributed over different sections and departments of the Institute was commissioned and became operational since June 2002. The system had the capacity to incorporate 230 nodes without any upgradation in switch configuration. CGCRI Website (http://www.cgcri.res.in) containing the then up-to-date information of the Institute's R&D activities was hosted on the server for ready access by the outer world.

Award Received

Two Scientists received CSIR Young Scientists awards to bring laurels to the Institute. Dr. Dipten Bhattacharya received the Award in 2001 and Dr. Rabibrata Mukherjee received the Award in 2006.

Science and Technology of Glass and Ceramics

Glimpses of the Library



Library and Information Services - **A Knowledge Resource Center**

The Beginning and the first decade

The library, an integral part of the R&D activities of the Institute, started functioning and evolving with the requirement of the Institute. A total five hundred eighty seven books were procured before formal inauguration of the Institute on 26th August, 1950. The first book entitled 'Recent advances in Physical and Inorganic Chemistry' written by Stewart and Wilson, 7th Edition, published by Longmans Green & Co, London, priced Rs 24 /- was received on 17th January 1946. In early stage, after formal opening of the building of August 26, 1950, the library was housed in a hall adjacent to Director's office. By the end of the 1950s, the collection size went more than 8100.

1960's: the second decade

In the second decade, with a view to provide a medium for rapid dissemination of information to scientist and technologists on the important contents of world literature on glass, ceramics, enamels, refractories, mica, etc., the Institute library started bringing out a monthly publication of classified titles under the title "CGCRI Documentation List". The first number of the bulletin was brought out in the month June 1966. It listed 268 titles. The publication enumerated references scanned from the then current scientific literature received at the Institute. The entries were arranged subjectwise according to Documentation Europeenne Ceramique system of classification.

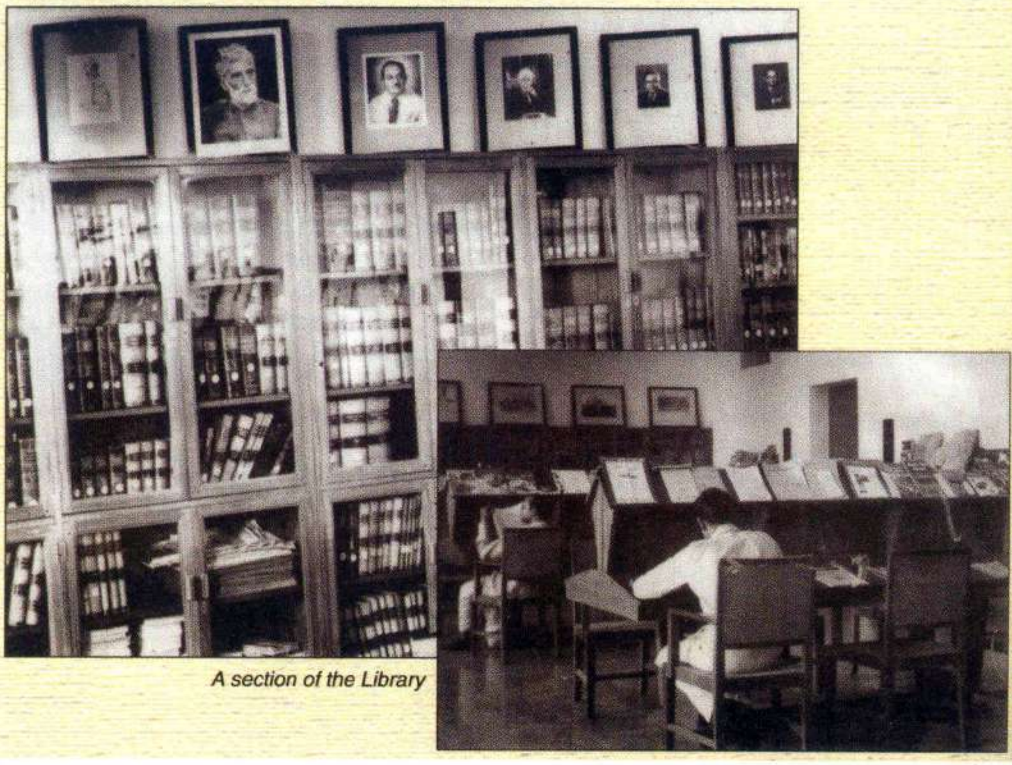
By the end of the 1960's, the collection size, *i.e.* total number of books including bound volumes had reached 25243. The number of scientific and technical journal subscriptions including those received against membership of learned societies was one hundred forty nine. Many journals were also received in the library on exchange basis against CGCRI Bulletin.

1970's: the third decade

The activities of the library and information processing work of the Institute were carried out then in three different sections, namely Library, Documentation and Data Bank. In order to cope with the progressive increase, annex having floor area 61 ft X 25 ft, was constructed and the entire library was reorganized for effecting overall improvement in storage and preservation of documents to ensure quick retrieval. Amenities in the reading room were also increased.

Consequent to the establishment of an outreach center at Naroda, action was taken to set up the Naroda Center Library. Development activities in information retrieval techniques were also continued and a model thesaurus was developed on glass fiber technology for deep subject indexing with controlled vocabulary for the bibliography on glass fiber technology. Another important work done was receipt and technical processing of scientific publications offered by the Ministry of Overseas Development, U.K., through the British Council, Calcutta.

Information was catered to the researchers through supply of reference materials on various research and industry matters. Selective short bibliographies were prepared and supplied on request from the scientists.



A section of the Library

Library in its early stage

The work of processing and the publication of subject bibliographies were continued. Evaluation of a system for collection, organisation, storage and retrieval of scientific and technical and techno-economic data were undertaken. Apart from the existing database compilation work on raw materials, process, production, capacity, quality, control, demand, costs, factory layout, plants, manpower, exports, imports, and other techno-economic data in the field of glass and ceramic were taken up.

By the end of the 1970s, the collection size, *i.e.* total number of books including bound volumes reached 31,235. The number of scientific and technical journals received on subscription and membership basis 139, of which 124 on exchange basis and 75 on complimentary basis.

1980's: the fourth decade

The library continued to render infrastructural information facilities to the R&D personnel of the Institute as well as to those from the glass and ceramic industries, universities, and other research organisations. For the purpose of wider dissemination of information, Documentation Unit of the Institute made available subject references and information relevant to the different R&D projects to the project leaders. Data Bank also continued to cater to the various compilations of technoeconomic, industrial and commercial data/information needs of the R&D personnel of the Institute as well as of the related industries, consultancy organisations. National Information

Center for Advanced Ceramics (NICAC) under aegis of the National Information System for Science and Technology (NISSAT), Govt. of India, was set up to meet the consistent demands from the industries, business houses, etc. in India and abroad in the Library. "Directory on ceramic and glass industries in India" – a National directory" was compiled by the Documentation Unit. The same was published by Vilmy Ricerche, Italy, for international circulation.

The end of the 1980s saw the computerization of documentation services. In order to cope with the increasing volume of the existing conventional bibliographic data base as well as for quick current awareness, and bibliographic services, steps were taken to computerize the information storage and retrieval system. To implement the first phase of the plan for the computerization of the documentation services input of bibliographical references selected from the relevant literature was given to the computer. In an effort to create a comprehensive bibliographical database in the relevant fields, the computer was also fed with a portion of the retrospective bibliographical references from the manual database of the section.

Planned activities of document procurement programme were also continued for the development of Khurja Center Library. The CGCRI, Library participated in the exhibition on "Information for Industry" organized by IASLIC during September 25-28, 1985 at Asutosh Centenary Hall, Calcutta.

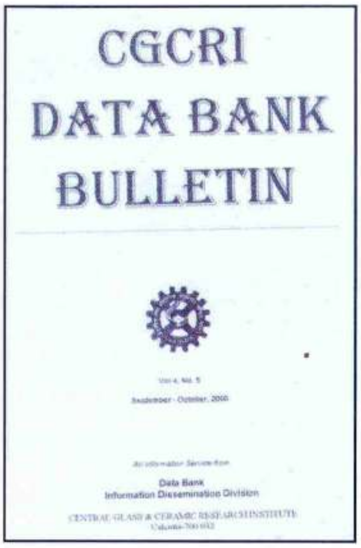
A detailed programme for development of a microform library unit was prepared and included within the purview of overall "Informatics" programme of the seventh and eight five-year plans of the Institute. The Library was also included in the computer networking of scientific and technical libraries (LIBNET) programme sponsored by NISSAT, Government of India, New Delhi.

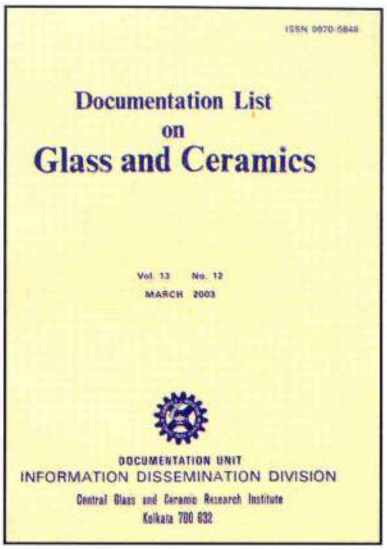
By the end of the 1980's, the collection size, *i.e.*, total number of books and publications including bound volumes of journals, standards, microdocuments, etc. reached 35,531. The number of scientific and technical journals received on subscription and membership basis was 73, on exchange basis 110 and on complimentary basis, 30 respectively.

1990's: the fifth decade

The Calcutta Library Network (CALIBNET) as envisaged by NISSAT, Government of India, was a Metropolitan Area Network (MAN) for libraries in Calcutta. The CGCRI Library was included as one of the 40 S&T libraries of the CALIBNET programme which aimed at automating the nodal libraries as well as creating a library service organisation for providing global user services. The CGCRI Library expanded services through CALIBNET. The Data Bank continued development, augmentation and updating of techno-economic, industrial and commercial data bases. The two important services of the Documentation and Data Bank were to bring out Documentation List on Glass and Ceramics and CGCRI Data Bank Bulletin for the wider dissemination of glass and ceramic information for the Scientist of the Institute as well as for the related industries, business house and others.

However, at the dawn of the 1990s, new trends and developments worldwide posed great challenges for library services in India. This was information and communications technology, which opened new doors in every profession and segment of the society. by the end of the 1990's, there was a great change in information access due to Internet. Library introduced dial up Internet access facility in the library and provided informal training to the users of the library as and when they requested for the same in respect to how to surf net, how to use e-mail facilities, etc. In a word, the users were acquainted with how to access internet resources and services. In 1999, on the occasion of National Science Day, a demonstration was held in which around 100 students from different schools were offered a glimpse of the world of information science and technology through lectures and practical demonstrations on classical and current options in the collection, classification, sifting and use of information, mainly for academic pursuits in the library. The school children were also





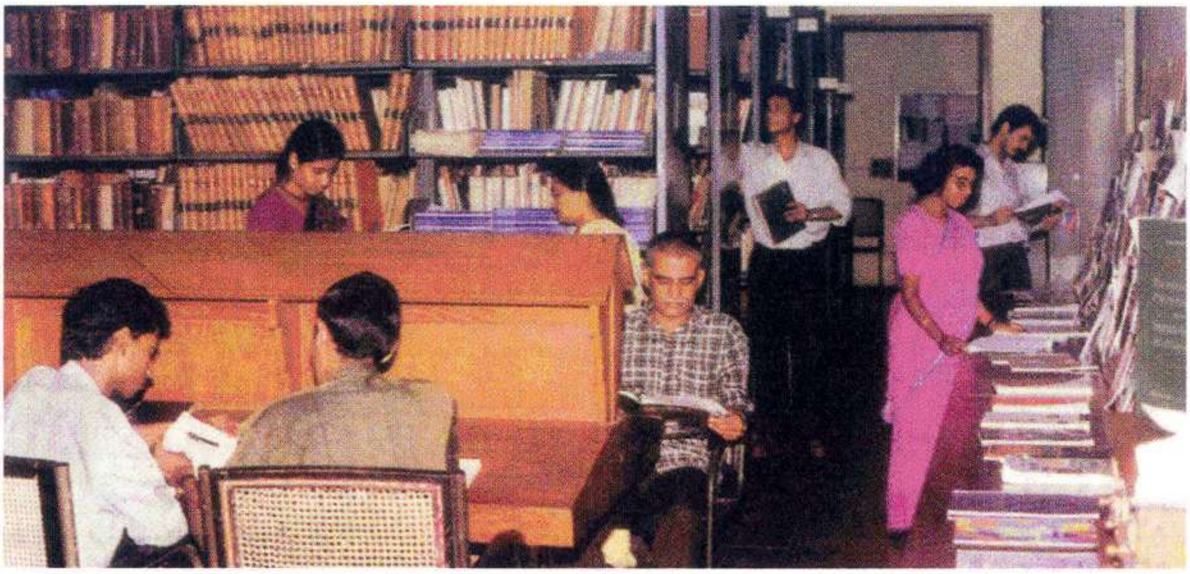
introduced to the application of computers as a tool for disseminating and retrieving information, and multimedia applications through Internet.

By the end of this decade, another great achievement of the Library was the introduction of e-journal services to the users of the library that were free on print subscription. By this time, library resources were not confined within four walls of the Institute.

2000: the sixth decade and A New Millenium

By this decade, library resources consisted of both print and digital document. Due to CSIR e-journal Consortium library has now enormous number of journal access of various publishers including patent, standard and citation databases. Managing

Student being explained the use of CD-ROMs during National Science Day



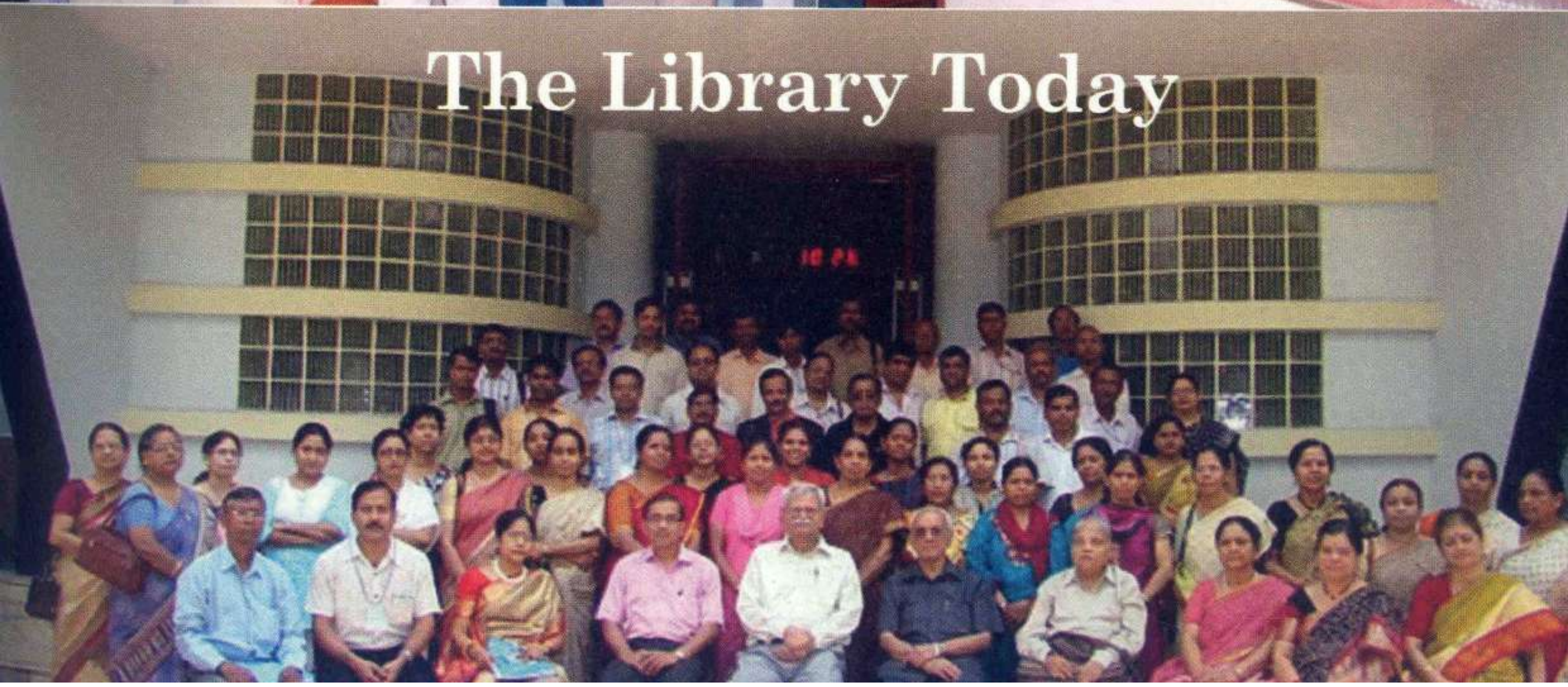
Reading area in the library in 1990's

services of the e-journals were the most important issues. E-journals added enormous resources to the collection and improved the service of the library, enhanced access to journal literature, and decreased the demand for photocopy services as well as document delivery of single articles. Library organized both formal and informal training to the staff as well as library users as and when required. In 2002, to improve the over all efficiency of the library services, it was decided to automate library's key functions such as acquisitions, serials control, cataloging, circulation and the public access catalog. Accordingly, Libsys an integrated library software was installed in 2003 and retrospective data approx for 3,000 documents were fed into the system including books and bound volume of journals. In 2005, the Library was shifted to a new site of the Institute, having floor area of 6000 sq ft merged with the three units, namely, Library, Documentation and Data Bank and named the S Kumar Library. Subsequently, the Library has been was renamed as CGCRI Knowledge Resource Center as decided in the last meet of the Head of the Libraries of the CSIR Laboratories held at Ghaziabad, U.P.

2010 and Diamond Jubilee

In 2011, on the occasion of year-long Diamond Jubilee celebration of the Institute, the Library had first time opportunity to organize a National Seminar on Information and Knowledge Dissemination: Present Status and Future Direction.

The Library Today



Diamond Jubilee

A matured experienced Institute of international repute steped into Diamond Jubilee Year. In this year a new leader joined to move the Institute towards a new challenging direction.

Prof. Indranil Manna took over as Director

Prof. Indranil Manna took over the charge of the Institute as Director on March 1, 2010.

Diamond Jubilee Celebration

To commemorate sixty years of journey of the Institute a programme Down Memory Lane was organized at the Institute. At the outset, all the staff members took pledge by signing a historical document. All the employees of CGCRI signed a pledge on August 26, 2010, the 60^{th} CGCRI's Foundation Day to uphold and implement the vision and mission of CGCRI and CSIR.

Prof. Indranil Manna
Director, March 1, 2010 –

Dr. S Kumar, Dr. B.K. Sarkar, both former Directors of CGCRI and Mr. V.K. Viash, a surviving member who witnessed the inauguration of the Institute and was on its payroll as scientist till his superannuation, were felicitated in the programme and they shared their memorable moments during their time in the institute with the audience.

Further, to motivate young research workers and staff members of the Institute for promoting innovation and work efficiency, they were awarded for their work in different categories.

The gala event of inauguration of Diamond Jubilee Celebrations was held on September 4, 2010. Shri Prithviraj Chavan, the then Hon'ble Minister of State for Science & Technology and Earth Sciences and Vice-President, CSIR attended the function.

Among other important dignitaries, Dr. J.J. Irani, Director, Tata Sons and Ex-MD, Tata Steel was the Guest of Honour, while Prof. S. K. Brahmachari, Director General-CSIR and Secretary-DSIR and Dr. Srikumar Banerjee, Secretary-DAE and Chairman-AEC, Government of India , who is also the Chairman of CGCRI's Research Council, graced the function as Distinguished Guests. India's renowned Orthopaedic surgeon, Padma Vibhushan Dr. K. H. Sancheti, Director of Sancheti Institute of Orthopaedics & Rehabilatation, Pune, Prof. Siddartha Roy, Director, Indian Institute of Chemical Biology, Kolkata, Dr. S. Srikanth, Director, National Metallurgical Laboratory, Jamshedpur and Dr. S. Basu, Chairman, Nuclear Research Board were among the important guests. The Hon'ble Minister, who also released the CGCRI's maiden logo and a souvenir for the Diamond Jubilee.

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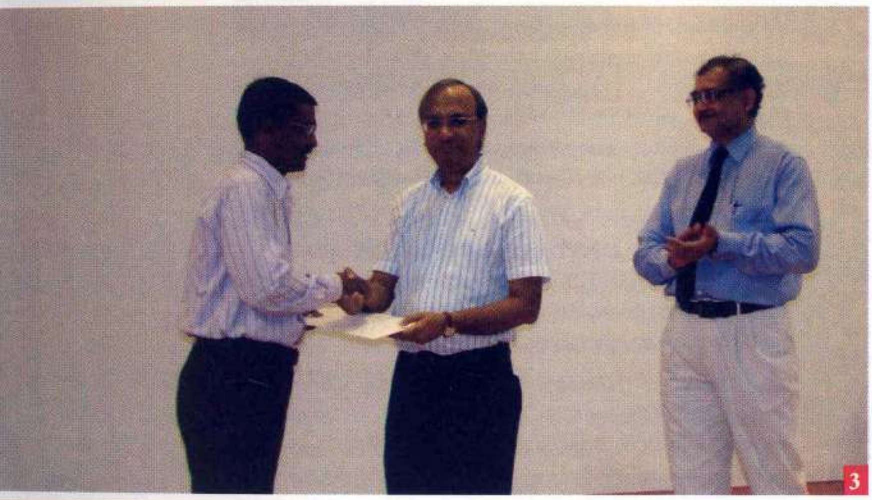

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1. Dr. Kaushik Biswas, Scientist, Glass Division delivering his presentation. (Awarded best Young Scientist)

2. Ms. Saheli Ganguly, Senior Research Fellow, Advance Clay & Traditional Ceramics Division, receiving First prize for Best Young Research Scholar

3. Mr. Ananda Ram Halder, Technician, Programme Management Division receiving Best Employee award

4. Dr.(Mrs.) K Annapurna, Scientist, Glass Division receiving Best Paper award in Glass & Ceramics as one of the co-authors

5. Mr. S.K.Saha, Sr Superintending Engineer, Engineering Division receiving Best Supporting Section award as the HOD

In his welcome address, Prof. Indranil Manna, Director, CGCRI retraced the Institute's journey over 60 years and highlighted a few notable achievements. Prof. Manna also narrated the recent success stories of CGCRI concerning the specialty fiber and glasses, prosthesis and implants, non-oxide ceramic components, water purification plants and FBG based sensors. He declared that CGCRI would soon set up a water purifier plant in the Taki Municipality close to Bangladesh border in West Bengal with a capacity of 30,000 gallons per hour. He spelt out CGCRI's priorities in the forthcoming 12th five year plan period including a supra-institutional project on specialty glasses and network projects on bio-prosthesis, structural ceramics, nano-coatings and new ceramics for energy and environmental applications.

Prof. Manna informed that the Institute would soon initiate an M.Tech/Ph.D programme in glass and ceramics under Academic of Council & Scientific Research Institute. He also informed that CGCRI had instituted a new system of identifying and rewarding talents in different categories of staff in order to inspire and motivate the internal staff members to perform and achieve.

In his address, Dr. Srikumar Banerjee hailed CGCRI for the supply of RSW glasses to BARC. He stressed the need of transferring the technology to a joint venture company for continuous supply of RSW glasses to the reprocessing plants of DAE. Dr. Banerjee reminded the audience that fundamental studies on glass are as essential as the applied projects. In this connection, he announced that DAE would actively consider the proposal of Director, CGCRI to establish a CGCRI—DAE Advanced Technology Cell in CGCRI.

Prof. S.K. Brahmachari hailed CGCRI contributions to the strategic, industrial, societal and academic sectors. He expounded on how CGCRI could do justice to these difficult and demanding activities which on one side necessitates high quality science and on the other side demands knack to the technology assessment, development and implementation in the competitive market. Prof. Brahmachari explained that CSIR has launched CSIR—800 programme to remain relevant to the 800 million poor people of the country. He hailed Acharya P.C. Roy, whose 150th birth year fell that year and said that Acharya became entrepreneur at the age of 32 by launching Bengal Chemicals. Congratulating CGCRI on its 60th birthday, he reminded the employees of CGCRI about their future tasks and milestones to achieve in order to establish this Institute as the leader in Glass and Ceramics.

In his lecture, Dr. K. H. Sancheti explained that with further enhancement in life expectancy, bone ailments are likely to increase. He lauded the fruitful interaction of his Institute with CGCRI. He made on stage presentation about a few beneficiaries, belonging to different age groups, who had received CGCRI's prosthesis technology, and undergone surgery under his supervision. Dr. Sancheti was felicitated with a memento by the Hon'ble Minister.

There were also presentations by organisations: IFGL-Kolkata, NEST-Cochin, OCL-Bhubaneshwar, RCI-Hyderabad, H R Johnson-Mumbai and Entech-Kolkata who have successfully implemented CGCRI technologies in the recent past.

The Guest of Honour, Dr. J J Irani, said that geographically small countries like France and Britain could dominate the world because they had undergone an early development in their science & technology. There is a problem in our mind set which we must shake off. Dr. Irani lauded CSIR as the brain of nation.

In his speech as Chief Guest, the Hon'ble Minister lauded the contributions of CGCRI in the area of Bioceramics, Fiber optics, Specialty glass and Refractories. The Hon'ble Minister advocated that the clustered approach adopted by DG, CSIR was a welcome strategy to streamline the activities of CSIR laboratories and achieve the desired goal. The Minister lauded the DAE-CGCRI cooperation as a classic example of a success story. He congratulated CGCRI on its Diamond Jubilee year and hoped that the Institute would contribute strongly to transform India into a scientific and technological leader.

Hon'ble Minister Shri Prithviraj Chavan and DG, CSIR Prof. S K Brahmachari

The Minister also addressed the media at a press conference and inaugurated an exhibition and two facilities—Bioceramics building and the Specialty Fiber Fabrication facility.

DG, CSIR also met several representatives from the industry, the partners of CGCRI and the concerned scientists. The day also saw inauguration of a newly built Gymnasium of CGCRI.

Since the inauguration of the Diamond Jubilee Celebrations on September 4, 2010, a number of activities have taken place in the Institute. Among them a number of international and national Symposia, Conferences and Seminars were being organized at the Institute. In total, thirteen international and national Symposia, Conferences and Seminars as given below and third time 42nd Shanti Swarup Bhatnagar Memorial Tournament Zonal – III (Indoor) were organized by the Institute.

- DST-SERC School on Guided Wave Optics and Devices
- International Symposium on Advances in Nanomaterials
- International Symposium on Energy Materials: Opportunities and Challenges (ISEM-2011)
- National Conference on Sensors & Actuators (NCSA -2011)
- National Seminar on Information and Knowledge Dissemination: Present Status and Future Direction (IKD-2011)
- International Conference on "Biomaterials and Implants: Prospects and Possibilities in the New Millennium(BIO-2011)
- National Workshop on Recent Challenges and Innovations in Castable Refractory Technology (ICRT-2011)
- International Conference on Specialty Glass and Optical Fiber: Materials, Technology and Devices (ICGF-2011)

The Central Glass & Ceramic Research Institute (CGCRI) Khurja Center also organized and conducted a National Seminar on Traditional Ceramics (NSTC)—2011 as a part of the Diamond Jubilee celebration of CGCRI Kolkata.

The logo of the Institute was released at the inaugural ceremony of the Diamond Jubilee Celebrations. The design was developed by Prof. H S Ray and Sukamal Mondal


तथा औद्योगिक अनुसंधान





Inaugural function of IKD-2011:
Dr. S. Bandhopadhyay, Chief Guest, lighting the lamp

Inaugural function of BIO-2011:
Prof. R Chidambaran delivering his keynote lecture

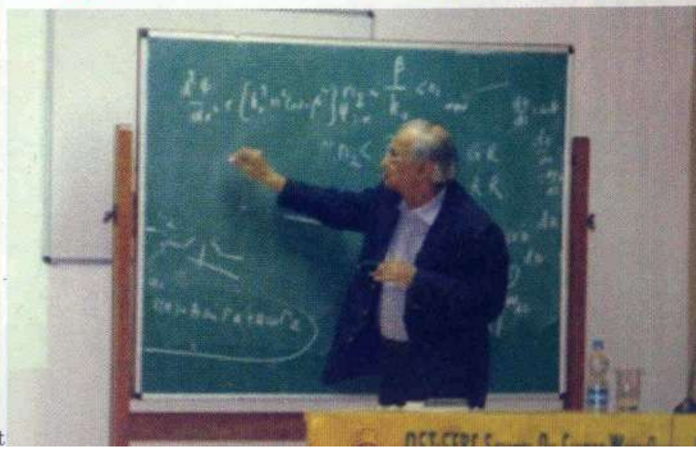
- The brick colour symbolizes terracotta - one of the basics of ceramics
- The faint outline is a styled version of the Ashoka pillar 3 lion emblem to represent Government of India. within the ambit of which CSIR operates. The outlines also symbolizes a ceramic pot
- The writing in official language, Hindi on top is spell out for CSIR
- The word CSIR in English is placed between the blades of the wheel drawn from CSIR Logo signifying CGCRI as a CSIR unit
- CGCRI has a stylised reflection in glass. There is also a crystal effect
- The Sanskrit sloka at the bottom is verse 20, Chapter-2 of Bhagvat Gita. It means – WORK ALONE LEADS TO PERFECTION
- The word CGCRI has a different shade. This and the horizontal band were provided for aesthetic reasons.

Further, other important performances of the Institute during the period are now narrated here.

The Institute participated in the CSIR Technofest 2010, along with the other CSIR laboratories. The Technofest 2010 was organized as a part of the India International Trade Fair at Pragati Maidan in New Delhi. Spread over 14 days, the mega event was inaugurated on November 14, 2010 by Shri Kapil Sibal, the then Union Minister for Human Resource Development, Science & Technology and Earth sciences. The event was a first ever in the history of CSIR and it highlighted the spirit of Team CSIR in its persistent effort to transform India through science and innovation. The special focus was to project as to how CSIR can enable and empower the country's underprivileged masses with CSIR technologies and create opportunities for research-oriented higher level education in specialized areas of science & technology. The novelty of the show was to project CSIR's contribution to Indian society in a theme specific manner instead of traditional lab centric approach. CSIR projected its contribution in 15 theme areas out of which CGCRI turned up in 6 theme stalls. These themes were Aerospace, CSIR—800, Energy, Healthcare, Mining Minerals & Materials and Water. While CGCRI led several other


NATIONAL CONFERENCE
OPTICAL FIBER: MATERIALS, TECHNOLOGY
(ICOF - 2011)


Diamond Jubilee Celebration of CGCRI
NATIONAL CONFERENCE
ON



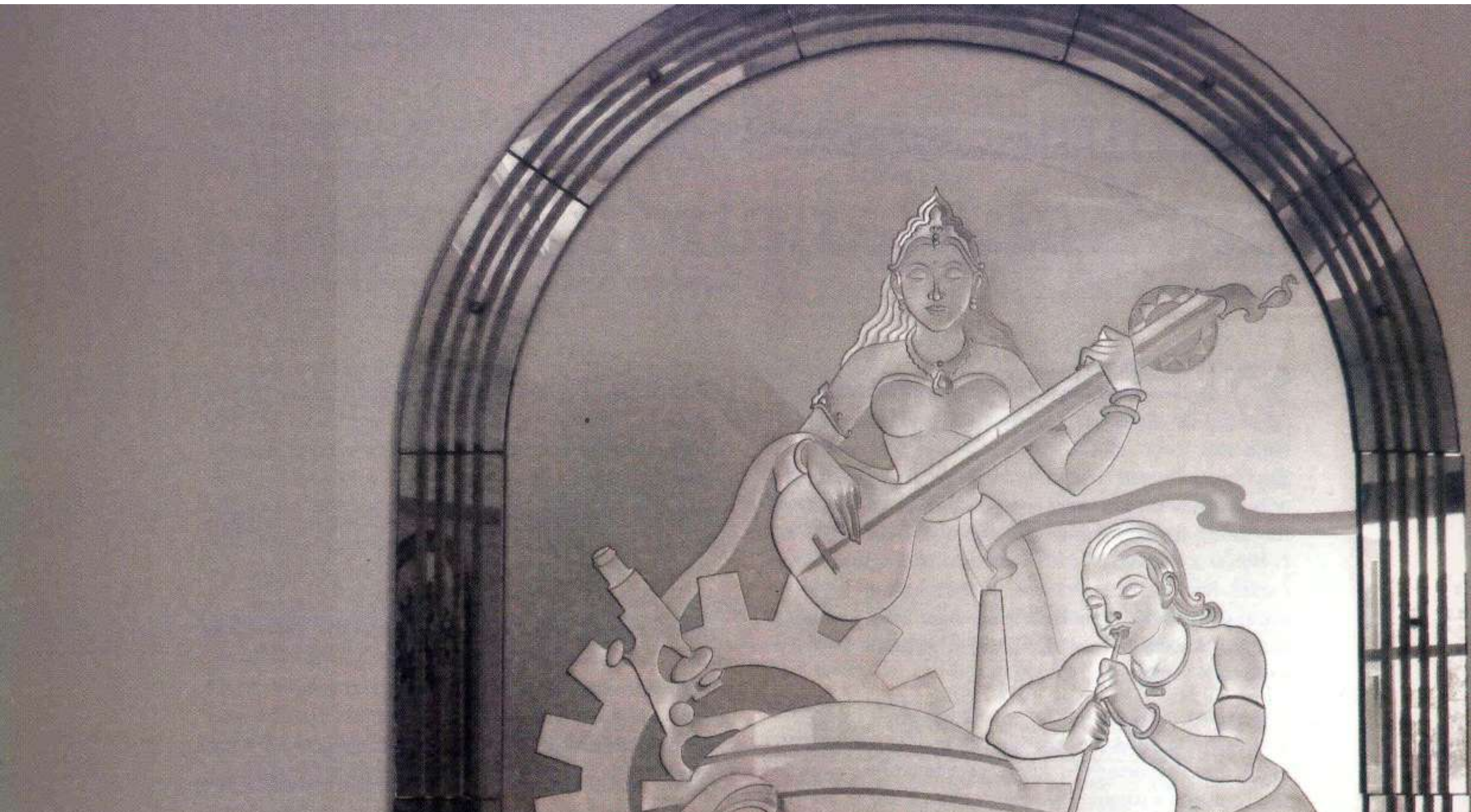
labs in the Strategic sector theme, it partnered with many other labs in the rest of the theme pavillions. Few beneficiary industries of the CGCRI technologies partnered with the Institute in this big event and showcased the products successfully marketed by them. Several important personalities of the country visited the CGCRI stalls.

The Institute signed an agreement with M/s. H.R. Johnson (India), a Division of Prism Cement Limited, Mumbai for utilizing the knowhow for manufacture of glass beads, nodules used for nuclear waste immobilization. The signing of agreement took place on May 11, 2010, which also marked the Technology Day of the nation. Further, an agreement was signed on July 26, 2010 for a collaborative R&D project for improvement of MgO-C refractory brick quality for enhancement of converter life with this company that is a corporate body of Visakhapatnam Steel Plant, Visakhapatnam

Another important incident needs to be specially mentioned is the prestigious CSIR Technology award, 2010 delivered to Dr. D.Basu and his fellow team members for the work 'Development of Biomedical Implants'.

Logo of CGCRI

Dr. D.Basu (3rd from left side) and his fellow team members receives CSIR Technology Award, 2010 for the work 'Development of Biomedical Implants'



Science and Technology of Glass and Ceramics

Reminiscences

Reminiscences of **Sachchidananda Kumar**

It was 1952, only five years after India's Independence. A young man, full of energy and ambition, received his D. Sc. degree from the Dept. of Glass Technology, University of Sheffield, United Kingdom and returned to India only to find that it was not possible to get a job of his liking in Kolkata or elsewhere. He met Prof. M N Saha, a colleague of his father to seek suggestions for his future. Dr. Saha was kind enough to arrange an appointment with Dr. Atma Ram who promised that he would be considered for a suitable position sometime in the near future.

The young man waited for a call for some interview and many months passed. Finally he went to CGCRI again and requested Dr. Atma Ram to let him work in the Institute without any salary. He wanted to stay in touch with his discipline and latest developments. His sincerity must have impressed Dr. Atma Ram because soon afterwards there was a formal interview and the young man was offered a position of a Senior Scientific Assistant of the Institute and placed under Dr. S. N. Prasad, then Head of the Department of Glass Technology. The young man was me Dr. S Kumar who one day retired as the Director of this Institute.

At the dawn of the Institute, the emphasis was on setting up of a new infrastructure. Different departments were created: Refractory, Glass, White ware, Enamel and so on. The Information Section of the Institute was started during that period under the leadership of Dr. R. L Thakur. Some of the thrust areas identified were: Survey, evaluation and beneficiation of various raw materials of the country, formation of standards for raw materials as well as fundamental products, development of improved varieties of ceramic products of Indian raw materials, substitution of imported raw materials using Indian minerals, technical assistance and testing was another important area of activity which brought some revenues to the Institute.

To highlight the activities of the Institute Information Section started a Bulletin of the Institute with Dr. R. L Thakur as Editor. There were also efforts to develop new products using indigenous raw materials. A notable work was hot-face insulation refractory which had practical value. A few plants were set up and product was used mainly in the Villai Steel Plant which was then under construction. This was probably around 1954, or 1955.

A new instrument was developed for the classification of mica blocks based on the measurement of the electrical properties. In addition to this quite a few other products were also developed some of which was found application in the industry.

In the 50's two senior most scientists of the Institute, namely, Mr. K. D. Sharma and J. C. Banerjee were deputed to the National Bureau of Standard, Washington to acquire the technical know-how for production of optical glass. After their return, they started a major programme in 1958 which was highly appreciated by the scientific community in general and specially the establishment at defense. The then Director General of CSIR and Dr. Atma Ram met the Prime Minister of India and appraised him about the achievements. The optical glasses produced were later used in the high temperature operations in Bhaba Atomic Research Center, Bombay.

The important basic researches conducted then were:

(1) Optical properties of transition metals of partially filled 3d orbital.

(2) IR spectroscopy of clay minerals.

(3) Development of newer methods of chemical analysis of ceramic raw materials and finished products.

These received high appreciation from many experts that included Prof. Rustom Roy.

In the 60's the Institute started to face sever power problem leading to frequent load shedding. Gradually things started moving from bad to worse and work of the Institute practically halted. The newer areas of activity towards the end of 60's and early 70's initiated were non-oxide ceramics, fixation of nuclear waste in glass and low thermal expansion of glass ceramics.

The Institute developed three types of ion selective glass electrodes, *viz.* Na+ and K+ glass electrodes, low impedance glass electrode for *pH* measurements and capillary glass electrode for measurement of blood *pH*.

Some of the problems faced during this period were lack of mutual appreciation amongst colleagues for significant developments and inadequate financial resources to augment R&D work in the newer areas.

The other major developments were establishment of an extension center of CGCRI at Naroda near Gujarat. Considering initial success in running the new extension center, the authorities wondered if some of the major activities of the Institute could be transferred from Kolkata to Naroda.

Towards the end of 70's and early 80's, several major areas of research were initiated, most notable among them was development of optical fibers for communication and other applications; development of newer glasses and glass-coatings of sol-gel technique, development of enamels used in production of fighter air crafts engine; development of high performance refractories based on the synthetic mullite refractories and refractories cement, etc.

A second extension center was set up in Khurja for manufacture of ceramics in 1982. Work of the center was appreciated by the local industries. A large number of the processes and products developed during the period were successfully transferred to the industry. Yet another new field initiated was development of bio-ceramics for prosthetic application.

The Fourteenth International Congress on Glass was organized by the Institute under the aegis of International Commission on Glass at Vigyan Bhavan, New Delhi to project the achievements of our Institute in the international field. The Commission selected me, then Director of the Institute, as the President of the Congress and Dr. K. P. Srivastava, Head, Glass Laboratory of the Institute as its General Organizing Secretary. One more highlight of the Congress was the screening of a documentary film on "Glass". The documentary film specially produced by the Institute for the occasion on the basis of my book "Story of Glass" was judged the best documentary film and I was given the Rajat Kamal Award. The film depicted the important milestones in the history of glass till the modern times and projected the then present glass scenario against the global perspective

Encouraged by the success of the Institute in transfer of technology to the industry, a new center was set up in a small cottage in village Panchmura, Bankura for the manufacture of low cost ceramic items using local raw materials. The center is still running successfully. At that time problem faced by the management was labour unrest which was, however, not uncommon in various organisations of the state of West Bengal at that time.

From an early period several internationally famous noted Scientists, Prof. White of Sheffield University, Prof. Rustam Roy and Nobel laureate Linus Pauling, J.D. Burnel, from abroad came to visit Institute on various occasions.

I feel tempted to remember one incident. One internationally famous Glass Technologist who visited the Institute and stayed here for a few days was Prof. W. E. S. Turner. It was a big event and the Director Dr. Atma Ram deputed me as one of the youngest scientists to go to Bombay to receive him and bring him into the Institute. He was fairly old at that time and when I asked how was his travel he remarked "Nothing catastrophic happened and bottom of the aircraft did not fall".

Several innovations were made in the Institute. New research work was initiated from time to time in new areas. The steady improvement in the area of Advance Ceramics; Bio-ceramics (prosthesis work); Nano Ceramics were quite significant. I would love to mention that the Association of Employees rendered me splendid support for the development of the Institute during my tenure. I had a cordial relation even with those apparently hostile elements!

The general impression I have now is that the quality of scientists and research scholars have improved. Today's research in modern ceramic is significantly better than my earlier work. The Institute is now well recognized in the field. There are so many new laboratories. Bright young Scientists have joined to steer the R&D and several scientist are collaborating with their foreign counterparts. Many hurdles have been overcome. Today, the Institute is definitely a Center of Excellence.

Reminiscences of **Bijit Kumar Sarkar**

I arrived early in a cab and left it at the gate on the day I joined the Central Glass and Ceramic Research Institute, Calcutta, one of the four premier and historic Institutions of CSIR that was founded in 1940's. The day was Thursday, September 1, 1988. I noticed that the main gate was closed but there was a small crowd taking their early teas and snacks at the tea stalls decorating the pavement. Few of them stirred and took notice of me calling out "Director, Director" and rushed in through the side gate. With trepidation and excitement I went in and climbed the stairs and entered the office. Mr. Mukhopadhay and Mr. Mallick greeted me with a big smile and ushered me into the office to occupy the chair for the next few years.

The room and the place were not unfamiliar to me since I would visit the Institute on occasions with some errand from ISRO, Trivandrum, where I as Director, Materials Group, was engaged in the development of Satellite Launch Vehicles and Satellites. It was to discuss about the development of a highly porous alumina catalyst substrate, a collaborative effort between the two Institutions that I would come to Dr. Sharma, former Director, Sen and Guha for assistance and later at the insistence from my predecessor Dr. Kumar I got associated with the Indian Ceramic Society, I thus came to know the Institute superficially, including a witness or two of the gate meetings by the staff with which I was relatively familiar at Trivandrum.

To my surprise I found that the coffer of the Institute was virtually empty except for the salary component that left the Institute panting. I lapsed in taking note of its magnitude at the time of my interview in Delhi

Dr. Bijit Kumar Sarkar with Dr. A.P.J. Abdul Kalam at Research Council meeting

with the then DG, Dr. A. P. Mitra, who casually enquired of my knowledge of resources from where funds could be acquired for research activities. I also noticed that due to a serious paucity of travel budget, the scientists hardly would go out to other national departments with project proposals to fetch funds. After a meeting with the DG and his finance officer in our Institute later I could get an extra budget allocation which bailed me out from the immediate crisis. This was not the case of our Institute alone but was true for the entire national laboratories of CSIR. The country in general was then experiencing an immense economic crisis, till a change was brought in the market economy by the then PM and FM and opened up to globalization. It was only a couple of years later that we as an Institute, CSIR in general began to breathe freely.

My immediate task was to see how funds could be raised for research and there were several means. A kind of contingency plan, was adopted, *viz.*, send scientists outside with project proposals for external funding; make all out efforts to transfer the available technologies to industries; increase publicity of the capabilities of the Institute. Technology transfer to industries has never been easy. I was once told by an eminent industrialist, former President of ICS, "Why should I take your technology when it is available from abroad as a package which will fetch me returns within a year." No doubt, an age old undeniable mindset. Such odds had played against CSIR since its inception. The Research Council headed by Dr. A.P.J.Abdul Kalam, the then Director of DRDL, Hydrabad, was a blessing to my efforts. I knew Dr. Kalam well from my days at ISRO who would not only sit as Chairman at the meetings but also help the concerned scientists towards fetching external funds.

An incident of his sincerity was on the communication fiber development. The activity was initiated by Dr. Kumar and there were similar activities pursued with larger sophisticated drawing towers at IIT, Kharagpur and DRL, Dehra Dun. Whilst the others were struggling to draw the fiber of quality the group at CGCRI could successfully draw the fibers and made a working model for telephone conversation between the laboratory and the Atma Ram Committee Room which was demonstrated in one of the RC meetings. To pool the resources and evolve a joint dedicated programme with the available knowhow and resources in the country. Dr. Kalam called all the concerned scientists for a discussion at CGCRI, it was midnight when we met, him catching flight to Balasore for an Agni launch next day. Unfortunately, a well defined modus operandi could not be arrived at. In 1992, a telephone communication system was installed in the Tata

The first patient implanted with a bioceramic hip joint prosthesis

colliery at Dhanbad, between the mine's interior pit and control office on the surface, with CGCRI developed fiber, CSIO, Chandigarh's electronic device and MRI, Dhanbad making the mining installation component. This was perhaps a first successful combined effort of three CSIR laboratories working together with a common goal for an industry. I was equally fortunate to have late Dr. Sadhan Dutt, Chairman DCL, a renowned industrialist as our next RC Chairman.

Replacing human bone joints with ceramic implants were popular abroad. The alumina based hip joint bio ceramic in particular, begun by Dr. Kumar, was another successful effort that the Institute saw it implanted on Mrs. Banerjee by an eminent orthopedic surgeon Dr. Bhattacharjee, at Woodland Nursing Home, Calcutta in 1991.

In spite of the budgetary constraints and working with near obsolete equipments an aggressive marketing by several Departments like Refractories, Ceramic Coatings, Glass, Non Oxide Ceramics, Sol Gel, amongst others made significant inroads into industries, either by transferring technologies or acquiring sponsored research. To demonstrate the worthiness of the building materials developed in the Institute a building above the garage in the premises was constructed where the Ceramic Society Office was shifted making more laboratory space in the main building. Few new areas of research like ceramic membrane, superconducting ceramics, ceramic fuel cell could be initiated.

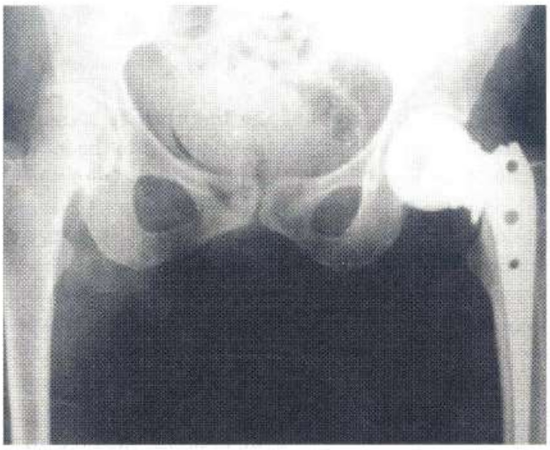
My story will remain incomplete if I leave out the story of the Institute's crown jewel. The Optical Glass Pilot Plant, the pet project of Dr. Atma Ram, the only plant of its kind in the country underwent serious production problems for want of quality refractory raw materials for the pot lining. Materials available had to be fired over 72 hours to make it durable with the molten glass. Added to its woes, CSIR in 1991 took a decision to close down all pilot plants in its laboratories, primarily due to budget constraints. This affected the moral of the staff all over. However, the decision remained deferred and thus saved the Defense from languishing, who were our main

Implantee with the artificial joint in the left hip after 10 years of the operation

customer for their optical devices at a time when an embargo was in force on our defense equipments and components.

The two external arms of the Institute at Naroda and Khurja continued with their support to the local ceramic industries. During my period there were over 250 coal fired kilns at Khurja and when on operation would obliterate the glaring sun. A pollution hazard by today's standard would have given a closure notice to the concerned industries. The scientists there could change the attitudes of the industrialists to reject the coal fired kilns and accept shuttle kilns, then in vogue, and gas fired kilns. The Furnace Section could make a few innovations in its design. The Naroda Center also had an accomplished record in serving the local pottery industries that made a dent in their export.

An important event that took place at our Institute during December 14 to 17, 1990 when our Institute was organizing the Shanti Swarup Bhatnagar Memorial Tournament (SSBMT), a platform created to foster the Team CSIR spirit, for the first time in association with IICB, our next door sister laboratory, which cheered and lifted the morale of the staff from the budgetary woes. I being a sports person myself having played football, cricket and badminton in my youth held a soft spot for those players and supported sports always. It was most exciting to see the entire CGCRI staff rising to the occasion working together for long hours to make it a grand success. We had been always proud of our teams and the Volleyball team was very special. Ending runners up to CMERI in that last event was heartbreaking for we had been the champions in the previous years. It was a real thriller running neck to neck to the last point of three games in presence of all the dignitaries including DG and other Directors and family members. DG was pleased to grant us a tennis court later. Next year I was given the responsibility to chair the Bhatnagar Tournament Committee and had unstinted support from Mr. Rajagopal of HQ and members.



The artificial joint

The Government differentiated between the administrative staff and their scientific partners in their retirement ages of 58 and 60 respectively, yet both serving under the same roof for the same objectives which created dissatisfaction affecting their performance. The acceptance of 'induction' in 1994 by CSIR that raised the retirement age of the administrative staff to 60 years spear headed by the CGCRI general and scientific unions was a unique normalisation. They also helped me to remove the tea stalls just outside the gate that created an odour of environment pollution in general, giving a negative image to the Institute. At times I would stand at the entrance in the mornings adopting 'Vidyasagar technology' watching the late comers, hoping to improve their timely attendance. The news would spread and they would wait outside the gate till I stepped back to my room. I later learnt that Dr. Maity could introduce punch card system for all staff.

A mouthpiece of the Institute for publicity featuring its capabilities and achievements amongst the CSIR family as well for ceramic and glass industries was felt necessary for long. A publication in the name of 'GLANCE', acronym for glass and ceramic, was started getting published every month covering all S&T and staff news. A science and technology committee (STC) with division and section heads as members would meet regularly on a specific date every month for an open discussion on technical and administrative matters including presentations on the activities of the divisions by the concerned scientists, helped to resolve problems, outstanding issues, take future course of action, budget necessary, etc. This created an openness and awareness amongst the scientists to exchange ideas dispelling the parochial attitudes of some. There were other two committees like WOPEC and JCC, the former to scrutinize the quotations and approve work orders and the later to jointly consult on issues pertaining to overall management and image of the Institute helped me considerably. Lest the future generation of scientists and staff who shall tread into the portals of CGCRI decades from now forget the names of their eminent and illustrious founder members, the two main committee rooms, one of Director's and the auditorium were named after Dr. Atma Ram and M. N. Saha respectively. There were numerous pleasant memories I would have wished to mention, but for the limited space I have for this brief memoir. The period of my stay was most satisfying and memorable receiving unstinted support from all quarters. The Institute had a glorious and chequered past and I shall remain with expectations to hear more of its excellence in my twilight years.

Reminiscences of **Chaitanyamoy Ganguly**

My tenure at the Central Glass and Ceramic Research Institute (CGCRI), Kolkata was short, sweet and challenging. I came in November 1995 , I saw till the end of 1997 , I could not conquer but got conquered and left the Institute in January 1998, with fond memories etched permanently in my mind's eye. The Institute taught me a lot on human engineering and exposed me to the appropriate technologies in glass and ceramic industry needed for improving our quality of life. I could understand and appreciate the conventional and advanced manufacturing techniques and unique applications of optical and laser glass, radiation shielding window, optical communication fiber, ceramic coatings, advanced oxide and non-oxide ceramics and refractory and above all traditional ceramics and rural potteries.

For me, the transition from hands-on , focused and well funded R & D activities on uranium , plutonium and thorium–based oxide and non–oxide ceramic nuclear fuels at Radio Metallurgy Division, Bhabha Atomic Research Center (BARC) to the not so well structured and practically unfunded programme of CGCRI was indeed a challenge. In the mid 1990's, the CSIR family was undergoing a paradigm shift under the dynamic leadership of Dr. Mashelkar. He wanted the laboratories to become financially self reliant and rely less on CSIR grants. We were asked to increase our "laboratory reserves" by taking up more sponsored research. The "publish or perish" directive of the past was replaced with the pragmatic approach of "patent, publish and prosper" (Dr. Mashelkar was fondly known as Mr. Patentkar). I realized that the need of the hour was to do some trumpet blowing of CGCRI activities and try for a few high value, low volume and long term sponsored projects from the major science and technology departments of the Government of India, namely, the DST, DAE, DOS and the DDR . The private players in glass and ceramic industries in India, with the exception of a few, were neither aware of what CGCRI can do for them nor were generous in funding research. Thanks to the generous support of Dr. Mashelkar, DG, CSIR and the whole hearted co-operation of my scientist colleagues, young and old.

In the initial phase it was a painful decision to give up my identity as a scientist, abandon my lab coat and play the role of a research manager , clad in business suit and tie with a 'frequent flier' membership in pocket. My intuitions told me that "optical glass" and "traditional ceramics" are the two main pillars of CGCRI. We should take up more activities in these areas and simultaneously look for new projects on engineering and electroceramics and refractory materials that relate to energy conservation and environmental protection. Armed with the colourful "CGCRI Highlights" and attractive slides prepared by my colleagues, I travelled to Delhi, Mumbai, Chandigarh, Ahmedabad, Indore and Bangalore to show case CGCRI in several forums. My contacts in DAE units, particularly in BARC, Mumbai and Center of Advanced Technology (CAT), Indore did help and within a very short time we were entrusted with a couple of high value projects like developing and manufacturing high density (> 5.2 g/cm3) lead glass for radiation shielding window, Nd-doped laser glass and zero expansion glass , mainly for DAE and DOS.

Dr. C. Ganguly with Prof. Sankar Sen, Minister of Power, West Bengal during Prof. Sen's visit in the Institute

Dr. C. Ganguly with Prof. C. N. R. Rao during Prof. Rao's visits in the Institute

What impressed me most was the optical glass pilot plant in the campus and the enthusiasm of my worker colleagues involved in melting, casting, shaping and polishing a wide variety of borosilicate crown and flint glass components. The societal missions on traditional ceramics and rural potteries carried out mainly at the Khurja and Naroda centers of CGCRI were equally attractive and provided me a unique opportunity to interact closely with small scale entrepreneurs and rural artisans in the field of tiles, tableware and novelty ware. I was amazed to see the talent and creativity of the potters and artisans of rural India - the terracotta tiles and murals, the black pottery, the colourful flower vases and the novelty wares of each region distinctly portrayed the local culture – from Panchmura in the East to Morvi and districts of Rajasthan in the West, from Khurja in the North to Kanya Kumari in the South. I could see fundamental unity in the novelty ware amidst endless diversity. We realized that the potters mainly needed infrastructural support from us for improving their productivity and product quality. We supported them by providing laboratory analysis of clay and other raw materials, setting up co-operative centers with simple, low cost and robust machinery and equipment and kiln for making, shaping and treating local clay and developing formulations for low cost glazes, based on environment–friendly, local materials.

Fortunately, I did not have any research hobby horse and did not feel the need to have my own research group and research facility. I was fortunate to lead a laboratory with highly competent and totally committed scientists, who were eminent experts in their fields. They were my teachers. I ensured that they enjoyed full freedom and gave them a free hand, avoiding micro management. In fact, the scientific interaction with Drs Tarun Bandopadhyay, Dibyendu Ganguly, Minati Chatterjee, Gautam Banerjee, Himadri Sekhar Maiti, K K Phani, K N Maiti, R. N. Dwivedi, S. Ghatak and a few self-motivated young scientists like D Basu and S. K. Bhadra , mostly after the office hours and on week ends, was the most rewarding experience of my tenure.

Whenever I am in Kolkata , I often pass by CGCRI. The campus stands out in the crowded locality of Jadavpur. Going down the memory lane , I recall my primary school days in the late 1950s in St Andrews School, which is located very near to CGCRI. I used to stare at the colossal structure with awe and admiration and wondered as to what went inside. I never dreamt of working here. I had the shortest tenure amongst the very esteemed Directors of CGCRI but perhaps my admiration for the Institute is the longest - from the late 1950s till date.

Reminiscences of **Himadri Sekhar Maiti**

As in the life of a human being, all organisations go through distinct phases of "ups" and "downs" in their life time, particularly as they grow old. Ageing is possibly a common phenomenon in many of the organisations of this country. Central Glass and Ceramic Research Institute at Kolkata, a public funded R&D organisation, the only one of its kind in this country, which has just completed 60 years of its existence, is not an exception. The Institute started its journey in mid-forties (even though 1950, the year of inauguration of its main building, for some reason, has been recognized as the year of its foundation) with great expectations under the dynamic leadership of its founder Director, Dr. Atma Ram. It was one of the first four constituent laboratories of the then newly constituted Council of Scientific and Industrial Research (CSIR) to promote industrial growth of India with the backing of indigenous R&D.

During the initial years, the Institute made significant contribution in providing technical inputs to many of the glass and ceramic industries of the country. A few of the important contributions include indigenous development of coloured glasses for the railway signaling system, grading of mica as per its dielectric parameters in order to promote export of this mineral to earn foreign exchange and development of several refractory products from locally available raw materials. In sixties, the Institute earned the unique distinction of indigenous development of optical glasses followed by establishment of a pilot plant for small scale production of a few of the varieties of the glass for fulfilling the needs of Indian Defence Establishments as a part of promoting self-reliance. Setting-up of this labour-intensive supply mode facility, based on a technology earlier practiced by National Bureau of Standards, USA gave the Institute a unique recognition in the national scenario. Most unfortunately, this also became the nucleus of an unprecedented "Trade Union" activity and poor R&D culture in the rest of the Institute at a much later stage particularly during late seventies and onwards. The trade union activity, in particular, gained a strong momentum because of the existing political environment in the state of West Bengal during that time. Even though, the R&D activity, by that time had diversified in many different areas *e.g.* hydrothermal growth of quartz single crystal, non-oxide ceramics, alumina ceramics, radiation shielding glass, glasses for radioactive waste disposal, etc. unfortunately, many of these useful initiatives were overshadowed by unfavourable work culture, inadequate budgetary support and of course to some extent the lack of vision on the part of the then leadership.

With one more change in leadership in early 1980s certain initiatives were taken to initiate R&D in a few more areas of advance glass and ceramics *e.g.* fiber optics, glass fiber reinforced composites, sol-gel processing and electro-ceramics. It was also the time when the Institute decided to induct from outside a few scientists at a relatively higher level. This provided the author an opportunity to join the Institute as a Senior Scientist in early 1987 after spending more than a decade as a member of the faculty of the Materials Science Center at IIT, Kharagpur. Unfortunately by that time the Institute was heavily infected with a very strong trade union activity in which both the supporting staff and the scientific community were participating with almost equal strength. Work culture and organisational discipline took a severe jolt. The leadership possibly was left with little option but to make compromises with these forces, often beyond the scope of the normal administrative procedures, to maintain apparent peace and tranquility in the Institute. This was possibly a reason for a strong difference of opinion between the senior most scientists of that time and the Institute management. They were having an unusually bitter relationship with the then leadership. Factionalism was the order of the day. Arising from a strong hierarchical set-up, the Institute, for all practical purposes was spilt vertically in multiple factions. All these created unusually negative impact in the academic and scientific community across the country including the CSIR headquarters. The author's primary objective of joining the Institute was to get an opportunity to develop useful technologies instead of carrying out only academic research. Within no time, however, it became clear to him that the Institute neither had the necessary infrastructure nor the management policy or the financial prowess to develop proven technologies for commercialization particularly in the areas of advanced materials.

In 1988, there was yet another change of guard in the Institute. For the first time, a person from outside the system was inducted as the Director of the Institute possibly with the hope that the Institute would be able to set aside its internal problems and would spring back to its lost glory. He tried his best to infuse professionalism and the concept of participative management in the system. Marginal improvements in R&D activity were noticed. Unfortunately, the dominance of the trade union leaders in different decision making activity continued, there was hardly any improvement in work culture and organisational discipline. During this period, the Institute witnessed the emergence of a second Employees' Union and for obvious reason the management had very difficult time to maintain a balance between their conflicting demands. Attempts to attract major externally funded R&D projects from selected strategic sectors such as the Departments of Space and Defence did not materialize primarily because of the uncertain delivery potentiality of the Institute arising from the poor work culture and a markedly inefficient system which was in vogue.

During the eighty's and in early part of ninety's, the Institute, even though had a few success stories in the form of technology transfers particularly in the areas of refractories, glass fiber reinforced composites, fiber optics, sol-gel derived glasses, etc, their impact has always been overshadowed by previously described organisational weaknesses and the lack of scientific temperament on the part of the research community in general. The trade union activity possibly reached its peak during the tenure of the next Director, who joined the Institute in 1995, once again from outside the CSIR system and tried to take certain extra-ordinary measures to revive the financial condition of the Institute particularly by borrowing money from Word Bank with the full support of CSIR headquarters. Unfortunately, this decision of the management was not taken so kindly by both the Scientific Workers' Association as well as the Employees' Union. The conflict did not remain peaceful all the time. However, within a short time the Director concerned got a better opportunity in his parent department and left the Institute much before the end of his normal tenure. This gave this author an opportunity to lead the Institute initially on an officiating capacity (from March, 1998) and then on a regular basis since January, 1999.

The Institute by then was in shambles. The Leadership at CSIR headquarters practically lost all hope of its revival. They were very unhappy primarily because their attempt to revive the economic condition of the Institute with World Bank loan was not acceptable to the Institute community. This was reflected in the allocation of "Modernization Grant", a onetime grant which was especially given by the Central Government to CSIR for the modernization of its R&D infrastructure in all its constituent laboratories. CGCRI was allocated the lowest per-capita grant on this account among all the 40 laboratories under the Council.

During that time CSIR had introduced the concept of ECF (External Cash Flow) primarily to generate extra-budgetary support to its R&D activity and at the same time expose its scientific community to the challenges of industry as well as other line ministries of the Government including the strategic sector departments such as Defence, Space and Atomic Energy. Another purpose of introducing this concept was to test the credibility of the individuals, Institutes and the research groups in terms of their capacity of delivery, accountability and responsibilities. This posed a far greater challenge to CGCRI's continued existence. With the kind of prevailing working environment and the on-going R&D programmes, it was practically impossible to regain the confidence of the CSIR Head Quarters and thereby put the Institute back on rails. Something extra-ordinary was obviously required to be done. A strategic planning became necessary to demonstrate its inherent strength.

Several rounds of discussions were held particularly with the Senior Scientists and the Divisional Heads. A brief strategy to enhance the annual ECF was drawn-up. It was decided to lay emphasis on a relatively small number of big-budget externally funded projects instead of taking up a large number of small value projects, which were thought to be consuming more internal resources but the impact was relatively less. It was, however, author's personal conviction that whatever might be Institute's strategic planning, nothing could be realized without sending a clear and loud signal to the funding agencies that the Institute is determined to make certain fundamental changes in its day-to-day functioning, bring back organisational discipline and its commitment to deliver value added public goods. The very first thing which came to his mind was the improvement in organisational discipline and more cordial reception and hospitality to the visiting dignitaries.

Among many others, attendance of the employees was the most sensitive but a critical issue. Till that time, as in most of the public Institutions, scientists and other officers were not required to sign any attendance register, but all others were required to do so. Besides, the rules were being followed differently by different Divisional Heads; some were very strict while others being relatively lenient. This was not well-accepted by the majority of the supporting staff, who were inclined to take advantage of this disparity. Taking any disciplinary action on this count by the management was a near impossibility. The only option left was the introduction of a computerized attendance system in which nobody is required to put a signature but to swipe a card and which can be applied uniformly to all, the officers as well the supporting staff. This was no doubt the toughest and the most revolutionary, and possibly the most effective decision the author had taken at the very early stage of his tenure as Director of the Institute. After an extensive preparatory exercise over a period of nearly one year, which, included selection of the hardware, its installation after necessary civil engineering modification at the main gate, strengthening the security system and above all generating various custom built softwares to suit the Institute's own requirement particularly taking care of the existing GOI rule provisions and providing certain flexibility in 'entry' and 'exit' timings and also sensitizing all the members of staff on the use of this new system, the computerized attendance system formally started functioning from 1st July, 1999. It is most gratifying that the system is still in operation without any break in spite of attempts by sections of the staff for its discontinuation on several occasions. In his opinion this has been a major turning point as far as the revival of the Institute is concerned. For nearly a decade the system ran with a bar-coded identity-cum-attendance card. Later it was modified to a bio-metric system. This was the first time any CSIR laboratory (including headquarters) introduced such an attendance system. Slowly several other Institutes of CSIR followed suit.

Another image building exercise taken up concurrently was the expansion and renovation of the CSIR guest house at Kolkata which was under the administrative control of CGCRI. Kolkata being the gateway to almost all the CSIR laboratories of the

Eastern India and also having the advanced medical facilities often required by the employees of these laboratories, the overall load on this guest house has always been much above average. In absence of appropriate maintenance and supervision, the service condition of the guest house was absolutely inadequate for any visiting dignitaries. Realizing that all these were adversely affecting the overall image of the Institute, immediate corrective actions were initiated. Two of the vacant quarters were converted to a temporary guest house together with complete renovation of the existing accommodation. For the first time, three special suites were constructed particularly for the important visitors. The entire management system was overhauled. Soon the guest house was recognized as one of the best maintained guest houses within the CSIR system and thus made a positive impact as far as the image of the Institute to external dignitaries/ visitors was concerned. At a later stage an additional floor was constructed on the main guest house building to increase its capacity further and also a computerized booking system was developed and made operational.

On the R&D front, as mentioned earlier, the challenge was to attract high value externally funded projects, for which it was necessary to carry out an internal exercise of SWOT analysis and thereby identify the areas where such projects could be attempted. It was realized that the Institute did not have the potential to attract high value projects either in basic or applied research in any of the disciplines. On the other hand, the Institute has been a long time partner to both Defence Research and the Department of Atomic Energy particularly for developing and/ or supplying certain special variety of glasses *e.g.* optical glass, RSW glass, laser glass and ultra-low expansion glass-ceramics. Developmental work on these glasses were initiated by the Institute quite some time back, but their manufacturing technologies were never perfected with sufficient engineering input and therefore no vendor for their supply to the respective departments could be developed. Except for optical glass, pilot plant activity for the production of any other varieties of advanced glasses was also not initiated. Engineering component of the development was totally absent. At the same time, the technology for the production of optical glass was also not upgraded and consequently the cost of production was no longer competitive. In fact, around this time CSIR decided to discontinue separate budget allocation for this pilot plant as well. Consequently, the technical staff associated with this activity (around 50 in number) became available for some other activity of similar nature. Based on all these considerations, it was decided to take up the challenging task of developing the manufacturing technologies of some of these glasses, which the strategic sectors were not able to import because of the sanctions imposed on them. This was certainly not a very easy decision to take for several reasons: 1) the Institute did not have sufficient expertise to design the plants for such advanced manufacturing technologies 2) there has always been a debate whether CSIR laboratories should get involved in such supply mode activity and 3) whether CSIR laboratory's job would to be centered around import substitution only. Unfortunately, the Institute was in such a dire state that these considerations were not of much concern at that stage. All these points were debated in several meetings of the Research Council, who finally agreed to the proposal of the Director to go ahead with such a strategy at least as a temporary measure primarily to tide over the grim financial condition of the Institute. Fortunately for the Institute, three such projects got approved in two consecutive financial years with an overall budgetary outlay of around Rs.20.00 Cr. The figure was considered to be of great significance when compared with the average yearly R&D budget of only Rs.2.0-2.5Cr for the whole Institute. As a result of this, the annual ECF quickly jumped from around Rs.3.00 Cr to a value of Rs.10.00Cr, which became another turning point in the history of CGCRI.

The author has no hesitation in accepting the fact that it was a tremendously risky decision, the Institute took in accepting such highly challenging tasks for the strategic departments of the country. As it was a "do or die" situation for the Institute, there was possibly no other option to bring the Institute out of its hapless situation. However, today everybody possibly agree that the risk taking has finally paid off. Since then, the Institute did not have to look back. The overall R&D output together with its financial health has improved quite significantly. Budgetary support from the headquarters is not a constraint any more. 2001-02 experienced a triggering impact when ECF increased by almost 100%. The enhancement in ECF generation continued with total ECF generation of Rs.76.25Cr during the author's tenure with an average of Rs.6.35Cr per year. With this consolidated financial strength the Institute is definitely poised for a much brighter future beyond its Diamond Jubilee year.

As legendary soccer player, Mia Hamm, once remarked "success breeds success", this has precisely been the case with CGCRI in recent past. After restoration of the work culture and thereby regaining the confidence of the strategic departments particularly in the area of glass, there was no dearth of externally funded projects in many different areas such as fiber optics, non-oxide ceramics, ceramic membranes, fuel cells and batteries, bio-ceramics and coatings, sensors and actuators, sol-gel processing, refractories and even clays and traditional ceramics, funded either by the external agencies or supported by CSIR's plan allocation. The overall R&D budget of the Institute could be enhanced by nearly tenfold during the last two plan periods. This is no doubt one of the unprecedented turn around by a CSIR laboratory in recent past. Even though CGCRI did not get sufficient modernization grant, considerable funding has been later provided by the CSIR headquarters under different Network projects during both 10th and 11th Five Year Plan period, which helped the Institute to modernize most of its research facilities and also venture into new areas of R&D *e.g.* Ceramic membranes, Solid Oxide Fuel Cell and lithium batteries and ceramic armour. A few of the advanced R&D facilities created during this period are: 1) FESEM; 2) AFM; 3) TEM; 4) High Temperature Hot Press-cum-Sintering Furnace; 5) Mini HIP; 6) XRF; 7) Low Angle XRD; 8) Plasma Coating Unit 9) Magnetron Sputtering Unit 10) Rapid prototyping for bio-ceramics 11) CNC Lathe for fabrication of Bio-ceramic components; 12) Gamma Chamber; 13) Complete laboratory facility for fabrication of planar SOFC; 14) Most modern preparation and characterization facility of optical fibers of different types and 15) A Centralized World Class Materials Characterization Facility.

Consequent to the establishment of these world class research facilities, there has been a significant growth in research output, particularly in terms of research publications. The number of publications per year became more than three times crossing a target figure of 100 per year during the tenure of directorship of the author.

Concurrent to the strategic planning in the area of R&D, streamlining of the administrative support system together with renovation/ modernization of nearly all the laboratories of the Institute and also that of the office space were very much on the priority agenda. Fortunately, necessary financial support could be arranged from the CSIR headquarters. The same officers at CSIR headquarters, who were reluctant to allocate the modernization grant, became quite supportive to the cause of the Institute only after seeing the initial phases of success and the sincerity and commitment on the part of the leadership to turn the table. It could finally be possible to change the face of the Institute in many different ways. Almost all the laboratory space could be renovated and air-conditioned including the office space of the administration, finance and stores & purchase. Several new laboratory buildings have been constructed replacing the dilapidated workshop like sheds. Creation of new library space and establishment of an electronic knowledge center, renovation of the Institute auditorium and committee rooms, construction of an additional lecture hall, a multipurpose hall which can be used as a dinning space during conferences as well as an exhibition space, installation of the only service lift of the Institute and nearly 500KVA of back-up power, renovation of the canteen, modernization of the recreation facilities at the staff club and also to take a decision of creating a gymnasium for the members of staff are a few of the initiatives taken to make the institute presentable to international community. The face-lifting of the Institute Building and the premises were considered important in order to create a better environment and imbibing the sense of pride in all the members of staff of·the Institute and thereby inject professionalism in their activity.

Assessment and recruitment has been another area in which significant attention was paid. In order to promote efficiency and effectiveness both in R&D and administration, assessments were carried out with considerable seriousness and objectivity. A clear message was conveyed for promotions based purely on performance but not based only on experience. Attempts were made to clearly distinguish between performers and non-performers.

As discussed under different contexts, irrational trade union activity was one of the major causes of organisational weakness at CGCRI over a long period of more than two decades. However, CGCRI was not the only Institution affected by this culture. Several other CSIR laboratories across the country suffered more or less in a similar manner from this disease. Realizing this, CSIR headquarters took a revolutionary decision in the year 2000 to derecognize any form of trade union activity in CSIR, instead promote trade associations of different categories of staff and constitution of a joint consultative mechanism both at Institutional and headquarters level. It is interesting to note that while many of the laboratories have already formed trade associations as per the CSIR guidelines, employees of CGCRI have so far refused to accept the same. Consequently, there is no existence of a Joint Consultative Mechanism in the Institute. It is possibly another wrong decision on the part of the employees of CGCRI. It's not clear what has been the philosophy behind this thought process.

Bringing back the organisational discipline has not, however, been a cake-walk.There have been countless attempts by a section of the employees (scientists not excluded) to challenge almost each and every decision of the Director particularly during the initial phases of his tenure. Two basic philosophies followed to bring back the organisational discipline and work culture were: 1) To hold the bull by its horn wherever and whenever necessary and 2) Calling spades a spade at any time and every time. In order to practice these principles one needs to demonstrate the basic honesty and sincerity in their entirety. At the same time, one cannot avoid taking unpleasant decisions and in the process attract the wrath from a section of the employee. This, unfortunately, the price an honest and sincere reformer has to pay at the end of the day.

Let this article be concluded with a note that the author has no intention of hurting anybody's sentiment or criticizing anybody's decision or philosophy of life, but tried to make an honest assessment of the situation as per his personal belief and perception. While writing this article, his personal exposures, his own analysis of the situation and the circumstances he had to deal with, flushed in back from his memories. The article, might not be a literary excellence, yet will definitely remain as an honest retrospection of the author, his life time experience that he wanted to share with his readers who may like to know the history of a very crucial phase of the Institute from the perspective of its Director of that time. It was most gratifying for him to receive several congratulatory notes from many a renowned personalities from different corners of the nation and also from abroad recognizing his hard work for the revival of CGCRI.

The author is thankful to Prof. Indranil Manna, the present Director of CGCRI for his kind gesture of inviting him to write this memoir for the commemorative volume being published on the occasion of the closing ceremony of the year long Diamond Jubilee Celebration of the Institute.

Reminiscences
of Hem Shanker Ray

In research, glassmelting was my first love, and like most love affairs, it was accidental. After graduating in Met. Engg. From I.I.T., Kharagpur (1962), I had gone to the University of Toronto where my guide for graduate research happened to suggest that I could do physico-chemical measurements using some low melting glass. The first thing I learnt was to make that glass and it was fascinating to see a glass batch made of drab chemicals turn into a transparent and often brilliant and colourful material. I fell in love with the sparkle.

I joined IIT, Kanpur in early 1967 and planned to extend my work but that was not possible because of non-availability of platinum crucibles- I planned to be a process metallurgist instead. The lure of glass remained and that made me go to R&D Pilkington Bros. Ltd. in U.K. for some time to work on glassmelting. I could have continued but I had fallen in love with my metallurgy also and, so, I returned. Fortunately, I could come back to glass melting and viscosity measurements after my retirement when I could get a position in this Institute (CGCRI) (2000). I spent ten happy years, first five as an Emeritus Scientist (CSIR) and second five as Emeritus Fellow (AICTE). My name never appeared in the rolls of the Institute but when I left in 2010 I was no longer an 'Outsider'.

Ten years were a fairly long time to know the Institute and to learn many new things. Fortunately, I had known some of the Directors earlier and a few Scientists also. I came to know Himadri when he joined IIT, Kanpur to start his research under Dr. E. C. Subbarao after two or three years of my joining. We had shared some academic interests. As Dr. H. S. Maiti, he left to join the Materials Science Center of IIT, Kharagpur where I met him again when I moved there in 1980. Sometime later, when I was in the Research Council of the National Metallurgical Laboratory (NML), Jamshedpur he was offered a position there but he chose to join this Institute instead. Eventually he became the Director here and changed the face of the Institute. While he was in Kharagpur, he helped me to organize a National Conference of Thermal Analyses. I could see that he had the ability to be meticulous about things. I remain grateful to him and CSIR for accommodating me here after my retirement.

During my stay at Kharagpur I was closely associated with NML and became familiar with CSIR. I had come to know Dr. B. K. Sarkar and Dr. C. Ganguly who would be Directors here. That familiarity, however, was rather formal and professional. I came to know Dr. Sarkar of this Institute better after I moved to the Regional Research Laboratory (RRL), now called Institute of Minerals, and Materials Technology (IMMT), Bhubaneswar (1990). I was, for one term, the member of the Research Council (RC) here and came here frequently. I always visited the Optical Glass Division where the stirring mechanism during glass melting never ceased to fascinate me. I wanted to work there some day.

Dr. Sarkar and I became close, especially because we shared common problems. Lack of funds was one, mini mutinies were another. He often lamented the fact that CSIR never planned any single big project where all the laboratories would have inputs. He dreamt of producing a CSIR car. There were no 'Network' projects then.

Dr. Ganguly's stay was brief but I had interactions with him too. During one Selection Committee Meeting, he had made me the Chairman and fixed a time for lunch break. During interviewing the candidates, however, he invariably carried on questioning and explaining. I had to cut him short abruptly. He was aghast, 'but I am the Director here!', he said. 'And I am the Chairman here appointed by you and I will stick to your deadline', I replied. He relented graciously. A top-notch Scientist, Chaitanya was also a gifted singer. During one Directors' meeting, in cold winter of Chandigarh, he enthralled the audience till the early morning (with minor support from me). Thanks to that performance and because he left CSIR soon after, Dr. Mashelkar made me Chairman of a Committee that helped to create the CSIR anthem.

When I left this Institute in 2010 Dr. Maiti was still there. I was extremely happy when soon after Dr. Indranil Manna was chosen to succeed Dr. Maiti. He had joined IIT, Kharagpur as a young lecturer a few years after my moving there. Soon it was evident that Dr. Manna was destined to go places. We have maintained a cordial relationship ever since even though I was away in Bhubaneswar for so many years. I was also happy when Dr. Satyen Misra joined as Scientist-in-Charge in the Naroda Center, Gujarat. I had known Satyen as a man of ideas and great energy when he did his Ph.D. under my supervision at IIT, Kharagpur.

My first visit to this Institute sometime in the early 80's remain etched in my memory. I saw much of the entrance and the entire ground floor corridor decorated with artistic, colourful posters, all neatly pasted. That day there were not many persons in the Institute because there was an important cricket match in the city. There were similar posters to greet me when I joined RRL, Bhubaneswar (1990) but the posters were fewer and not so neat. Thanks to my earlier visits here, those posters had little impact on me. CSIR has now come out of those days of turmoil as a better and stronger organisation.

Prof. H S Ray narrating his association with CGCRI scientists

No doubt that a great change was initiated by Dr. Maiti after he joined as Director, What helped him was enhanced financial support from CSIR which was earlier dismal and also cooperation of a large section of employees, specially all his senior colleagues. I am well aware of the contributions of the earlier Directors also, specially Dr. S. Kumar who had initiated newer areas of R&D. I find his book on "Story of Glass" fascinating. I would have loved to work under him.

Apart from my two year stay in U.K., I have spent ten years each in four different institutions of which, perhaps, the ten years stay here was the happiest. There were many reasons of which I list a few.

First, I stayed in a third floor flat in SIRSA that overlooked the Lake. There was a good community life and there were trees. I had been afraid of a sudden shift from my earlier life in campuses full of trees to concrete blocks. Yet in SIRSA there was no dearth of trees, infact there was one mango tree whose branches touched a balcony of our flat. There I saw millions of blossoms produce tiny mangoes by thousands whose number gradually reduced because of storm, rain and birds. Finally only a handful turned into full and ripe fruits that I could have easily plucked. Abhijit Ghosh was a friendly neighbour.

Second, I enjoyed a unique position of some priviledges with no administrative responsibility. I could enjoy an office space, guide research, write books, hum songs and enjoy the ambience of the laboratory without having to take any decision for or against anybody. My room was open for anybody who cared to drop in and join me in rounds of tea. No wonder I made no enemies and perhaps, as an innocuous inclusion, I became somewhat popular too.

Third, I could learn a lot about glassmelting working with the Optical Glass Section through my association with Dr. K. K. Phani and Mr. Swarup Sarkar. I could contribute a bit also in the work of my Ph. D. student Sumit Pal. We took out a patent also for an interesting work on melting of Low Barium Carbonate glass but like many other patents it may well have gone into some black hole. Dr. Phani was a co-guide for Pal's work and Mr. Sarkar was very helpful also. Interestingly, I had been the Chairman of a Committee that had several years ago selected Sarkar. He never stopped teasing me about my opening question for his interview, 'What is the importance of viscosity in glass melting?' Eventually he taught me a lot more about the importance! In whatever research I could do here, Dr. Pranab Choudhury always contributed something and together we wrote several papers. Saikat Acharya and Subrata Ghosh collaborated with me in writing some management related articles. I continue to learn new things from Subrata.

In these reminiscences I have the opportunity of thanking persons who made my stay fruitful. I may not have received funds from CSIR, and specially AICTE without the persistence and paper work of P. K. Chakrabarti. Many friends here helped me organize a very large number of events by the Indian Association of Productivity, Quality and Reliability (IAPQR), the Millennium Institute of Energy and Environment Management (MIEEM) and CSIR Pensioners' Welfare Association (CPWAC). I must acknowledge the generous help of persons like Swapan Saha, Abijit Ghosh, Sukomol Mondal, Subrata Sengupta, Dipanjan Moitra, Sumana Majumdar, R. Jayashree and others. I could enjoy working with Gautam Banerjee, Paban Mukherjee, Chandana Patra, Sankar Ghatak and others in producing some souvenirs. I must have missed out on mentioning some other names and for that I apologize.

One thing I had really enjoyed was organizing weekly seminar with Anup Mukherjee. That made everybody more aware of what all R&D gets done in the Institute. Dr. Maiti sometimes gave a summary during various events. I am no longer here but I continue to visit. During one event sometime ago I was extremely impressed by a summary presented by Dr. Manna, his speech beautifully brief, yet wonderfully illuminating.

As many know, I was involved in creation of the Institute logo which may not be the world's best but it is good and it carries a message. The quotation was suggested by Pranab Choudhury. Sukomol Mondal, Dr. D. K. Bhattacharya and Dr. I. Manna had helped with their ideas. During the Diamond Jubilee celebrations, I was happy to help create the pledge which was later copied by NML. Unfortunately, as an 'Outsider' I really did not qualify to put my signature anywhere. It could have been there though as an innocuous inclusion.

Earlier, I had been a proper 'insider' and I know CSIR well. One knows the formal expansion of the abbreviation but there are also many other expansions including some naughty ones. There are some serious alternatives which have been expressed by higher ups.

One is Council of Scientific Industrial Research (less emphasis on pure science) and the other is Council of Scientific and Innovative Research (less emphasis on industry). Some kind of dichotomy and hierarchy has always existed in CSIR and generally it has been: Scientific research, Industrial research and Technologies for the rural sector. The first was related to the work of Universities while, at the other end, the last was close to grass root activities of many NGO's. Those served as different windows for different interest groups. The last category served well when Parliamentary delegations visited laboratories with oft-repeated slogans of 'Lab to Land and land to Lab'. Yet Scientists trying to develop technologies for rural industrialization have always felt sidelined. Whether the new CSIR 800 will change things only time can tell.

CGCRI, however, is one Institute which has an enviable mixture of all three. Few other laboratories can talk in one breath about publications in high SCI rating journals, viable technologies and products for various sectors such as optical and radiation shielding glasses, optical communication fibers,

Prof. H S Ray, Former Director, IMMT, Bhubaneshwar being greeted by a staff Ms Saheli Ganguly bioimplants, ceramics, refractories, etc. and at the same time about exemplary societal mission of Naroda Center in Gujarat and Khurja Center near Delhi. If the CSIR Academy does get the final approval then this Institute will have much to offer because of the tremendous variety in its R&D activities. What a research student can do here he can never do in a University set up. This is well accepted. Yet, whether some scientists should focus on academic programmes rather than R&D remains debatable.

There is a common perception that while CSIR has been changing, one section that has been unable to keep pace with, the rest is Administration which, unlike Finance and Accounts, has not been able to quantify its service. It remains unchanged with its traditional routines that emphasized control (note the word 'controller' of Administration) and compliance of rules and regulations whose interpretations have always been variable. Some are fully occupied seeking from the laboratories, status reports, write up on past achievements, future plans, parawise comments on anonymous letters, etc. as 'directed by the competent authority'. There is confusion as to who service provider is and who is the service seeker and basic concepts about JIT, TQM, QFD, etc. are virtually unknown. There is much one can learn from the TQM that runs today's industry: the basic thesis universally accepted beyond the futility of Quality Control and repair which is not value adding and is, in fact, self defeating. May be they don't know or don't know that they don't know or may be they know but are afraid to change age old traditions. Blessed is the laboratory that has benefitted from vigilance and technical audit reports and blessed is the laboratory that has moved forward because of the Administration and not irrespective or inspite of it. However, there is a flip side to this. The Administration can, justifiably, say that all rules, regulations and procedures are needed because they are answerable. People cannot be trusted because they are not trustworthy. And prevention is better than cure because legal procedures for "cure" are cumbersome.

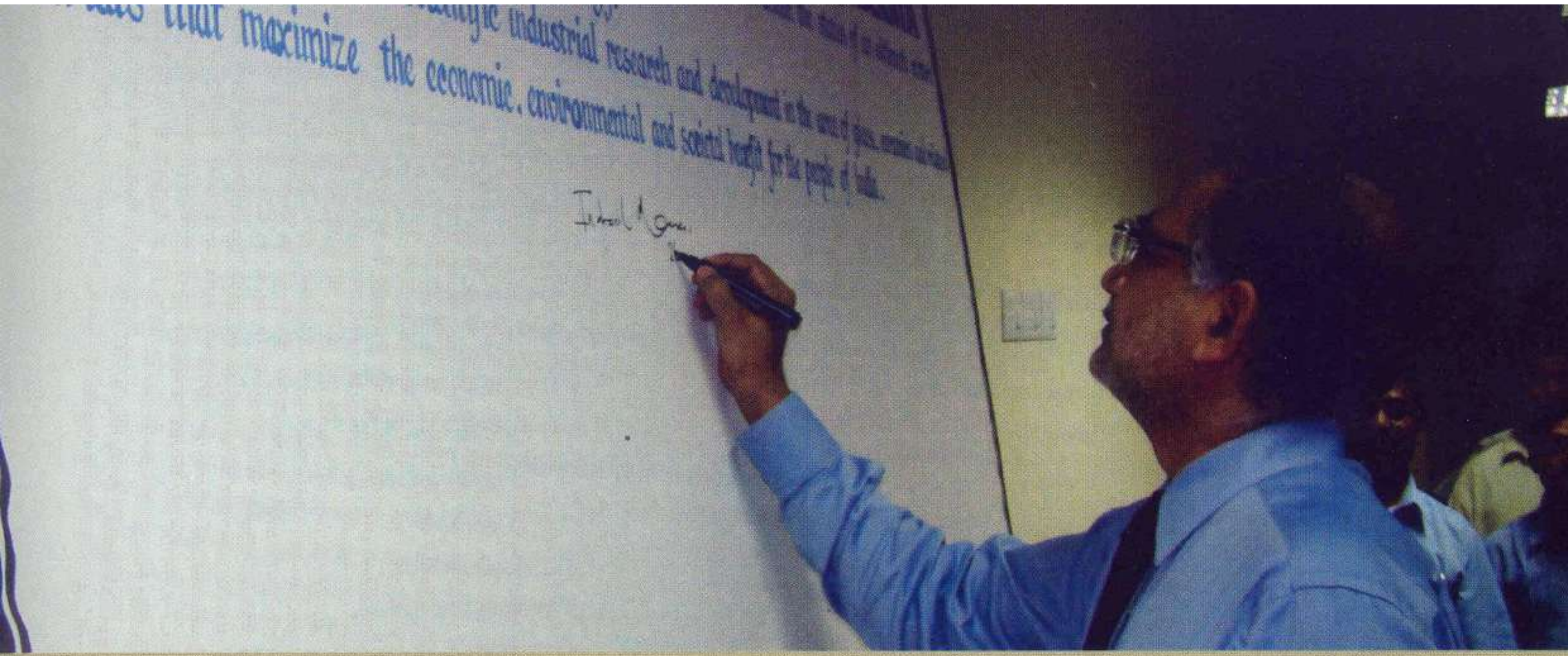
We can say that people get the Administration they deserve and this is a national malaise. The highest levels of our government have often opined that problems in governance bring down GDP growth rate by as much as 2%. Administrative problems adversely affect R&D efforts too. Yet seldom there has been organized effort to find remedies for the chasm between Administration and scientists. It is left to the Directors to bridge the gap and he is necessarily required to speak for the Administration when he is with the scientists and speak for the scientists when he is with the Administration.

Today all employees of CSIR need constant training in matters related to Aptitude and Attitude because what is more important is not what we have achieved but what more we could not inspite of having the potential.

Sometime ago I had written an article for the Diamond Jubilee Souvenir of the NML and I like to repeat some of my views expressed there because they are as relevant here. Innovative research today necessarily needs awareness about diverse subjects such as energy, environment, industrial metabolism, techno economics, various regulations, quality related issued forecasting, issues of knowledge management such as IPR, marketing, networking, etc. and above all values and ethics. R&D institutions are mushrooming all over the country, the bar is being raised all the time and the goal post is receding. Nobody can sit on past laurels, projects completed and awards earned long ago. It has been said that the past is history, and the future is a mystery. But the present is a 'gift', and that is why it is called 'present'. Planning means little and .... Does even decision making unless there is execution and implementation of decisions. Scientists must learn to dream because they can do new things if only they dream.

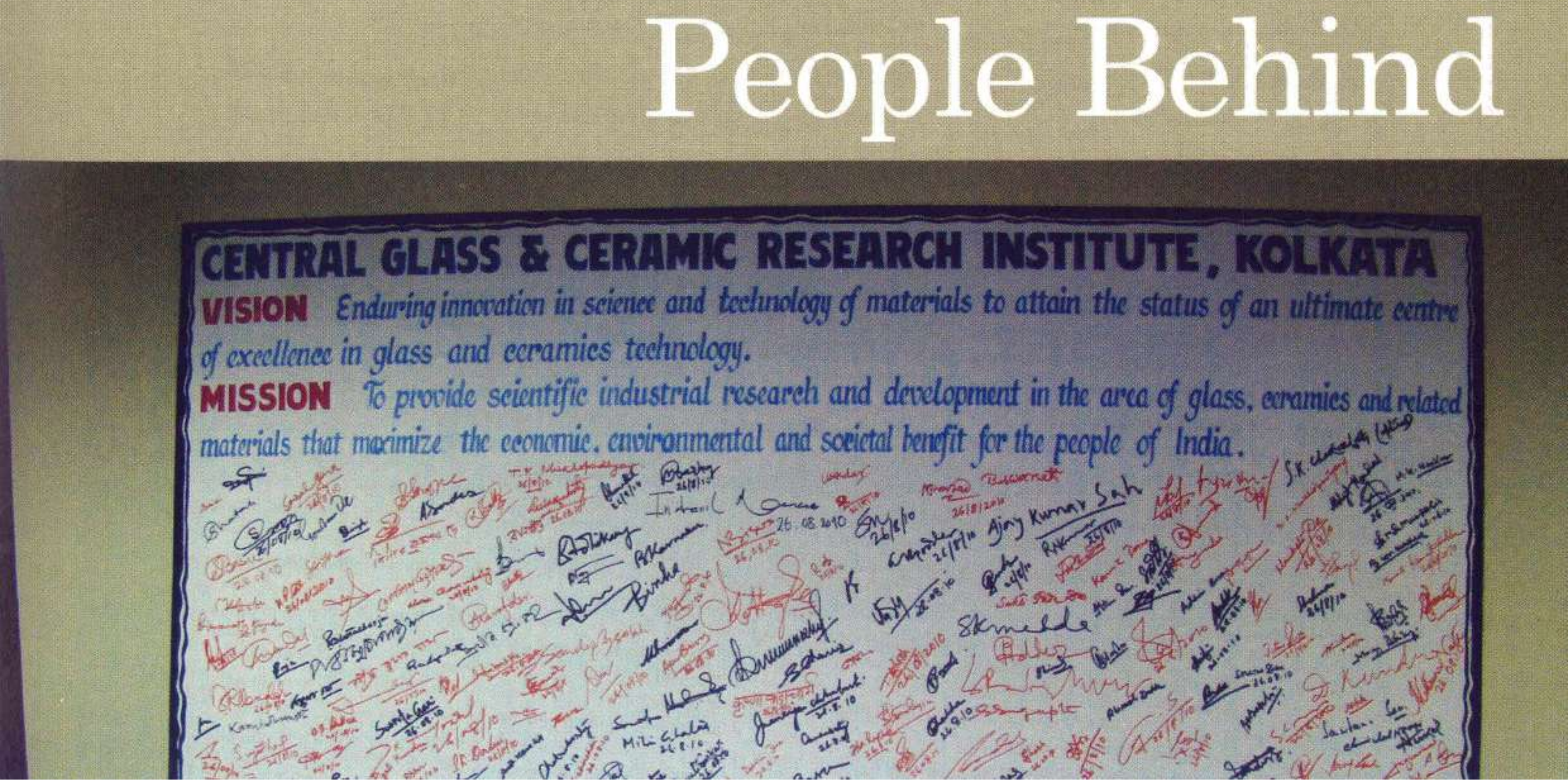
I often feel that excess of funds commits meetings, travels, vigilance and assessment and other modes of control, etc. end up creating more of a body with less of soul that forgets to dream. A dream needs the right balance of freedom to be random and boundaries of reality.

I hope that this Institute will find the magic formula. With Prof. Indranil Manna at the helm of affairs one can always hope.



Science and Technology of Glass and Ceramics

People Behind



Staff Members since 1945

Arranged as per Year of Joining

1945
Dr. Atma Ram
Majumder U. K.
Naskar C. C.

1946
Chatterjee D. N.
Chakraborty S. N.
Das N. G.

1948
Das J. B.
Dastidar A. K.
Dey A. B.
Nath Ray M
Sen A. K.
Sen S.N.
Sharma K.D.

1949
Dey M.N.
Jha K.N.
Ram Rambali
Roy S. B.

1950
Banerjee J. C.
Bharati R. K.
Bose G. C.
Chakraborty D.
Chakraborty M. C.
Chakraborty N. C.
Das M. G.
Krishnaswamy S.P.
Mandal S. S.
Nandi Dr. D. N.
Prasad Dr. S. N.
Ram Jatan
Roy B. K
Roy Ruston
Sen B. N.
Vaish V. K.

1951
Aich U.R.
Caprihan, M. C.
Chakraborty Ajit Kr.
Chatterjee N. B.
Choudhury B.C
Das J. N.
Ghosh S. K.
Gupta S. K.
R.V. Lele
Ramchandran P.S.
Sen Dr. S
Sen H. K.
Verma S. S.

1952
Aggarwal B. K.
Basu Mallick D. N.
Bhatye S. V.
Chakraborty Motilal
Chattejee A.
Dey S. K.
Jha Bhagat Narayan
Kumar Dr. S.
Singh Amar

1953
Banerjee M.C.
Bishui B. M.
Chakrahorty S. K.
Chowhan R. S.
Deb, S. R.
Ghosh S. N.
Mukherjee A. B.
Pradhan S. R.
Saha S. N.
Sarkar S. R.
Singh Rupdhari
Thakur Dr. R. L.

1954
Chatterjee H.
Das Binod Bihari
Das Swadesh
Deshprabhu C. N.
Dey Samir Kr.
Dhar R. N.
Dr. Prabhunath
Dutta Styandera
Ghosh P. L.
Guha S. K.
Mathur N. M.
Mitra S. K.
Mondal Dr. S.

Mondal Jagdish
Mookerjee S. K.
Nayak U. N.
Prasad Dr. J.
Roy C. R.
Roy Choudhury A. K.
Sarkar Bopal Ch.
Sengupta Baldev

1955

Biswas P. K.
Das M. C.
Sen R.
Sinha Dr. B. C.
Upadhyay V. G.

1956

Bhattacharjee S.K.
Bose B. N.
Chakraborty D.
Dasgupta Dr. S.
Dey Anil Ch.
Ghosh D. K.
Gupta M. M.
Gupta P. K.
Gupta R. K.
Gupta S. K.
Mallick K. K.
Mondal Dr. S.
Mondal K. P.
Quader F.
Roy Amalesh
Roy R. N.
Roy Srikant
Saha M. R.
Salim Abdus
Sarkar H. D.
Sarkar K. M.
Sen C. N.
Sen R. N.
Sen R. P.
Som S. K.

1957

Biswas K. K.
Chakraborty N. C.
Chowhan Ram
Das Sachin Ch.
Dasgupta Dr. S.M.
De Arabinda
Ghosh S.C.
Ghosh Saroj
Jarnadar Sankar
Karmakar N. L.
Mazumder S. C.
Mishra N. K.
Mondal K. K.
Nag B. B.
Naskar S. P.
Panti B. N.
Prasad Jagadish
Rafiqui Abdur
Roy A. K.
Roy Bimal
Srikantan G.M.

1958

Aich U R
Aich B. K.
Ananthakrishnan P S
Anganlal
Bag N. N.
Baijnath
Banerjee G.
Banerjee K. K.
Banerjee N. C.
Banerjee P. C.
Banerjee S. N.
Banerjee S. P.
Barua J.
Basu Mullick D.N
Basu A. K.
Basu K. N.
Bhardwaj, S. C.
Bharti R. K.
Bhowmik J. C.
Bhowmik N. C.
Biswas K. K.
Biswas M. N.
Biswas P. K.
Biswas R. C.
Biswas S. K.
Bose G. C.
Bose Suranjan
Chakraborty Ajit
Chakraborty D. N.
Chakraborty M. L.
Chakraborty N.
Chakraborty N. C.
Chakraborty N. K.
Chakraborty S. K.
Chakraborty S. N.
Chanda P. L.
Chandra L.K.
Chatterjee A.C.
Chatterjee Chuni lal
Chatterjee G.
Chatterjee Ajit
Chatterjee K. L.
Chattopadhyay U.
Chowdhury B. L.
Chowdhury A. K.
Chowdhury B. K.
Chowdhury D. C.
Chowdhury S. C.
Chowhan R. S.
Chowhan Sriram
Das A. K.
Das A. M.
Das B.

Das B .B.
Das B. N.
Das Bimbadhar
Das H. N.
Das J. N.
Das Kanai
Das M. C.
Das N. G.
Das N. N.
Das R. M.
Das S. C.
Dasgupta P. K.
Dasgupta S. P.
Dastidar A. K.
Datta N. L.
Datta N. N.
Dutta S. K.
Debnarayan
Dey A. B.
Dey A. C.
Dey Bhagabati
Dey M. N.
Dey P. K.
Dey S. B.
Dey S. K.
Dey S.
Dey Sukumar
Dukha Ram
Dutta M. S.
Ganguli D. D.

Ganguli K.C.
Ghosh B. N.
Ghosh M. L.
Ghosh P.C.
Ghosh P. L
Ghosh S. C.
Ghosh S. K.
Ghosh U. N.
Giri M.L.
Gokhale K. V. G. K.
Gomesh K. N.
Gopal Rao N. S.
Gorai Gusto
Gupta Sharma A. K.
Gupta D. B.
Gupta H. S.
Gupta M.
Guhta S.K.
Haque M. K.
Haque Z.
Hazra K. P.
Hazra S. K.
Jamadar Shankar
Jha K. N.
Jha Raj Kant
Jha Sova Kant
Jha U. K.
Karmakar S. C.
Kesoram V
Koul R. N.

Kumar-Tripit
Lachan
Lal M.M.
Mahato G.
Mahato Jitoo
Mahato Ram Bahadur
Maity D.
Maity D. N.
Majumder H.K.
Majumder S. B.
Majumder S. S.
Majumder U.K.
Mal Satish Ch.
Malakar K. N.
Mallick O. P.
Mallick R. C.
Mishra J. N.
Missir Sukdeo
Missir Tuntun
Mohanti G.
Mondal B.
Mondal J. N.
Mondal Jagadish
Mondal Janak
Mondal K. K.
Mondal Mahabir
Mondal S.C.
Mondal Dr. S. S.
Mondal Srikant
Mondal U. N.

Mukherjee A.B.
Mukherjee A.C.
Mukherjee N. R.
Mukherjee S. K.
Mukherjee S. S.
Mullick K. K.
Munnilal
Narayan B.
Narayan V.S.
Naskar B.N.
Naskar C. C.
Naskar K. C.
Nath Chowdhury S.B.
Nath Roy M.
Nath Trilok
Nayak G.
Jha U. K.
Ojha B.
Ojha Balaram
Padmapani
Pal Chowdhury B. B.
Pal G. B.
Pal S. C.
Pal S. N.
Pal T. C.
Pandey B. K.
Paridha K. C.
Patnaik J. K.
Patra J. M.
Patra S. D.

Paul A. C.
Paul S. N.
Poddar M.S.
Pradhan S. R.
Prajapati K. D.
Quader Fazle
Rafique Abdul .
Raghunathan N. V.
Ram Kailash
Ram Ramnath
Ram R. B.
Ramchandran P. S.
Ramjatam
Roul H.P.
Routh Gopal
Roy B.C.
Roy C. R.
Roy H. N.
Roy K.C.
Roy M. K.
Roy P.
Roy R. N.
Roy Srikant
Roy U. N.
Roy Chowdhury A. K.
Saha A. K.
Saha S.C.
Saha S.N.
Sarkar A.
Sarkar Gopal

Sarkar S. R.
Sanyal H. R.
Sen A. K.
Sen A. N.
Sen B. K.
Sen C. N.
Sen H.K.
Sen S. M.
Sen Rasamoy
Sen Sunil
Sen Sunil Kr.
Sengupta B.
Sengupta Kamala
Sengupta S.
Sharma R.L.
Sigh Maharaj
Singh D.K.
Singh M.
Singh R.D.
Singh R.S.
Singh Ram Ekbal
Singh Rupdhari
Singhal G.S.
Sinha R.N.
Sinha S.K.
Sircar Dr. N.R.
Sk Kaloo
Sk Khalil
Soinie O.P.
Srivastava B.P

Srivastava Dr. K. P.
Subramanian A.
Subramanian R.
Sukhla J.
Thapa Rabilal
Thapa S. B.
Thiagrajan Dr. S.
Thomas C. T.
Tuli S. K.
Venkataram P.K.
Dwajaee Garude B.
Sarkar K.M.

1959

Aich, B. K.
Bayan Narayan Pada
Chakraborty N.K.
Das K.C
Dasgupta P
Dasgupta S P
Dey Susanta Kr.
Mondal B.N.
Mukherjee N.R.
O.P. Saini
Raul Haripada
Roy B.C.
Sen Sunil Kr.

1960

Adak P. K.
Adi Narayan A.
Ahir Pujan
Balakrishnan A. A.
Banerjee A. K.
Bharti B. N.
Bhatta M.K.
Bhattacharyya A. P.
Biswas B. D.
Biswas P.B.
Biswas R.K.
Biswas S.C.
Bose B.N.
Chakraborty B. B.
Chakraborty Ranjit Kr.
Chatterjee A.K.
Chatterjee Bhaskar
Chatterjee S.K.
Chatterjee S.D.
Chatterjee Gurudas
Chowdhury Ram Ch,
Chowdhury Rameswar
Das B.
Das H.N.
Dasgupta J. N.
Dey D.C.
Dwajan B. Garuda
Ghorai R.G.
Ghosh S. K_
Ghosh Ashim Kr.
Gope Tori
Guchait A.B.

Guha D.K.
Gupta M.K.
Halder Arabinda
Jana Pasupati
Jha B.
Jha Deb Kant
Jha Shib Kant
Mahato Ram Udit
Mahandra B
Misra Palit
Moitra A. K.
Mondal M. M
Mukherjee A. K.
Mukhopadhayay A.K.
Nagorkoti Monilal
Nasiruddin
Naskar P.C.
Nath Baid
Nath P.K.
Patra B.N.
Patra Jiten
Paul Sujit
Prajapati S.D.
Prapajati C.P.
Prasad Ramayan
Rai B.B.
Ray Moti
Ram Hari Dayal
Ram Ramnath
Ram Pyari

Rama Devi
Ramesam K.
Routh Billet
Roy A. K.
Roy A. K.
Roy S.C.
Roy Niharendu
Saha A. K.
Saha S.K.
Sahoo B. K.
Sarkar Amalendu
Sen J.
Sengupta D.P.
Sheet P.C.
Singh Rameswar
Singh S.B.
Srimani P.L
Sundarajan R.
Venkataraman P. K.
Sarkar N.R.
Dutta A. K.
Karmakar N.C.
Choudhury Ramdeor

1961

Aggarwal B.M.
Banerjee N.R.
Bhattacharjee A. R.
Bhattacharjee A.K.
Bhattacharjee K.B.
Biswas D.K.
Chakraboty H.N.
Das B.C.
Das Manaranjan
Das Prasadi
Das S. P.
Das S. R.
Das Sanatan
Das Sowresh Chandra
Datta A.K.
Datta S.N.
Dutta N.B.
Ghosal Sabita
Ghosh G.C.
Ghosh M.N.
Gupta S.P.
Halder S.K.
Jha Siya Ram
Karmakar N.C.
Kripashankar
Mahindra B.S.
Majumder M.L.
Mannu Ram
Mazumder M.L.
Mishra Baba Narayan
Mitra K.K.
Mondal B.P.
Naha N.K.
Nair K.M.
Naskar N.C.

Neogi Sagar Kr.
Pandey J.
Paul A.C.
Paul D.K.
Poddar B. D.
Radhakrishnan P
Ram Manna
Ram Saran
Rama Rao B.S.
Roy D.R.
Saha Dr. P
Sarkar A.
Sen Purabi
Sen S.K.
Sengupta Tapas
Sharma B.S.
Singh Tapeswar
Singh U.
Srivastava D.D.
Tirkey J.
Verma C.N.S.Prasad
Ward Purabi

1962

Ahir Varmadin
Bakshi Shibdas
Balmiki Omi
Banerjee Ajit Kumar
Banerjee B.
Banerjee N.L.

Banerjee Reba
Basu K.K.
Basu S.K.
Basu Samir Kumar
Bhattachaljee Sunil
Bhattacharjee B.N.
Bhattacherjee R. K.
Bhattacherjee, D. K.
Biswas B.P.
Biswas Anukul
Chakrahorty Prabodh
Chakrahorty R.K.
Chatteijee Amitava
Chatterjee A. K.
Chowdhury Nirmalya
Chowhan Ramnath
Das Dhindra Ch.
Das Roy P. K.
Das Sunil Kumar
Dasgupta Arati
Datta M.K.
Deb Roy D. K.
Devedi G.N.
Dey Ashit Kr.
Dey Dipesh Ch.
Dey Upendra Ch.
Dubey V.D.
Dutta H.P.
Ganguly P.K.
Ghatak S.B.

Ghosh Asim Kumar
Ghosh B. N.
Ghosh M.C.
Ghosh N.R.
Ghosh S.N.
Goswami B.C.
Goswami S.K.
Guha N.N.
Guha S.
Guha S.C.
Gupta R.N.
Halder Niharendu
Halder S.R.
Hasnat Abul
Hassat Abdul C.H.M.
Hela Munilal
Jha Dasarath
Jha Pheku Nath
Jim Debkant
Krishnamurty A.S.
Mahato Maharaj
Majumder Anil Chandra
Mazumder K.L.
Mishra Nalini Kr.
Mishra Tripit Narayan
Modi S.R.
Mondal Ranjit Kr.
Mukherjee S.P.
Nair M.K.N.
Naskar Atul Kr.

Naskar Samarnath
Nath P.K.
Nath Ram
Newar Nar Bahadur
Pal M.R.
Prasad J.
Rai Ram Sevak
Roy Souresh Ch.
Ruidas Fakir Chand
Sahoo Brindaban
Sarkar N.C.
Sarkar Sahadeb Ch.
Sen Ranjit
Sengupta Subhas Ch.
Seshadri Tarimala
Sikdar A. C.
Singh Omarao
Singh Radha Gobinda

1963

Aggarwal Dr. P.S.
Bandopadhyay Dr. T . K.
Baneijee M P
Banerjee Sita Rain
Banik Shankar
Barma J.M.
Bhusan Dr. B.
Chakraborty S.
Chaturvedi Asha
Chowhan Rajdhari
Dalui Becharam
Dey Asit Kr.
Dhar Minati
Dutta Manju
Dutta Sadhan
Ghosh Ashim Kr.
Halder N.
Krishnaswamy S.P.
Mondol Madar Ali
Mukerji Dr. Joydev
Mukherjee Sudhanshu
Mukherjee U.N.
Naskar S.N.
Nayak Sankar
Rao K.S.Nagaraja
Sanyal S.B.
Sengupta S.
Sengupta S.C.
Srinivas N.
Sur Sukumar
Vishwanathan K. N.

1964

Apasthamvan T. V.
Bag Sanjit Kr.
Baidya M.M.
Banerjee Ajit Kumar
Banerjee D.
Banerjee Mukul Kr.
Basu Samir Kumar

Bhanja S.S.
Bose S.C.
Chakarborty Basudeb
Chakarborty Shreedhar
Chatterjee Anjali
Chowdhury A.K.
Das Basropan
Das P. K.
Das Ram Narayan
Das S. K.
Dasgupta S.N.
Dey Dulal Ch.
Dutta B.C.
Ganguli Dr. D.
Ganguly Santi Pada
Ghosh U.K.
Jadav Sukhan
Jamadar Babulal
Jha Siya Ram
Karmakar S.N.
Kaushlal J.N.
Kayal S.C.
Khan S.K.
Kumar Pitambar
Kushwah B. S.
Mehrotra S.P.
MishraT.N.
Moitra A. K.
Mollah A.K.
Mondal H.R.
Mukherjee Adhir Ch.
Mukherjee Shyamalendu
Naskar B.N.
Nath Provash Kr.
Neogi S. K.
Peto Subal Ch.
Ram Sheojanam
Roy M. K.
Roy Prasun Kr.
Roy Ranjit Kr.
Roy Suniti Kr.
Sardar S. K.
Sen Jayanta
Sen Susanta
Sircar Arunendu
Tarafdar Kalidas

1965

Agarwal B.M.
Aziz Abdul
Bahadur Gurung
Bal L.N.
Bandopadhyay Shreedhar
Bandopadhyay Shymal Kr.
Bandyopadhyay Tapan Kumar
Banerjee Balai Kumar
Banerjee Pankaj Kr
Banik N.R.
Basak G C
Basu P.K.
Bhadra A. K.
Bhar G.S.
Bhattacharjee Haridas
Bhattacharjee J.K.
Bhattacharjee K.K.
Bhattacharjee T.P.
Bhattacharjee Tripti
Biswas Amalendra
Biswas J. R.
Biswas Sunil Ranjan
Boral S.C.
Bose A.K.
Bose D.S.
Chakarborty N.C.
Chakarborty Parimal Kr.
Chakraborty B.B.
Chakraborty Bani
Chakraborty P .K.
Chakraborty P K
Chakraborty R.K.
Chattopadhyay Debdas
Chattopadhyay Mantas Kr
Chowdhury A.K.
Chowhan Babulal
Chowhan Palakdhari
Das Amarnath
Das Haripada
Das R.N.
Dasgupta Bimal
Dasgupta Subhas
De Sarkar B.K.
Dey Asit
Dey Birendra Ch.
Dey Khitish Ch.
Dhar A. K.
Dhar H.S.
Dhar Nitya Nanda
Dutta Madhusudhan
Dutta Mazumder N.
Ganguly K D
Ganguly M.K.
Ghosh B.K.
Ghosh Dostidar Puspa
Ghosh P.G.
Ghosh Srikrishna
Guha S.
Halder Sushil Kumar
Jha L.K.
Kar Jyoti Kumar
Kar S.K.
Karmakar R.N.
Lalji
Laskar Sneharmoy
Mahato Mahajan
Maji Banamali
Manna Biswanath
Mishra Baidyanath
Mitra B.L.
Mohanty Trilochan
Moitra Doli

Mondal B.N.
Mondol K. K.
Mukherjce Dilip Kr.
Mukherjee Samir Kumar
Mullick P.N.
Naskar Dilip Kumar
Naskar S.N.
Nayak G.B.
Nayak Gopabandhu
Neogi S.K.
Ojha Siya Ram
Pahari Jugal Kishore
Pal K.L.
Pal G. L.
Paul R.K.
Podder K.C.
Rao G.R.
Roy Ajay kr.
Roy C.C.
Roy Choudhury A.
Roy Choudhury K.K.
Roy Samir. Kr.
Roy Sidheswar
Saha Asish Kr.
Saha Radha Shyam
Sahu Ram Saran
Samaddar A. K.
Samanta N.S.
Sarkar Himanshu Prasad
Sarkar N.G.
Sarkar R C
Seal Moloy
Sen G.C.
Sen Jayanta
Sen Subir Kumar
Sen Susanta
Sen Tapankar
Sengupta Kahiraj V.B.
Sengupta Pratibha
Sengupta S.
Sharma Damodar
Shaw Ram Ashis
Singh M.N.
Singh Ram Kishore Das
Thakur S.
Tiwari Briendra
Yadav Aparbal

1967

Banerjee S.K.
Banik N.R.
Barik Anil Kurmar
Bose Amarendra Nath
Bose P K
Bug Sridum Ch.
Chakraborty Dr. D.
Chatterjee Anil Ch.
Chatterjee P
Chowdhury Jawahar
Chowdhury Kaviraj
Chowdhury R.C.
Chowhan Ram Nath
Das Anukul
Das Dilip Kumar
Das S N
Das Satya Ranjan
Das Subrata
Dey Ranjit
Jana A. K.
Karmakar Sanatan
Kundu B.K.
Kundu J.C.
Mahato B.N.
Mahato Baijnath
Mishra Shiv Das
Mukherjee S.N.
Mutsuddy P.B.
Nandi Dr. Ashok Kunlar
Naskar K L
Oraon Manna
Paikara Shambhu
Roy Asrati
Roy G C
Roy Pratul Kurmar
Roy Ram Krishna
Sanyal Dr. A.S.
Sardar K. K.
Singh Awadh Bihari
Silgh Ram Kailash
Srikishan

1968

Banerjee B. L.
Banerjee Pranab Kumar
Chakraborty Prantosh
Chakraborty Tapan
Chakrahorty Rupesh
Chatterjee Mantu
Das Polak Dhari
Das Shankar Kumar
Dasgupta C.R.
Deb Majumder R.K.
Dey Amit Kumar
Dhar H.S.
Dutta Gupta Biswajit
Ghosh Kamal
Guha N.R.
Koshy M.
Mahato Teg Narayan
Majumder Amitava
Mondal Bankim Ch.
Mukherjee Prabhat Kumar
Mukhopadhyay Purnendu Kr
Mukhopadhyay T. K.
Nandy A.N.
Prasad S.S.
Ram Chengur
Saha D.N.
Saha Dipak Kumar
Sharma Mitra Pal

Singh Sambhu
Sinha Dr. Purnima
Sonelal

1969

Aich S.K.
Bahadhur Budhiman
Basu M.K.
Bayen N P
Bhattacharjee Gopal Chandra
Bhattacharya Gita
Bhowmick Biman Kumar
Chatterjee Lalit Mohan
Chowdhury Domon
Das Banamali
Das Ram Ch.
Dasgupta Ramchandra
Dey Ashok Kumar
Dhargupta, K. K.
Ghosh Swapan Kr.
Hore Subhash Chandra
Jana Sudhir Ch.
Jha Ram Chandra
Majumder Ashok Kr.
Mallick Suprabhat
Me. Samsuddin
Mishra Nirmalya
Mitra B.
Mukherjee Dilip Kumar
Mukherjee M. K.
Mukherjee P. K.
Paul Gour Gopal
Poddar A.S.
Roy Sekhar
Saha Niranjan
Sarkar Swapan Kr.
Shah Ismail
Singh Deo Kr.
Singh Ram
Tarafder P. K.
Tarafder S. K.

1970

Bandopadhyay R. Rabindranath
Banerjee Pronab Kr.
Chakraborty Sachidananda
Chatterjee Dr. Sandip Kumar
Das Bijay Kumar
Das Jiban Krishna
Deb Asoke Kumar`
Gayen Sushil Kumar
Goswami M.C.
Karmakar Bimal Chandra
Kashyap J. P.
Rai Ram Jatan
Ram Ramnaresh
Sengupta Santanu

1971

Agarwal, M. M.
Annamalai Dr. N
Banerjee Amit Kumar
Basu Ashis Kumar
Bhattacharjee Sandhya
Biswas Souren
Chakraborty Kalyan
Chatterjee Ajit Kumar
Das Dr. Sunil
Das H.C
Das K.K.
Das Naresh Ch.
Dasgupta Alokmoy
Dey Paritosh
Koyal P . B.
Majhi A. K.
Naskar Panchanan
Oraon Lachu
Poddar Pratima
Raut R.P.
Sarker Bidhan Ch.
Sikdar B.B.
Swain Pant Pahan

1972

Bandyopadhyay Niranjan
Bandyopadhyay Swapan Kr
Bapari Sudhir Kumar
Bhagat Khudia
Bhattacharjce B.K.
Biswas Anil Ranjan
Bose Samir Ranjan
Chakraborty Samir
Chandra Shankarlal
Chatterjee Dr. Minati
Chowdhury Priyatosh Kr.
Das Dulal Ch.
Das Laxman Ch.
Das Rajatesh
Dasgupta Amit
Dey Babulal
Dey T C.
Dutta Bijon Kumar
Ghosh Rabindra Nath
Hazra Nitai
Jadav Ram Chandra
Jar Sudarshan
Karinakar Santosh Kumar
Maity P. C.
Mishra Lakshmlan
Mondal Ashok Kumar
Mondal Sukumar
Mullick Rajabul
Naskar Amar Chandra
Nath N.N.
Patra Barun Ch.
Patra Maheswar

Paul Dipak Kumar
Rai Mahesh
Rain S.J. Sant
Ram Raghuhir
Ram Satya Narayan
Ray Prasanta
Roy Dilip Kr.
Sasmal Golok Ch.
Sengupta Sukhendu
Singh B. P.

1973

Adhikary R.M.
Banerjee Prabir Kr.
Bhattacharjee Ajit Kr.
Chakraborty Chandan Kr.
Chakraborty Nanda Lal
Chakraborty Parthasarathi
Chakraborty Prabir Kumar
Chowhan Dalsinger
Dutta Ashok Kr.
Dutta Banik Bani
Dutta Shankar Kumar
Ganguly Samiran
Ghorai Ranjit
Ghorai, K. K.
Jana Premananda
Laha Sambhu Nath
Majumder S.C.
Mishra Bhogendra
Narain Prakash
Naskar Dudh Kumar
Paul N R
Purkait Palan Ch.
Roy Ranjit Kumar
Roy Satyabrata
Saha Bhulu Ch.
Sarkar Madhusudan
Singh Sheo Mohan
Thapa Jang Bahadur

1974

Bhattarcharjee Dr. S K
Bose Ashish Kumar
Chowdhuri P.K.
Chowdhury Dr. A.K.
Das Dr. Samir Kumar
Dasgupta Salil Kumar
Debnath Keshab Ch.
Dutta R. N
Laskar P K.
Mondal Anuradha
Mondal B. K
Moullick K.N.
Mukherjee Dr. B.
Mukherjee S.P.
Roy Dr. C.S.
Sharma G.C.
Sikdar P K.

1975

Bhagwandas M.S.
Das S.C.
Das Shakti Pada
Datta Pradip Kumar
Guha Ashim Kr.
Kundu Dr. Paritosh
Nandi Asis Kurnar
Patra H. K.
Rathod Dr. B.S.
Sanyal Dr. P.
Sharma M.
Sinha A.S.

1976

Bhattacherjee S. N.
Bhika Sukha
Bibi Salema
Das B. P.
Datta Malay Kr.
Dey N. C.
Kavishwar M. U.
Kirloskar G.S.
Majumder Dr. B.
Manek Y .V.
Saha Dilip Kr.
Singh Wassan Harbhajan
Srinivasan K.N.
Subramanium R B V
Syed I M
Trilochan Naru
Vyas D R

1977

Adhikari U B
Ali Sayed Jalil
Bhaduri S.K.
Bhagat Dasarath
Bhagmoni Devi
Bhattacharya Abhijit
Bose Subhas Kumar
Das Dr. Anukul Ch
Das Sadhan
Datta Alokesh
Deb Barman P S
Dhar Murti Shyamal
Dwivedi Dr. R N
Harilal V.
Jha Sharvan Kumar
Kar Bireswar
Maity Ashoke Kumar
Maity R B
Majumder Dr. Sujata
Mazumder Balahari
Mondal Debadutta
Mondal Pradip Kumar
Naskar L K
Pal Mahadev
Radhakrishnan V.
Rajagopalan Leela

Rakshit Manmohan
Ram Bishunath
Ramakrishnan Dr. E.S.
Rout Minu
Roy Bhupesh Ch.
Roy Dr. B.N.
Saha Dr. Manjushree
Sengupta Dr. Kamalendu
Singh Mohinder

1978

Balmiki D. P.
Basu Ashim Kumar
Chakraborty Dr. A K
Chakraborty Dr. S
Chakraborty K.C.
Chowdhury Dr. Sitapati
Das Arun
Das Dinesh Kumar
Das Gopal Ch.
Dutta Ashoke Kumar
Ghosh B P
Ghosh Bula
Gupta Kasturi
Islam Rabiul
Karmakar Anath
Kumar Ram Narayan
Mary P D
Mukhopadhyay P.K.
Nag Prithis Ch.
Pal Dr. Dipti
Paul Tarak Ch.
Rakshit Dr. Jaganmay
Sengupta M.R.
Sinha A.B.

1979

Balmiki C S
Balmiki R C
Balmiki Shambhu
Chatterjee Somnath
Das Haradhan
Das Mihir
Das Paresh Nath
Das Rajendra
Dey S K
Gond V K
Jha Indrakant
Joshi S. R.
Kalundia Lalit
Laxmimani Devi
Mahato Rajkumar
Mandal M.R.
Mondal Jayanta Kumar
Mondal Ram Padarath
Mukherjee S. N.
Nagwadia J M
Nandi Banka Behari
Narayanan B.R.
Roy Tarak Nath
Saha Roy Pankaj Kurnar
Sharma I S
Sojitra B.G.

1980

Bandyopadhayay Dr. S
Banerjee Dr. S.K.
Biswas Dr. Sampad Kumar
Biswas Dr. N C
Biswas Dr. Nisha
Chakraborty, Shankar
Chandra Dr. Dhruba
Chowdhuri Alokesh
Das Dhruba Kurnar
Das Gouranga Ch.
Dey Haran Chandra
Dey Tapas Kumar
Dhar Aurobinda
Dhingra S.K.
Dhole N.K.
Dutta A. K.
Ghatak Dr. Sankar
Halder Panna Lal
Iyer K.R.Rajaram
Kar S.K.
Koyal Gopal Ch.
Kundu Dr. Dipali
Mandal B. R.
Mondal Jatin Chandra
Mondal S K
Mukherjee Pabir Kumar
Mullick Rajkumar
Oraon Gandurao
Sanpui Namita
Savsani R M
Sen Kalyani
Sen Maya
Singh Dr. Ramadhar
Singh K C
Sinha Dr. M. K.
Trivedi N R

1981

Banerjee S. K.
Biswas B. R.
Chakraborty B. K.
Chakraborty Dr. Mithilesh
Chakraborty Prantosh
Chakraborty Somnath
Chatterjee Sunil Kumar
Das Dr. Prabal Kumar
Das Dr. Ranjit
Deb Roy B.B.
Dey (Roy) Minati
Guchait Kashinath
Hela Sadhanlal

Majumder Balai Chand
Majumder Swapan Kumar
Mondal (Haldar) Dipti
Saha Prabir Kumar
Sen Prasanta
Shah H.M.
Sharma Bramhananda
Sur Subir Kumar

1982

Bandhopadhyay Subir
Bandyopadhyay Dr. Sibdas
Bhattacharya Swapan Kumar
Bose Dr. Nripati Ranjan
Bose Tarun Kanti
Chakraborty J.
Chakraborty Prof. D.
Chowhan O.P.S.
Das Gopesh Chandra
Das K. C.
Das Mouli Nath
Das Swapan Kumar
Dasgupta Saktimay
Deb Dr. Sukhendu
Devi Kamala
Dey Sisir Kumar
Dhanuk Tarakeswar
Ghose Mohan Kumar
Ghosh Nirmal Kumar
Ghosh Sujit
Gupta A K
Gupta Surajit
Jha Govindaji
Joardar Suhhas Kr
Lahiri Subhra
Maiti Asit Kumar
Maiti Dr. K N
Majumder A.
Mondal Savjit Kr
Mukherjee Sachindra Kr
Mukhopadhyay M.N.
Naskar Shyamal Kr
Phani Dr. K K
Prasad C. S.
Pratihar Swapan Kr.
Roy M.N.
Roy P.N.
Saha L N
Saha Prabir Kumar
Sarkar Dilip Kumar
Sarkar Swapan Kumar
Sen Dr. Suchitra
Sen Partha Sarathi
Singh Rajveer
Singh Shakti
Sk Kamaluddin
Vas Krishnapada

1983

Bandyopadhyay Kartick
Basu Jharna
Bhatacharjee Amar
Bhattacharjee Nirupam
Bhattacharjee P.K.
Biswas Apu
Biswas Nilratan
Chakraborty Dipak
Chowhan R.C.
Das Biswanath
Das K.
Das Kamal Lal
Das M.L.
Das Nikhil Kr.
Das P.B.
Das Paritosh Kumar
Das Robin Kumar
Das Sambhu Charan
Datta Dr. Someswar
Datta Samar Nath
Dey G. K.
Dey Mrinal Kanti
Dey Sanjib Kumar
Dhanuk Ganga Prasad
Ganguly Tarun Kumar
Ghosh A. K.
Ghosh Dr. Arup
Ghosh Dr. Sumita
Ghosh Shyamal
Ghosh Tarun Kanti
Giri P.C.
Giri Prem Prakash
Gupta Rana
Harikrishan V
Hazara Sukumar
Kundu B.K.
Maitra A. B.
Mandi Mahahir
Mazumder Himanshu
Mazumder Swapan Kumar
Mukherjee A K
Mukherjee Dr. Barundeb
Mukherjee S. K.
Mukhopadhyay Prabhas Kr
Mukhopdhayay Paban Kr
Mullick Banshi Badan
Mustafi S P
Naskar Niranjan
Nayak Shankar
Pal Chowdhury P. G.
Pal Narayan Chandra
Patanaik B. M.
Paul S.R.
Pradhan Sankar Lal
Prasad D.J.N.
Prasad Mithelesh

Roy Dr. A. K.
Roy Dr. Somendra Nath
Roy Swapan
Roy Chowdhury Manas
Saha Swapan Kumar
Sanpui S K
Seal B.N.
Sen Arun Kumar
Sen Ranjan
Sengupta D.C.
Sikdar Debasree
Singh Kali Charan
Singh Nar
Sinha Arun Kumar
Soren Sitaram

1984

Acharya A. C.
Banerjee Dr. Gautam
Bhadra Dr. S. K.
Bharati Nagendra
Bhattacharya T. K.
Biswas S. K.
Biswas Sabitri Bala
Chakraborty Aloke
Chatterjee Kamalesh
Chatterjee Bithika
Dana Chandan Kumar
Das Naba Kumar
Das Netai Chandra
Das Roma
Das Santi Ranjan
Dutta S. N.
Ghosh Amitabha
Ghosh Dr. Ambar
Gichait Ashok Kumar
Guha Animesh Kr.
Gupta Santanu
Kumar Dr. Rakesh
Machhoya B. B,
Misra Binodanand
Mondal Prosenjit
Naskar Dinabandhu
Pal S K
Paul Basudeb Chandra
Paul Dilip Kumar
Ray Chowdhury Alaka-Nanda
Saha Sushanta Kumar
Sengupta D.G.
Sengupta Subrata
Shimachalam G.

1985

Biswas Uma
Bug Joydeb
Chakraborty Shubhendu
Chatterjee Bithika
Chowdhury Tapati
Das Shankar
Dasgupta Tapan
Meena M.L.
Mishra Pavan Kumar
Nayak Bikram
Ojha Tarakeshwar
Ray Manasi
Sardar K. K.
Sk Sultani
Yadav Kalpati

1986

Dalui Srikant
Dasgupta Kamal
Dayal Prabhu
Goswami Kabi Kankan
Kumar Jagadish
Kundu Dr. Debtosh
Mukherjee Manju
Mukherjee S. S.
Mukhopadhyay Dr. Anoop Kr
Singh B. P.

1987

Arjunan P
Basu Dr. Debabrata
Bhattacharjee K K.
Bhattacharjee P.C.
Chakraborty Anjan
Chakraborty Ashim Kumar
Das Prasanjit Kr.
Debnath Dr. Radhaballav
Dutta M. L.
Ganguly Amal
Jana Bholanath
Kayal Dr. Tarun Kumar
Lahiri Dr. S. K.
Laskar Aparna
Maiti Dr. H. S.
Mukhopadhyay T. K.
Pal G. G.
Roy P. K.
Sen Dr. Amarnath

1988

Basu Dr. Rajendra Nath
Bhar Rina
Bhattacharjee Debasis
Biswas Dr. Prasanta
Biswas Nirmal Kumar
Chakraborty T. K.
Chand Bhikari
Chatterjee Anil
Chatterjee Dr. Arun Prasad
Chatterjee Surajit

Chowdhury Dr. Pranab
De Dr. Goutam
Gayen Mudhusudan
Ghatak Mihir Kumar
Ghosh Goutam
Kumar Dr. Amitabha
Maity M.P.
Mazumder Arijit
Misra Ashwini Kumar
Mondal Jalaluddin
Mondal Martha
Naik Padma Lochan
Paria Dr. Mangal Kanti
Prasad Sashikant
Roy R. L.
Saha J.C.
Saha Nonigopal.
Sarkar Dr. B. K.
Sengupta Tapas
Sezhian A
Shankar Dr. Ravi

1989

Basu N K
Chakraborty Dr. O P
Chattopadhyay Uttam
Chowdhury Bidhan Ch.
Dan Dr. T.K.
Das Partha Sarathi
Halder Ananda Ram
Kar Bijoy Kr
Mitra Tapas Kumar
Mondal Sitendu
Naskar Sushanta
Oraon Mila
Ram Motilal
Roy D. K.
Roy Nupur Kumar
Roy P. K.
Sengupta Shampoo

1990

Arya Anil Kumar
Banerjee Dr. Goutam
Basu Adhir Kumar
Chakraborty Samir
Dey Shyamal Kumar
Dutta Madhusudan
Halder Ashim Kumar
Jana Sridam Chandra
Mallick Banshi Badan
Mallick Ram Lal
Mukherjee Dr. Keka
Najinary Paresh Ch
Naskar Dr. Milan Kanti
Pal N C
Ram Yad
Rao Srinivasa
Roy Sudhakshina
Sarkar Dr. Samir Ranjan
Tarafder Arati

1991

Banerjee Dr. Rajat
Chowdhury Chittabrata
Das Dr. Sukhen
Das P C
Joardar A K
Mazumder Amalandu
Prasad Renu
Rao R. Krishna
Roy (Biswas) Subarna
Sarkar Swapan
Soren Sanatan

1992

Adhikary Krishnendu
Kerkata Chhoton
Kumar Dr. Anil
Mazumder Anish
Prasad Mahesh

1993

Bhattacharjee Krishna
Chowhan Dinesh Kumar
Dalui Janardan
Das Tarani
Dey Gouri
Ghosh Subrata Kumar
Halder Manas Kamal
Hore Krishna
Naskar Biplab Kumar
Roy Lina

1994

Banerjee. Muktipada
Barua Nirmal Kumar
Baskey Mansaram
Bepari Shekar Kumar
Chakraborty Bhavesh
Chakraborty Ruma
Chakraborty Soumitra
Gond Om Prakash
Mondol Sivnarayan
Paliwal Priyankar
Samaddar Sanjib
Singh Atraj
Singh Chandra Prakash
Singh Nalin Kumar

1995

Banerjee Dharma Das
Bhattacherjee Dr. Tarun Kanti
Das Minati
Dasgupta Dr. Subrata
Deb Palash

Ganguly Dr. C.
Ghosh Tapash
Gurung Yam Bahadur
Karmakar Dr. Basudev
Mitra P. K.
Pramanick Swapan Kr.
Prasad Shatrughan
Sen Sanatanu
Sengupta D R
Sengupta Samarjit
Sethi Duryodhan
Sinha Prasanta Kumar

1996

Annapurna Dr. Kalyandurg
Gangadharan S.
Patra Dr. Amitava
Roy Debabrata
Sircar Sarup
Sengupta Alo

1997

Banerjee Salil Kr.
Basak Dr. Samendra
Bishyoi B. M.
Chakraborty R K
Chatterjee Tapas Kumar
Chowdhury Prasanta
Das Prasanta Kumar
Das Sharma Dr. Abhijt
Das Swapan Kr
Das Dr. Swapan Kr.
Devi Dr. P Sujatha
Jana Dr. Sunirmal
Karmakar Dr. Debi Prasad
Mondol Sisir Kanti
Mukherjee Rabibrata
Mukhopadhya Rahuldeb
Patra (Maity) Chandana
Pal Dr. Mukul Chandra
Suresh P.
Tripathi Dr. H. S.
Vohra S.K.

1998

Banerjee J.L.
Bhattacharjee Sukanta
Chakraborty Anjan
Chakraborty Ranjan
Chakraborty Sandip
Das Alpana
Das Biswarup
Das Nirmal Chandra
Debnath Gopal
Ghosh Suspata
Kumar Dinesh
Md. A Peer Mahammad
Mistry Kalyan Kr.
Mondol Ashok Kr.
Roy Chowdhury Alok
Samaddar Ranjan
Sikdar Biswajit
Sreemany Monjoy
Trafdar Tapan
Vasisth Bishamber Dayal
Yadav Anju Kurmari

1999

Banerjee Manas
Chakraborty S.N.
Deb S. K.
Dey Siddhartha
Dhar Bodhiswatta
Kumar Vinay
Moitra Dipanjan
Mondal Sukamal
Mukherjee Rubai
Ram Hare
Saikia Rupam
Srivastav Kanaklata

2000

Bagti A. K.
Biswas Bidhan
Biswas Shankar
Ghosh Avijit
Mandal Dr. Sanjay.
Mishra Ramendra Kumar

2001

Acharya Saiketdeb
Agwaral Parvesh
Bhattacharjee Hari Sankar
Bhattacharya Dipten
Bhattacharya Kaushik
Biswas Anup Kumar
Das Sumana
Dutta Milan Kr
Majumder Mousumi
Majumder Sumana
Mollah Atiar Rahaman
Mondal Ashis Kumar
Mukherjee Abhoya Pada
Pal Mrinmay
Potatunda Ashok
Roy D K
Sarkar Ritwik

2002

Bagchi B. K.
Bandopdhyay Dr. Sonmath
Basu T. K.

Bhettacherjee Ratan
Chetia P C
Dan Dr. T.K.
Das A. K.
Das Dr. Nandini
Das Swarupa
Ghosal T K
Jayashree R.
Koyal Dr. Nijhuma
Mallick B.C.
Nandi P.K.
Neogi C.L.
Sanyal Dipayan
Sarkar D.
Sen Shrma Sudhendu
Sengupta Subhra

2003

Bandopadhyay D C
Banerjee Arun Kr
Biswas Snehasis
Chakraborty B D
Chakraborty Ratan
Dutta Namita
Ghosh Indrajit
Mandal B R
Mohanty M
Poddar A K
Rathod M D
Roy P K

2004

Basu Dr. R N
Bhattacharya D K
Dash Chowdhury A
Majumder, Swachchha
Roy S C
Sharma Dr. L K

2005

Achuthan Asha T
Bhattacharya Suprabhat
Chakraborty Dr. Jui
Dana Kausik
Das Mitun
Ghosh Jiten
Ghosh Dr. Sourja
Kumar Kaushal
Kumar S Senthil
Kumar Subodh
Kundu Biswanath
Lepcha Sarmistha
Md Shabudeen
Pal Atasi
Ram Hare
Sahoo Dr. Ganesh Ch
Sardar Sudipta
Seelan S

2006

Acharya Nabanita
Adhikary Mrinmoy
Bahinipati R K
Barik Shibasish
Basu Sumantra
Biswas Indranil
Biswas Palas
Chakraborty Shirshendu
Chakradhar Dr. R P S
Das Shyamal
Das Sourav Kr
Das Suman
Das U S
Dasgupta Rana
Dey Biswajit
Dey Nitai
Ghosh Sudip Kr
Gond V K
Hemrom Asian
Karshanbhai K H
Kumar Deepak
Maity Titir
Mallick Aparajita
Medda S K
Misra Dr. S N
Mitra Biplab Kr
Mohan Babu I
Mukhopadhyay Jayanta
Narjinary Mousumi
Pal Ananda Sunder
Pradhan Bibhudatta
Roy Karmakar Subrata
Sahoo T P
Sarkar Sandeep
Seshagiri K V V
Shuruba P M
Tarafder Anal

2007

Balaji S
Bhattacharya T K
Bysakh Dr. Sandip
Dana Kaushik
De Moumita
Dhawan O P
Gangopadhyay Dr. T K
Halder Barun
Maity Debjit
Mallick A K
Mohanty Dr. Sourindra
Naskar M K (Dr.)
Payra Indranil

Prasad Abjijit
Reddy V P
Roy Rubai
Saha Debdulal
Samanta Swati
Sarkar Subhendu
Seal Anshuman
Sinha Mahapatra Somnath

2008

Antil R S
Balmiki Laxman
Bhattacharjee Rintu
Dasgupta Kajari
Mandal Samarendra
Mandal Sanat
Nag Sourav
Oraon Sushil

2009

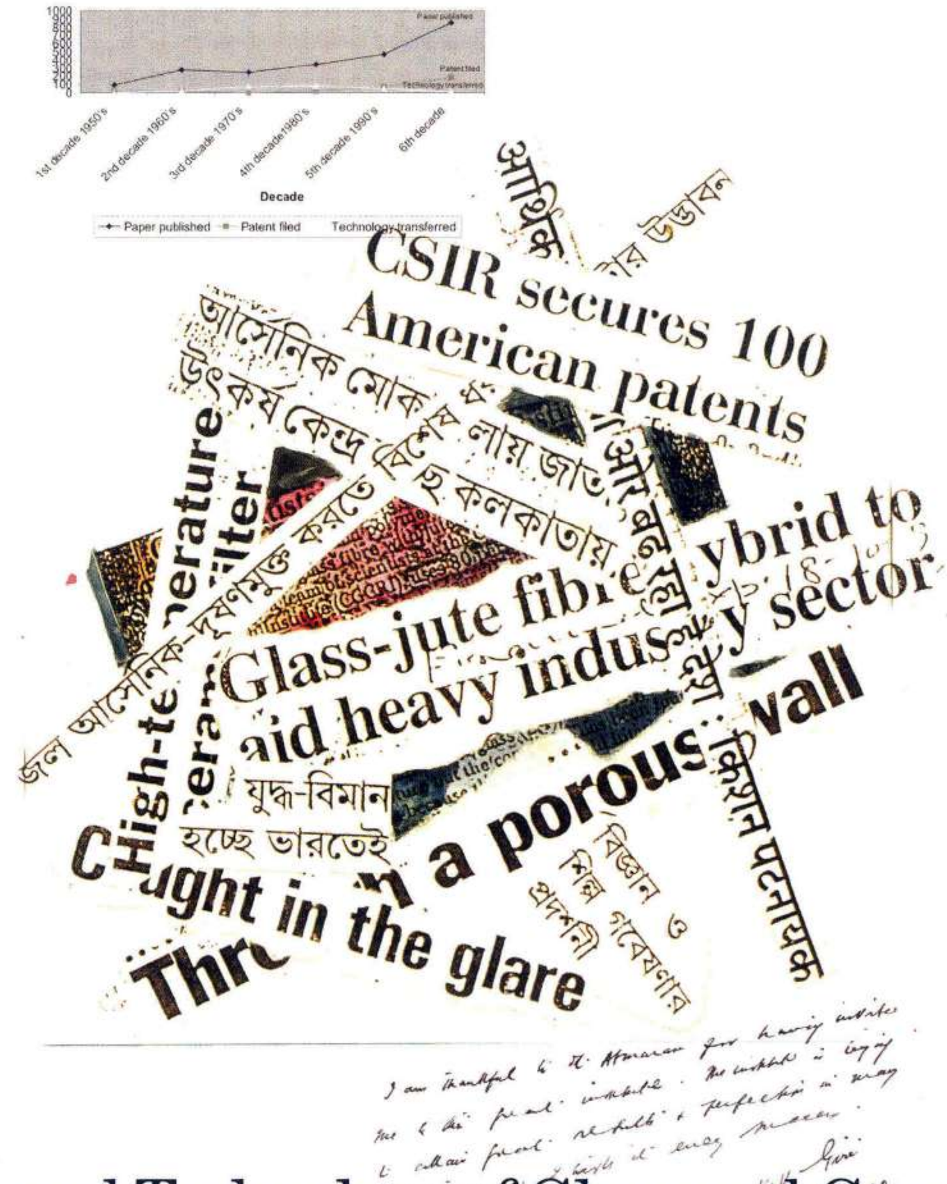
Basumallick Nandini
Chaudhary Ravi Shankar
Kundu Susmita
Mukherjee Samir

2010

Barik Satyendra Nath
Biswas Indranil
Biswas Subhash Ch
Boruah Jayanta M
Chalak Gouranga
Charchari Smarjit
Churnilal P. R.
Das Pradip Sekhar
Das Sanjiban
Das Somnath
Das Souma
Das Subrata
Garai Amit
Ghorui Amar
Ghosh Pratik
Ghosh Sudip
Halder Indrajit
Joshi Naresh R
Kundu Piyali
Manna Prof. Indranil
Mondal Bikash
Mondal Subhendu Bikas
Mursalin Shri Sk Md
Nath Sumit
Oraon Naresh Kr
Panja Subrata
Parekh R K Chunilal
Roy Sujoy
Sah Ajay Kr
Sen Sudeep
Sen Dr. Shrabanee
Sikder Unmana
Singh Anurag

2011

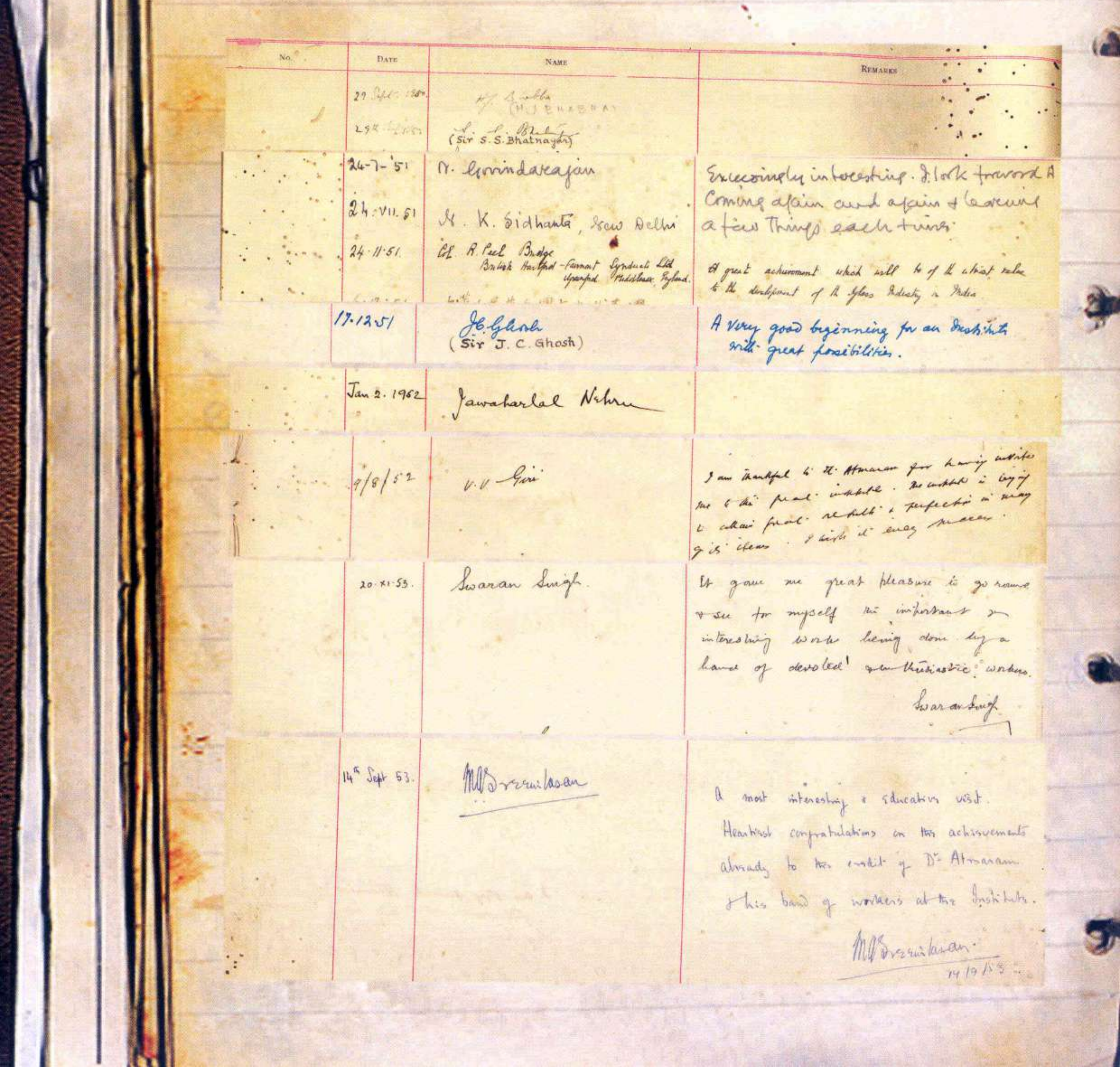
Bandyopadhyay Aninda
Kumar Bipin
Patel M. Alpesh Kumar



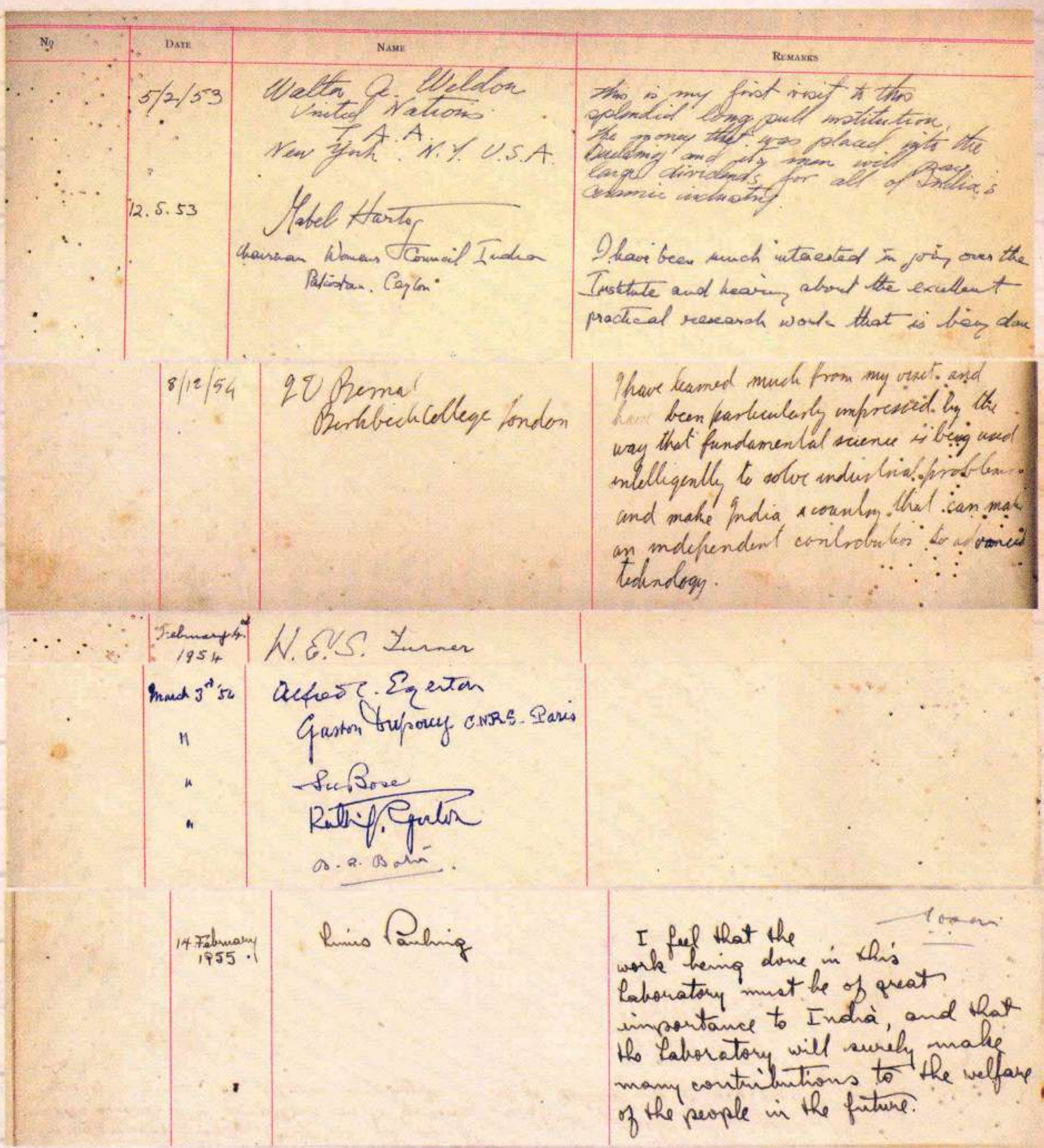
Science and Technology of Glass and Ceramics

Visitors' Comments, Performance Data and Institute in the News

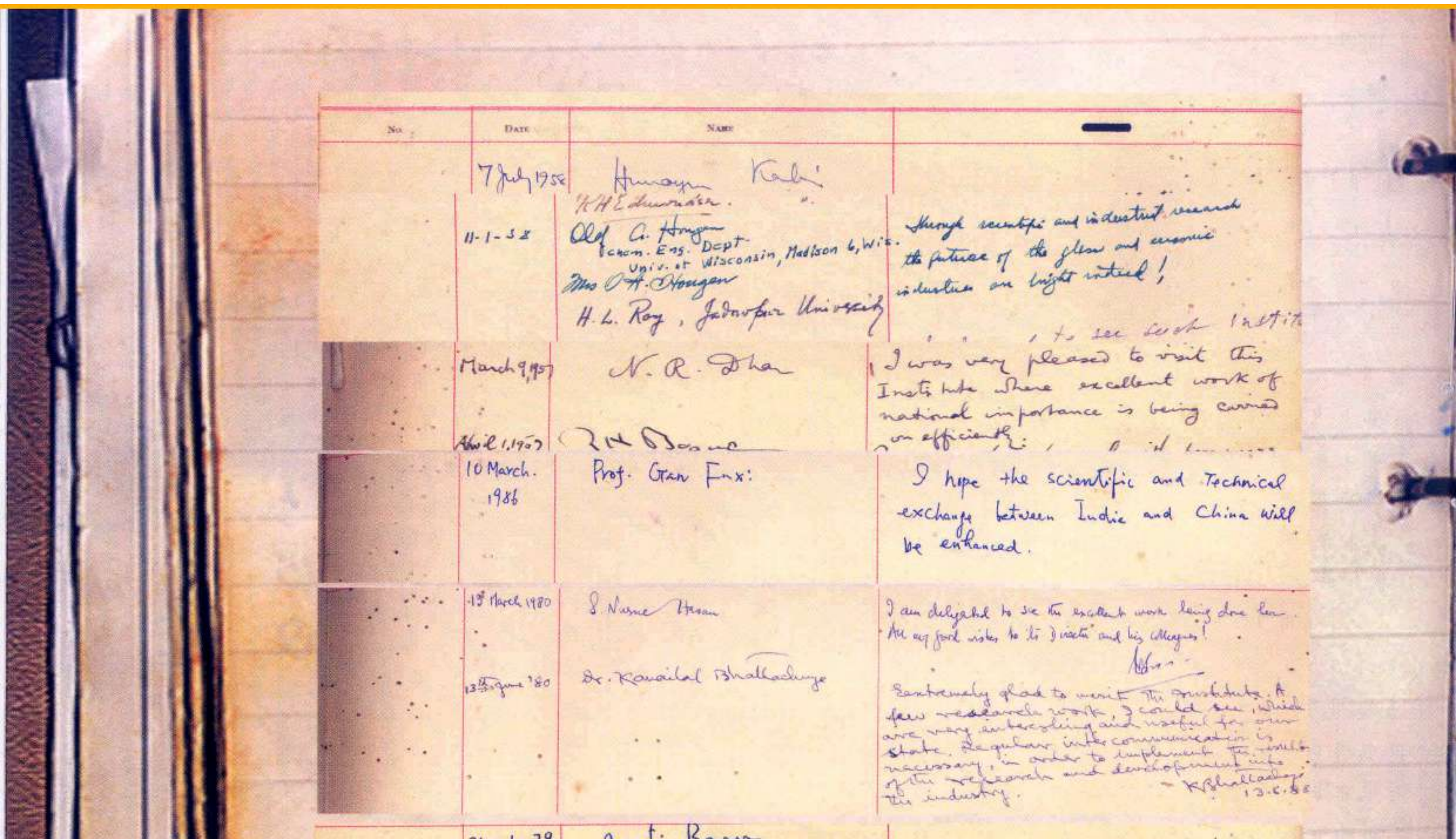
Visitors' Comments



No.	Date	Name	Remarks
	27 Sept. 1950	H. J. Bhabha (H. J. BHABHA)	
	29 [illegible]	S. S. Bhatnagar (Sir S. S. Bhatnagar)	
	24-7-'51	N. Govindarajan	Exceedingly interesting. I look forward to coming again and again & learning a few things each time.
	24.VII.51	N. K. Sidhanta, New Delhi	
	24.11.51.	Col. R. Peel Bridge, British Hartford-Fairmont Syndicate Ltd, Greenford, Middlesex, England.	A great achievement which will be of the utmost value to the development of the Glass Industry in India
	17.12.51	J. C. Ghosh (Sir J. C. Ghosh)	A very good beginning for an Institute with great possibilities.
	Jan 2. 1952	Jawaharlal Nehru	
	9/8/52	V. V. Giri	I am thankful to Dr. Atmaram for having [illegible] me to this great institute. The institute is [illegible] [illegible] perfection in [illegible] [illegible] great results [illegible]. I wish it every success [illegible]
	20.XI.53.	Swaran Singh.	It gave me great pleasure to go round & see for myself the important & interesting work being done by a band of devoted & enthusiastic workers. Swaran Singh
	14th Sept 53.	M. S. Sreenivasan	A most interesting & educative visit. Heartiest congratulations on the achievements already to the credit of Dr. Atmaram & his band of workers at the Institute. M. S. Sreenivasan 14/9/53



No	Date	Name	Remarks
	5/2/53	Walter A. Weldon, United Nations, T.A.A., New York N.Y. U.S.A.	This is my first visit to this splendid long pull institution. The money that was placed into the building and its men will pay large dividends for all of India's ceramic industry
	12.5.53	Mabel Hartog, Chairman Women's Council India, Pakistan, Ceylon	I have been much interested in going over the Institute and hearing about the excellent practical research work that is being done
	8/12/54	J.D. Bernal, Birkbeck College London	I have learned much from my visit and have been particularly impressed by the way that fundamental science is being used intelligently to solve industrial problems and make India a country that can make an independent contributor to advanced technology.
	February 4th 1954	H.E.S. Turner	
	March 3rd 54	Alfred C. Egerton	
	"	Gaston Dupouy CNRS Paris	
	"	S.N. Bose	
	"	Ruth J. Egerton	
		S.R. Bahl	
	14 February 1955	Linus Pauling	I feel that the work being done in this laboratory must be of great importance to India, and that the laboratory will surely make many contributions to the welfare of the people in the future.



No.	Date	Name	[redacted]
	7 July 1958	Humayun Kabir	
		K.H. Edmondson. "	
	11-1-58	Olaf A. Hougen Chem. Eng. Dept. Univ. of Wisconsin, Madison 6, Wis. Mrs O.A. Hougen	Through scientific and industrial research the futures of the glass and ceramic industries are bright indeed!
		H.L. Roy, Jadavpur University	
	March 9, 1957	N.R. Dhar	I was very pleased to visit this Institute where excellent work of national importance is being carried on efficiently.
	April 1, 1957	[illegible]	
	10 March. 1986	Prof. Gan Fuxi	I hope the scientific and Technical exchange between India and China will be enhanced.
	19th March 1980	S. Nurul Hasan	I am delighted to see the excellent work being done here. All my good wishes to the Director and his colleagues!
	13th June '80	Dr. Kanailal Bhattacharya	Extremely glad to visit the Institute. A few research work, I could see, which are very interesting and useful for our state. Regular intercommunication is necessary, in order to implement the results of the research and development into the industry. — K. Bhattacharya 13.6.80
	31-1-79	Jyoti Basu	
	86-4-8	Abid Hussain Member Planning Commission New Delhi	This visit has been a great experience. An eye-opener. It filled my heart with delight to see things being done & visualised for future. Dr. Kumar has provided the right type of leadership to the Lab. The cooperation that exists between staff & scientists is mainly responsible for the existence of right creative environment. I'm sure future is bright & many splendoured things could be expected of the scientists here. I wish the Lab a glorious future.

Remarks of Shri Abid Hussain, Member, Planning Commission, after his visit to CGCRI on August 4, 1986

" This visit has been a great experience. An eye-opener. It filled my heart with delight to see things being done and visualised for future. Dr. Kumar has provided the right type of leadership to the Lab. The cooperation that exists between the staff and the Scientists is mainly responsible for the existence of right creative environment. I am sure future is bright and many splendoured things could be expected of the Scientists here. I wish the Lab a glorious future ".

No	Date	Name	Remarks
	12 Feb 1988	Prof B. Ramachandra Rao Member, Parliament (Rajya Sabha) New Delhi	Remarkable developments in frontier Areas are taking place and this laboratory is in the forefront of research in ceramic and glass materials of tremendous potential. It is unfortunate that I had not been able to visit this lab earlier. I congratulate all the Scientists for their contribution not only high Science and Technology areas but also in the field of applications to rural Communities. My best wishes to one and all. B. Ramachandra Rao
	26 August 1950	कैलाश नाथ काटजू (His Excellency Dr. K.N. KATJU)	आज का दिन बड़ा शुभ दिन है प्रार्थना है कि सदा यह प्रयोगशाला सफल हो और बनी रहे और यहां के विद्यार्थी फलें फूलें. कैलाश नाथ काटजू
17/7/84	→	Shivraj V. Patil.	Good work is being done. I am sure what is being done here would be useful in sophisticated areas, as well as to the people coming from rural areas. I would like to congratulate the Scientists and all others for what they have achieved and are trying to achieve. [signature] 17/7/84

Central Glass & Ceramic Research Institute deserve Congratulations for the work that is being carried on in the laboratory & then applied in the industry.
[illegible]
[illegible] .1.65

Economic Times 06-08-1989.

TRACKING THE FRONTIERS OF SCIENCE AND ...

...search Institute

...t in the glare

...other way, even as an indigenous technology puts the rest in the shade.

... and a suitable royalty fee, the process for coating sheet glass (and for Rs 50,000, opthalmic glasses) ... available from both CGCRI and NRDC — far cheaper than ... imported technology. ... surprisingly, almost 40 companies, including the tyre manufacturer MRF, approached CGCRI for obtaining the know-how. However, all stipulated the condition of wanting to be exclusive ... of the know-how. A ... that resulted in no one benefiting from the technology. "It is against government policy to encourage monopolies and, therefore, neither CGCRI nor NRDC is in a position to part with the know-how to firms seeking it on exclusive terms," says a concerned scientist. "Yet, all the companies agree that the technology is excellent."

Many prospective buyers feel that since the technology has only been tested on a pilot project, the risk of commercialising the process can only be borne if the technology is sold exclusively. Even Ganguli frankly admits that the German technology has been tested out over a considerable period of time, whereas, the indigenously de...

THE CGCRI PROCESS ; TESTING TIMES

Results of detergent abrasion tests on single layer coatings (Anti-glare coatings deposited on sheet glass by sol gel process)

Nature of detergent	Coating maturity (temp.°C)	Rubbing time (in min.)	Visual observation
Liquid detergent	450	5	No damage
		20	No damage
	500	5	No damage
		20	No damage
	550	5	No damage
			No damage
Solid detergent (10g / 100ml suspension in water)	450	5	Very slight damage
		20	Slight damage
	500	5	Slight damage
		20	Total damage
	550	5	
		20	
Solid detergent (dry powder)	450	5	Partial damage
		20	Total damage

each case, which can be kept approximately constant throughout the visible range. As a result, there is no distortion in the colour of the objects viewed — a defect that is common in tinted glasses. Secondly, the coating also blocks substantial amount of harmful ultra-violet radiation.

Equally significantly, the technique developed by the CGCRI helps in cutting off external heat — for example, from the rays of the sun — to a certain degree. And if the same process of dip-and-drip is repeated, the several coatings can prevent heat transmission to a large extent.

With sheets of such coated glass on the windows, the expenditure on air-conditioning can considerably come down in automobiles, offices, manufacturing concerns, electronic plants, etc. "In an intensely illuminated place, where the actual colour of an object — for example signal lights in airfields — must be constantly observed, such glass can prevent fatigue of the eyes by cutting out the intense light," adds a CGCRI scientist.

For the media-shy Ganguli, ranked as one of the best international brains in sol-gel technology, the task started in 1982 continues to be a crusade to be pursued relentlessly. Not until anti-glare coating becomes a commercially viable project will be embark on his next mission to develop an anti-reflective coating.

Curiously enough, a number of opthalmic companies have already approached the CGCRI for technology to manufacture anti-reflection coatings. Ganguli however, continues to feel that anti-reflection is only of cosmetic value while anti-glare applications have a stronger element of safety to them — such coating on an automobile windscreen can save the ... from the dazzle effect of the ... lamps of trucks on highways, ... example.

ADDED to the fact that the CGCRI has "conservatively" estimated a demand potential of 2.50 lakh square meters of anti-glare sheet glass surface, and that most of the tinted glass is imported from abroad, the industry seems to be finally coming to its ... A Chandigarh-based com...

... present, though, while the ... might press for a col... and while the Japanese ... to pick the CGCRI ... it is the Indian industry ... has to discard its penchant ... technology. And re... the new process for what it ... gift horse.

...Roy in Calcutta

CGCRI ESTIMATES : NO TAKERS

	Rs. in lakh
CAPITAL INVESTMENT	
Land and building (2800 sq. ft)	5.60
Plant and machinery (including contingency)	15.00
Working capital (90 days' manufacturing ...	

THE PIONEER

LUCKNOW, FEBRUARY 2, 1992

Anti-glare coats for vehicle drivers

Staff Reporter

Kanpur

THE anti-glare coats developed by Dr DS Ganguli and Dr FK Biswas of the Central Glass and Ceramic Research Institute, Calcutta, will help users drive vehicles at night.

Dr Ganguli was in the city on Saturday to address a meeting of opticians and eye specialists, organised by anti-glare coaters.

Talking to newsmen Dr Ganguli said, the anti-glare coating on ophthalmic glass lense is done by solgel technique. After coating, the lens becomes resistant to the glare, thereby reducing the glare to the eyes from powerful light sources like headlights of cars, lamps and strong sunlight.

The coating also reduces transmission of ultraviolet rays and infra-red rays to the eyes subsequently slowing down the process of cataract formation, Dr Ganguli said.

Update of glass technology at city institute

The Telegraph 6-3-2000 p-19

BY SUBHRO SAHA

The Central Glass and Ceramic Research Institute (CGCRI) is collaborating with the University of Technology, Aachen, Germany, to equip the Indian glass and ceramics industry to tackle energy and environment-related problems better and, ultimately, lower cost of the end-product.

As part of the Jadavpur-based institute's golden jubilee celebrations, CGCRI representatives, after talks with a team of German scientists, have identified a few core projects and proposals have already been drafted.

The thrust areas of this novel joint effort are: energy utilisation and process optimisation in the glass industry; development and use of water-based sols and gels for the synthesis of glass and ceramics; development of corrosion-resistant thermal barrier coatings for gas turbines; development of slip-cast refractories for application in the iron and steel industries.

Says Dr. H. S. Maiti, director of the leading institute of its kind in the country: "We are trying to extend the benefits of co-operative R&D between the two countries to the Indian glass industry, which was built more as ... There is ample scope for the application of modern tools to enable the units to conserve energy, control pollution, and reduce furnace wear."

Asked why India was chosen as a destination for such collaboration, Prof. R. Conradt said: "At Aachen, we have this forum of North-South cooperation which looks into possibilities of such ventures outside highly developed countries like Japan and the US, and India surely fits the bill. Besides, we have had this co-operation agreement between the CGCRI and our research centre of Juelich for the last decade. Our aim is to identify arena of common R&D to broaden the base of this co-operation."

The CGCRI will interact with Indian glass manufacturers to collect data for validation of the mathematical model to be framed. Similar data of German industries will be collected by Aachen. The results derived from such scientific investigations will be passed on to the glass units.

The only hitch on the horizon, according to Dr Maiti, "is getting round the intellectual property rights". But he is hopeful that "since the German scientists will be interacting directly with the CGCRI, it should cut red tape to a large extent".

THE ECONOMIC TIMES CALCUTTA THURSDAY JULY 6 1989 PAGE SEVEN

CGCRI develops process for anti-glare coating

CALCUTTA, July 5. ...

Ceramic heads being moulded from alumi...

A join...

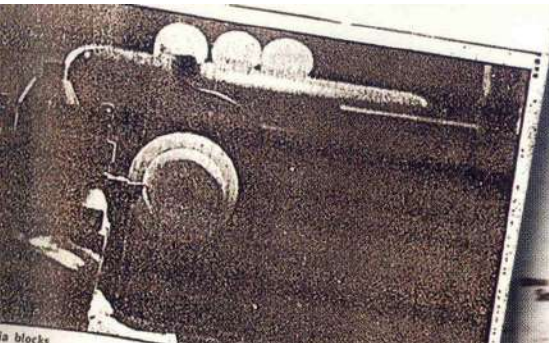
Scientists the world over are now experimenting with ceramic as a substitute for replacing damaged bones in the human body. Ceramicists say that the human bone has similar properties as ceramic and Japanese scientists claim to have developed a kind of porous ceramic substance which has bone-forming properties.

A breakthrough in the field of bio-ceramics was achieved in the country when the Central Glass and Ceramic Research Institute (CGCRI), Calcutta, developed a spherical head as a substitute for the hip joint. It all began about two years ago when Dr Anjan Bhattacharya, an orthopaedic surgeon of the Calcutta Medical Research Institute (CMRI), collected some foreign medical journals and samples of ceramic substitute for the bone and asked scientists at CGCRI if they could develop the same model here.

At that time spherical stainless steel balls were used if the hip joints needed replacement. The ceramic joint is, however, much superior because it is lighter than metal. There is no danger of it developing metallic reactions on any kind of toxicity. Since the bone is of c... the chances o... ing ceramic ... much less. Als... mic material c... due to friction.

The ceramic ... of alumina pow... minium oxide. ... powder is press... to prepare bloc... then moulded int... threaded spheric... ples of the hea... are then tested fo... al characteristics ... Immunity Resear... which then certifi... heads are "f... compatible and n... heads are then scr... stainless steel stem... pushed into the bone ... so that only the cer... juts out and is fitte... socket of the pelvic ... ceramic head with ... stem is then sent to ... Bombay, for sterilisat...

The ceramic head ... joint prosthesis" was ... fully implanted on a ... old woman at the C... Medical Research Insti... May 9 by Dr Subrata Da... another orthopaedic surg... the CMRI. This implan... was the first of its kind ... country. Dr B.K. Sarkar, ...



...t breakthrough

...tor of the CGCRI, said: "This is also the first time that we research scientists have worked on a project along with those of the medical profession and have achieved something of use." A second such implantation was carried out on another 52-year-old woman at the CMRI on June 23. Both women are reported to be recovering rapidly. Dr Sarkar added, "Now that we have been successful in developing hip joints, we will start working on ceramic is elbow joints and knee caps."

Dr Dasgupta opined that "Despite its advantages, ceramic heads are not being used in the country because we are not manufacturing it here. Imported heads cost Rs 8,000. How many people can afford that. The head prepared at the CGCRI costs around Rs 1,000. Once commercial production commences, the cost could be even added.

The key personnel who worked on the project at the CGCRI were Mr Debabrata Basu and Mr Sandip Chatterjee as project leaders and Mr M.K. Basu as project coordinator. The ceramic joints produced at the CGCRI are of a high standard. After producing such ceramic substitutes for various joints in the body, the team may start researching on porous ceramic substitutes, which can be used as "spacers" if bone grafting is not possible.

According to Bhattacharyya, medical journals from the USA, Germany and Japan, show that ceramic materials are in use in these countries for damaged ankles, as well. "Fibre growth is not possible with metal and this is why ceramic based materials are more in use today for bone replacements," he stated. "At the CGCRI, research in bio-ceramics will be a continuing process and we may change the design or the technology if required," Dr Sarkar said. The need for joint replacements is not rare and Calcutta Hospital alone gets about 50 patients a year for hip joint replacements. "When you are on the wrong side of 50 or 60 your bone becomes brittle, especially if you are a woman and the slightest knock somewhere could cause a fracture," disclosed Dr Dasgupta. It seems as if this breakthrough in bio-ceramics will provide the healing touch to the human body which seems more prone to breaking down now than ever before.

Sobha Menon

Better optical glass being developed

CALCUTTA: Indian scientists are developing new varieties of optical glasses for use in the defence and nuclear fields.

Researchers at the Central Glass and Ceramics Research Institute (CGCRI) here are working on glasses used to shield radiation in nuclear reactors and in defence equipment.

Development of these glasses will stop imports and give a boost to the indigenous industry, scientists say.

The work at CGCRI is mainly on the development of new varieties of crown, borate crown, dense crown and dense flint glasses intended for use in the imaging systems, without transmission losses.

Times of India 13/12/88

Optical glasses to avoid radiation

CALCUTTA, December 12 (UNI).

INDIAN scientists are developing new varieties of optical glasses for use in the defence and nuclear fields.

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Special glasses for use as radiation shields produced by CGCRI have been found to be good at the Bhabha Atomic Research Centre (BARC). Technology for their manufacture has been passed on to the Bharat Ophthalmic Glass Limited, Durgapur.

Modern trends in optical glasses are centred around the development of glasses with improved ultraviolet transmission, chemical durability and freedom from bubbles for use as microscopic lens, optical elements for analytical instruments and telescopes.

Special optical glasses are also being developed for night photography, guided missiles and search lights.

About 200 types of colourless optical glasses are produced globally.

One of the recent developments in the field is fluro-phosphate crown with high anomalous dispersion, excellent homogenity and good matchability for appochromatic correction in photography.

Glasses having high refractive indices and low dispersions are in demand for correction in high magnification optical systems.

H. Times 8/11/88

CGCRI develops laser glasses

CALCUTTA, Nov 7 (UNI) — Indian scientists have successfully developed indigenous laser glasses for application in defence and nuclear fields.

Researchers at the Central Glass and Ceramics Research Institute (CGCRI) here have produced silicate laser glasses for plasma application in nuclear reactors.

The laser glasses produced by CGCRI were evaluated by the Bhabha Atomic Research Centre (BARC) and found to yield 50 per cent higher energy output, when compared to the imported ones of similar type.

At present, India imports these glasses at prices varying from 700 to a few thousand dollars for a rod or disc depending on its dimensions.

Scientists consider indigenous development of silicate laser glasses as a 'significant achievement'.

"Laser glasses are a strategic items and their production technology is kept a guarded secret by advanced countries," a scientist said.

The next phase of work ... to develop pho...

CGCRI's small experimental production unit has been supplying glasses to the Dehra Dun-based Instrument Research and Development Establishment (IRDE) and the Vikram Sarabhai Space Research Centre at Trivandrum.

The most powerful lasers today are neodymium glass lasers producing pulses with peak powers exceeding a terra watt (for example, the Shiva laser developed by the Lawrence Livermore National Laboratory in the States).

Low-cost housing tech developed

Ec Times 8/11/88

Scientists develop laser glasses for N-applications

CALCUTTA, November 7.

Indian scientists have successfully developed indigenous laser glasses for application in defence and nuclear fields, UNI reports.

Researchers at the Central Glass and Ceramics Research Institute (CGCRI) here have produced silicate laser glasses for plasma application in nuclear reactors.

The laser glasses produced by CGCRI were evaluated by the Bhabha Atomic Research Centre (BARC) and found to yield 50 per cent higher energy output when compared to the imported ones of similar type.

At present, India imports these glasses at prices varying from seven hundred to a few thousand dollars for a rod or disc depending on its dimension.

Scientists consider indigenous development of silicate laser glasses as a "significant achievement". "Laser glasses are a strategic item and their production technology is kept a guarded secret by advanced countries," a scientist said.

The next phase of work at CGCRI is to develop phosphate laser glass, employing "doping technique". The method involves doping glasses with luminescent material. "Our idea is to develop neodymium-doped phosphate laser glass equivalent to highly-rated LHG-eight, developed by the Hoya Corporation of Japan", said Mr. S. K. Das, a scientist working on the project.

The work at CGCRI is being funded by the Board for Research in Nuclear Sciences (BRNS).

Neodymium-doped silicate laser glasses, which are suitable for use in defence equipment like range finders, were developed at CGCRI some time ago. The work has now been enlarged to produce phosphate laser glasses having improved lasing efficiency, researchers say.

Recently, the CGCRI scientists formulated a few phosphate glass compositions and constructed a furnace suitable for melting these glasses.

CGCRI's small experimental production unit has been supplying laser glasses to the Dehra Dun-based Instrument Research and Development Establishment (IRDE) and Vikram Sarabhai Space Research Centre at Trivandrum.

The most powerful lasers today are neodymium glass lasers producing pulses with peak powers exceeding a terra watt (for example, the Shiva laser developed by the Lawrence Livermore National Laboratory in the United States).

Although neodymium was recognised as a potential pulses laser element since 1961, not much research work was reported in India. Only in the 1970s, work on laser glasses was initiated simultaneously at CGCRI, the defence science laboratory, Delhi and in the department of ceramic engineering, Banaras Hindu University.

"The demand from the Dehra Dun establishment for neodymium-doped glass to work as an indigenous laser element in range finders was the driving force for our work," said a CGCRI scientist.

But, by the time CGCRI developed a barium crown glass doped with neodymium for the Dehra Dun establishment, the United States and Japan reported a superior variety of laser glass.

CGCRI took up as a challenge to develop equivalent glasses and in 1978 a glass was prepared which showed almost matching energy efficiency.

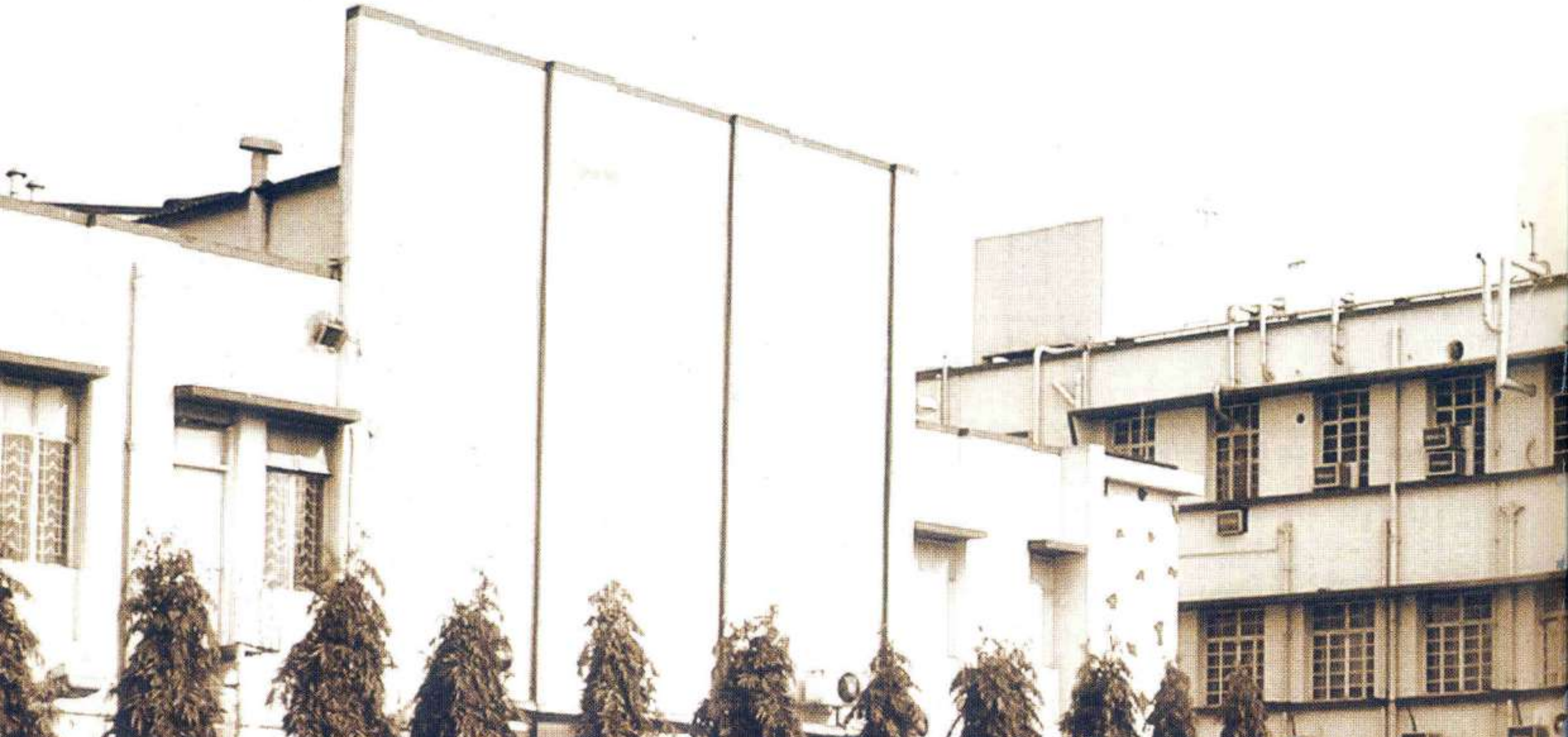
Currently, the institute has tie-ups with the Institute of Physics, Moscow, under an Indo-Soviet programme in laser technology.

Houses of hollow bricks

Institute in the News

Acknowledgement

The Editors express a deep sense of gratitude and indebtedness to all the personalities behind the publications of CSIR newsletter – CSIR News, CGCRI newsletter – Glance, Annual Reports –CSIR, Annual Reports – CGCRI, Central Glass and Ceramic Research Institute bulletin and various other documents such as brochures, pamphlets, souvenirs and other ephemeral documents created and brought out on different occasions of CGCRI, for their creations and contributions, without which the present book would have not seen the light of the day. They also wish to place on record their great appreciation to all the eminent personalities for their speeches delivered on different occasions which are incorporated in the present book. They would like to thank all, especially those who helped directly and indirectly to bring out the present book. Last, but not the least, they are thankful to D. Basu, K. Dasgupta, S. K. Bhadra, R. N. Basu, P. Sujatha Devi, T. K. Mukhopadhya for going through the manuscript, providing suggestions and comments. They also express a deep sense of gratitude to all the past and present familly members of CGCRI.



Oil Painting (1972) by Ranjit Bhattacharya, Former Scientist, CGCRI

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