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2023

CSIR - CGCRI
TECHNOLOGY
COMPENDIUM



CSIR-CENTRAL GLASS & CERAMIC RESEARCH INSTITUTE, KOLKATA

2023

CSIR - CGCRI TECHNOLOGY COMPENDIUM



CSIR-CENTRAL GLASS & CERAMIC RESEARCH INSTITUTE, KOLKATA

Editorial

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Foreword

Over the years, CSIR-CGCRI has been at the forefront of providing R&D and technological inputs to myriad challenges of industry and society. Ranging from supplementing technology denial items with indigenous technologies to import substitution to affordable technological solutions, the institute has played a seminal role in invigorating the national innovation system.

Atomic energy, defence and space have been three key areas where the institute's technology is in use. Along with it are the sectors of health care, telecom, environment, steel, manufacturing, mining, minerals, water & sanitation, energy, transportation, rural development, skill and capacity to name a few. Many of the institutional technologies have already been transferred to industries and end-users and are currently in use.

Currently, CSIR-CGCRI has a number of technologies at a readiness level that is amenable to translation. Along with this, there are a very large number of early stage technologies, technology leads and R&D proof-of-concepts that could be effectively scaled up through the technology value chain over the next 4-5 years.

This present booklet gives a snap shot of only the translatable technologies that are matured and available for licensing to industries. Most of them are patented in India and selected countries abroad. It gives an over view of the technology portfolio. Those interested to have further detailed information are encouraged to contact us at the relevant address that is provided.

This compendium is envisaged to be updated annually and will be available in the public domain. It is hoped that it will be useful to the industry and other stakeholders interested to use CSIR-CGCRI knowledge base.

Dr (Mrs) S.K. Mishra

Director >>>>

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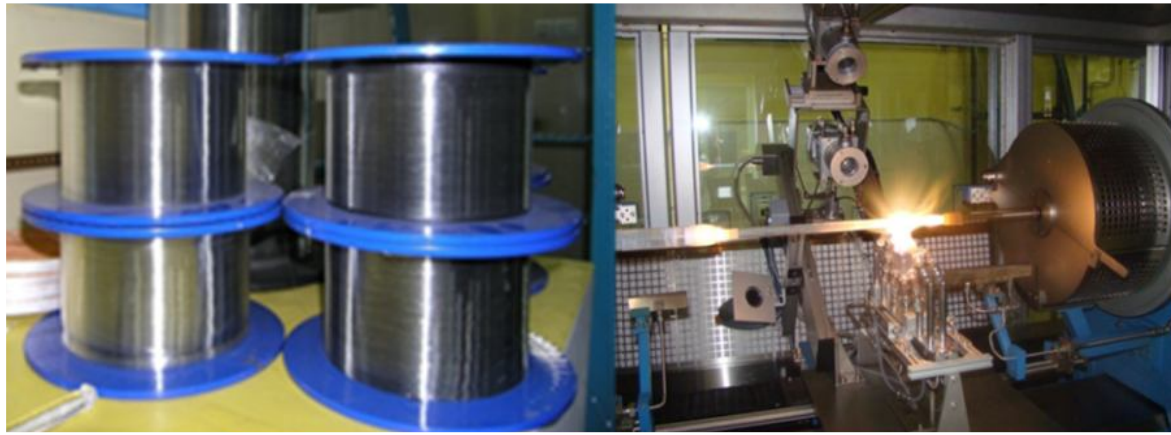
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Technology



CSIR-CENTRAL GLASS & CERAMIC RESEARCH INSTITUTE, KOLKATA



Optical fibre spools of Erbium doped fibre, photonic crystal fibre and double clad Ytterbium doped fibre

Specialty Optical Fibers

Salient Features

- Er-doped fiber for CATV and C-band optical amplifier
- Non-Linear Photonic Crystal Fiber (PCF) for Super continuum Source (500 – 2200nm)
- Double-clad Yb-doped fiber for laser application @ 1 micron regime

Technology: Specialty Optical Fibers

Domain: Fibre Optics

IPR Status: Patented

Specification:

| Fibre Parameters | Specifications |
|--|---------------------------|
| Cut-off Wavelength | 900 - 950nm |
| Mode Field Diameter at 1550nm | $6.0 \pm 0.5 \mu\text{m}$ |
| Absorption at Pump Wavelength (980 nm) | 4.0 dB/m |
| Background Loss | <10 dB/Km |
| Fibre Diameter | $125 \pm 0.5 \mu\text{m}$ |
| Coating Diameter | $245 \pm 2 \mu\text{m}$ |
| Coating Type | Dual Acrylate |

TRL: 8

Application/Uses: Optical Fiber Amplifier / Laser, Supercontinuum Source

Level/Scale of Development: Commercialized product, Commercialized through industrial partner

Line Ministry Mapping/ User Sector: Department of
Telecommunications, MeitY/ Telecommunication and IT sector





Commercial EDFA for Cable TV (CATV) Network

Er-doped Fiber Amplifier (EDFA)

Salient Features

- Output power Signal up to 24dBm
- Wide input dynamic range
- Low noise Figure
- 1 U 19 inches Rack mount type

Technology: Er-doped Fiber Amplifier (EDFA)

Domain: Fibre Optics

IPR: Patent filed on Er doped fiber (produced by CGCRI) which is the key component of an EDFA.

Specification:

- Operating wavelength: 1530 to 1565 nm (C-band)
- I/P Signal Power: - 10 to +3 dBm
- O/P Signal Power: 23 dBm (max)
- Optical Gain: 20 to 30dB
- Gain flatness: ± 0.5 dB
- Noise Figure: < 6 dB

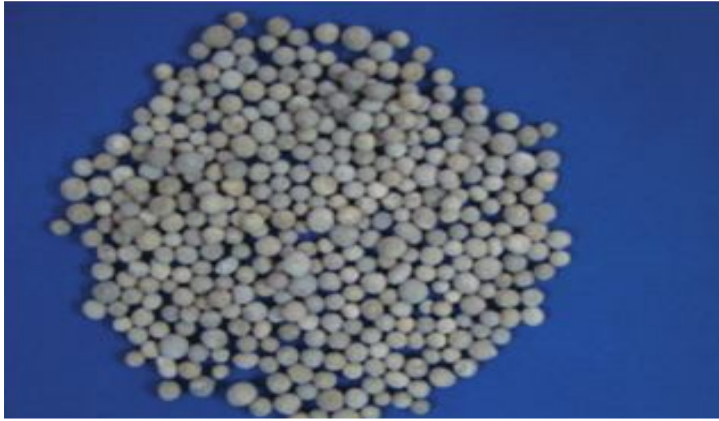
TRL: 8

Application/Uses: Cable-TV, Optical communication system

Level/ Scale of Development: Commercialized product/ Commercialized through industrial partner

Line Ministry Mapping/ User Sector: Department of Telecommunications, MeitY/
Telecommunication and IT sector





Borosilicate Glass Frit



Borosilicate Glass Bead

Specialty Glass Bead

Salient Features

- Use of glass bead of desired sizes made out of the melted frits (as basic precursor towards the formation of glass bead) has enhanced the process throughput and hence facilitated the immobilization of radioactive nuclear waste being adopted in the Joule Melter
- Spherical beads of dimensions in the range of 2-4 mm with stringent physical, chemical and mechanical properties have facilitated feeding into the Joule Melter and allow remote control of the entire operation. Technology is closely guarded and the material is critical for country's ambitious nuclear programme.

Technology: Specialty Glass Bead

Domain: Specialty Glass

IPR: Patented

TRL: 8

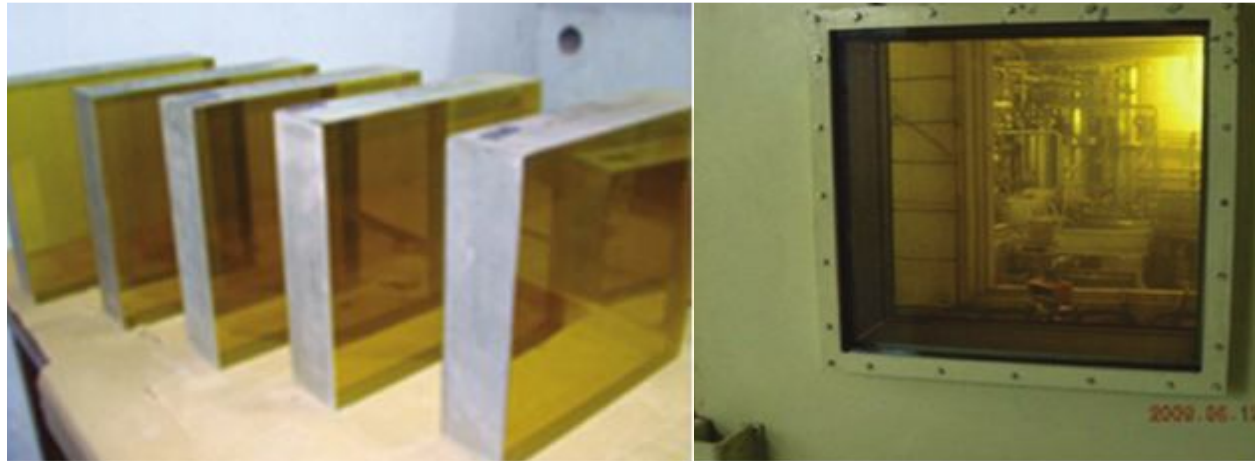
Application/Uses:

- Immobilization of high level radioactive liquid waste containing radioisotopes (which remain active for prolonged period) for safe disposal without threat to the environment.
- Strong impact on sustaining country's ambitious three-stage nuclear recycle program and significant contribution to power requirement

Level/ Scale of Development: Commercialized product, Commercialized through Industry partner

Line Ministry Mapping/ User Sector: Department of Atomic Energy/ Nuclear Power establishments





Radiation Shielding Window (RSW) Glass

Salient Features

- Involves cullet making in 310 lit refractory pot, final melting in 40 lit platinum pot, casting through bottom pouring technique (cast block size is $425 \times 425 \times 130$ mm³), annealing and final processing
- Windows of dimensions $550 \times 550 \times 50$ mm and $700 \times 700 \times 35$ mm from the same melt size through slumping technique in order to increase the viewing area has been developed

Technology: High Density Radiation Shielding Window Glass for Nuclear Hot Cell Application

Domain: Specialty Glass

IPR: Trade Secret

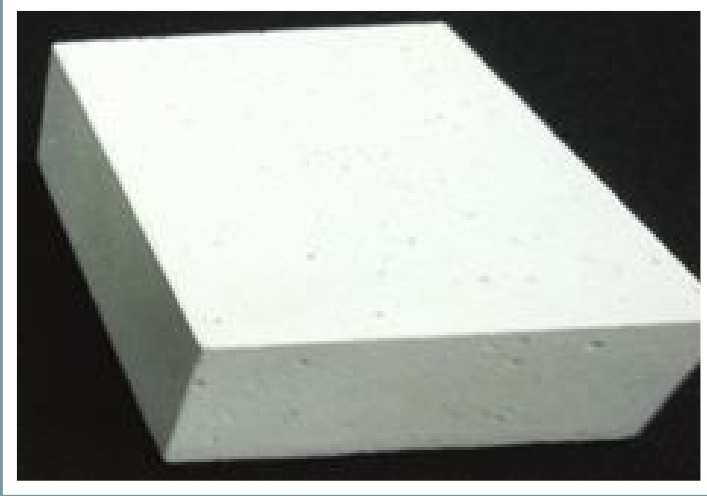
TRL: 8

Application/Uses: Nuclear Hot cell, X-ray room, Operation theatre, Radiation therapy room

Level/ Scale of Development: Pilot scale facility established. Technology for producing homogeneous and defect free high density RSW glass blocks up to $400 \times 400 \times 100$ mm³ sizes successfully demonstrated

Line Ministry Mapping/ User Sector: Department of Atomic Energy





Low moisture castable ($45-75\% \text{Al}_2\text{O}_3$)

Salient Features

- Unshaped refractory, jointless construction
- Moisture requirement $<5 \text{ wt}\%$

Technology: Low moisture castable (45-75% Al_2O_3)

Domain: Refractory

IPR: Off Patent

TRL: 9

Specification :

- Al_2O_3 : 45-75 wt%
- Moisture requirement <5wt%
- Service temperature : 1350-1600°C (based on Alumina Content)

Application/Uses: High temperature refractory in steel, cement, petrochemicals, thermal power plants etc.

Level/Scale of Development: Technology transferred and commercialized

Line Ministry Mapping/ User sector: Department of Steel/ Steel Industry, cement industry/
Ministry of Power





Mag-Chrome refractory aggregates from friable chrome ore

Salient Features

- Developed from friable chrome ore
- High corrosion resistance
- High Refractories under load (RUL:1700°C)

Technology: Mag-Chrome refractory aggregates from friable chrome ore

Domain: Refractory

IPR: Patented

Specification :

- Bulk Density : 3.20 g/c.c.
- Apparent Porosity : 14%
- CCS : 700kg/Cm²
- PLCR at 1600°C + 0.20%
- RUL, ta : 1700°C

TRL: 9

Application/Uses: Refractory for steel ladle, copper smelter, cement rotary kiln

Level/Scale of Development: Commercialized

Line Ministry Mapping/ User Sector: Ministry of Steel/ Ministry of Mines





Mullite Refractory Aggregates

Salient Features

- Mullite aggregates from inferior quality Bauxites of Indian origin
- Innovative phase modification technique to utilize low quality bauxite

Technology: Mullite refractory aggregates from Bauxite

Domain: Refractory

IPR: Patented

Specification :

- Al_2O_3 : 70 wt%
- Bulk Density : 2.8 g/cc
- Apparent Porosity : 10.1%
- RUL,ta : 1600 - 1630°C

TRL: 8

Application/Uses: Refractory for Blast furnace stove, Bosh, Shuttle kiln lining, Rotary kiln, Tunnel kiln

Level/Scale of Development: Commercial trial completed in refractory unit at a level of 30 Tons

Line Ministry Mapping/ User Sector: Ministry of Steel/ Ministry of Mines





Mag-Al spinel refractory aggregates

Salient Features

- High corrosion resistance
- High RUL
- Eco friendly alternative of Mag Chrome refractory

Technology: Mag-Al spinel refractory aggregates

Domain: Refractory

IPR: Patented

Specification:

| Properties | Al ₂ O ₃ content at% | | |
|---------------------|--|-------------|-------------|
| | 66 | 78 | 90 |
| Bulk Density, g/c.c | 3.2 - 3.3 | 3.22 - 3.25 | 3.37 - 3.40 |
| App. Porosity, % | 1.6 - 4.8 | 1.5 - 2.0 | 3.4 - 4.2 |
| Water absorption% | <1.0 | <1.0 | <1 |

TRL: 9

Application/Uses: Refractory for steel ladle, burning zone of cement rotary kiln

Level/Scale of Development: Successful Plant Trial (100 Tons)

Line Ministry mapping/ User sector: Ministry of Mines/ Ministry of Steel/ MoRTH,
Ministry of Heavy Industries



Lime refractory

Salient Features

- Thermodynamic stability at high temperature
- Improved hydration resistance
- High corrosion resistance at moderate basicity



Technology: Lime refractory

Domain: Refractory

IPR: Patented

Specification :

- Bulk Density : 2.83 g/cc
- Apparent Porosity : 15.3%
- CCS : 959kg/Cm²
- Shelf life : 4 weeks

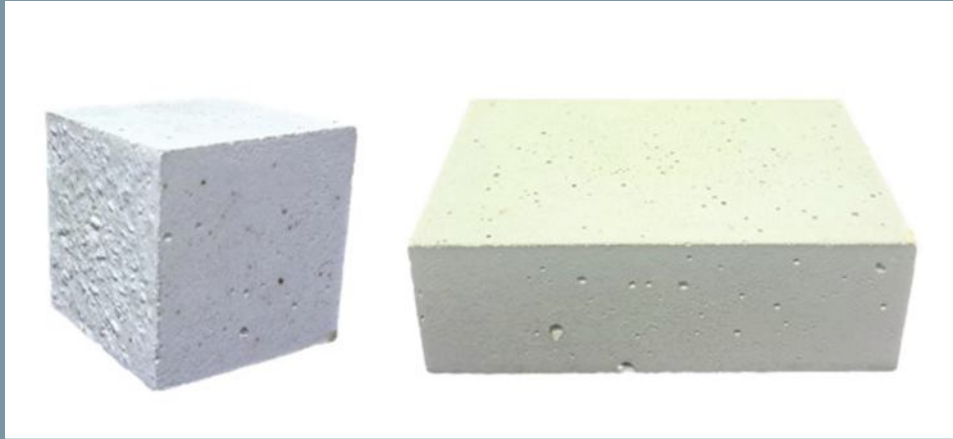
TRL: 8

Application/ Uses: Refractory for AOD vessel for secondary steel refining, Rotary kiln

Level/Scale of Development: Successful plant trial (100 Tons)

Line Ministry Mapping/ User sector: Ministry of Steel





70-90% Alumina cement free dense self flowing castable

Salient Features

- Easy installation
- Self flow -no vibration during application
- Less inventory
- Quicker and controlled cold setting property

Technology: 70-90% Alumina cement free dense self flowing castable

Domain: Refractory

IPR: Patented

TRL: 9

Specification :

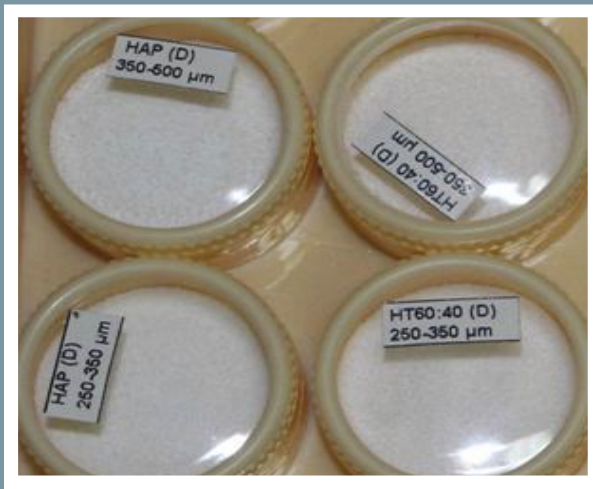
- Al_2O_3 : 70-90 wt%
- Bulk Density > 3.0 g/c.c
- Cold Compressive Strength > 1000 kg/cm²
- MoR > 200 kg/cm²
- Service temperature > 1600°C

Application/ Uses: High temperature refractory for steel, cement, petrochemicals, thermal power plants etc.

Level/Scale of Development: Technology transferred and commercialized

Line Ministry Mapping/ User sector: Ministry of Chemicals & petrochemicals/ Ministry of Steel/ Ministry of Power





Plasma spray grade hydroxyapatite (HAp) granules

Salient Features

- Phase pure hydroxyapatite (HAp) and / or bi-phasic (HAp + Tri-Calcium Phosphate) with spherical and/ or irregular shape
- Sizes can be tailor-made depending on the exact requirement
- Freely flowable
- Composition of HAp is as per ASTM spec., cost-effective, affordable

Technology: Manufacture of plasma spray grade hydroxyapatite (HAp) granules

Domain: Bioceramics

IPR: Covered (both composition of HAp and bi-phasic calcium phosphate are patented)

Specification: Composition – Hydroxyapatite or bi-phasic (HAp + Tri-Calcium Phosphate); Density – 3 to 3.17 g/c.c.; Particle size - Typically different sizes (e.g., 10-50 mm, 50-100 mm, etc.); Particle shape - Irregular to spherical; Porosity – 5 to 20%; Flowability - Suitable for plasma spray coating

TRL: 6-7

Application/Uses: Healthcare; most suitable for plasma spray coating on metallic stems or shells which are further used for THR arthroplasty extensively. This coating is also widely used on dental implants as well.

Level/Scale of Development: Commercialized product: Commercialized through Industry partner

Line Ministry/ User Sector: Ministry of Health & Family Welfare





Ceramic biomedical implants (hip joint rosthesis)

Salient Features

- Product is at per ISO spec., low wear, suits Indian patients, equivalent metallic implants has been discarded world-wide
- Long service life, cost-effective, affordable
- Superior quality implant with better patient compliance eliminating chances of revision surgery

Technology: Ceramic biomedical implants (hip joint prosthesis)

Domain: Bioceramics

IPR: Patented

Specification: Currently the head is being used again polyethylene cup (ceramic-on-PE) with significantly less wear loss compared to metal-on-PE system; Chemical Composition: Al_2O_3 ; Density: $> 3.90 \text{ g/c.c.}$; Hardness: $\sim 19 \text{ GPa}$; Compressive strength: $\sim 1200 \text{ MPa}$; Surface finish (Ra): $\sim 0.05 \mu\text{m}$

TRL: 9

Application/Uses: Healthcare; Total Hip Replacement (THR) based on ceramic head and polymer acetabular cup

Level/Scale of Development: Commercialized product: Commercialized through Industry partner

Line Ministry/ User sector: Ministry of Social Justice & Empowerment/ Ministry of Health & Family Welfare





Synthetic bone graft material

Salient Features

- Superior osteo-conductive/ inductive properties, most effective material when applied in case of bone loss due surgery or trauma or accident, Frequent use in periodontic applications, any regular size, shape can be fabricated and used,
- Can be used with pharmaceutical drugs or growth-factors.
- High-purity, crystalline and porous granules with various sizes produced using this technology can be used to fill bone, dental and soft tissue defects. The granules have excellent tissue bonding properties.
- The scaffolds would replace lost bone which otherwise substituted by analogous or autologous bones resulting additional wounds and transmission of AIDS infections.

Technology: Synthetic bone graft material

Domain: Bioceramics

IPR: Patented

Specification: Composition: Hydroxyapatite or bi-phasic (HAP + Tri-Calcium Phosphate); Bulk density: 0.5 to 2 g/c.c.; Porosity: 40 to 70%; Pore size: 100 to 300 μm ; Scaffold Size: customized/ as per requirement

TRL: 9

Application/ Uses: Porous scaffolds, granules, powders for bone development/ faster augmentation, dental filler, perodontic applications.

Level/Scale of Development: Commercialized product. Commercialized through Industry partner

Line Ministry Mapping/ User sector: Ministry of Health & Family Welfare





ZTA based ceramic-on-ceramic articulating components for Total Hip Replacement (THR)

Salient Features

- New compositions of highly-dense alumina ceramic matrix composite with zirconia, chromium, strontium carbonate and strontium niobate additives for load bearing bioceramic implants Total Hip Arthroplasty (THR), Total Knee Arthroplasty (TKA) and dental implant application.
- Process is simple, easy to operate, low in preparation cost, easy to popularize with tailored mechanical properties depending on the various new compositions claimed.
- Importance: Superior toughness and tribological properties; State-of-the-art and affordable technology
- Unmet need: Affordability and technology availability
- Competition advantage: Superior properties, functionality and affordability

Technology: Manufacturing ZTA based ceramic-on-ceramic articulating components for total hip replacement (THR)

Domain: Bioceramics

IPR: Patented

Specification: Composition – Alumina, Zirconia, Chromia, Strontium carbonate, Strontium niobate; Hardness - Upto 2100 HV; Fracture toughness – Upto 10 MPa $\sqrt{\text{m}}$; Grain size – 1 to 2 μm ; Wear rate – In the range of $1\text{-}2 \times 10^{-7} \text{ mm}^3/\text{N}\cdot\text{m}$; Surface energy - In the range of 20-45 mN/m

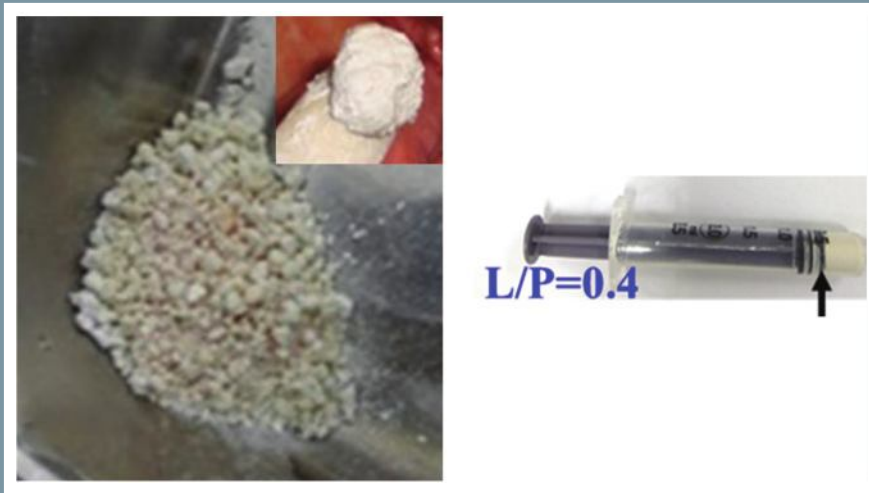
TRL: 6-7

Application/Uses: Healthcare; For load bearing bioceramic implants including total hip arthroplasty (THR), total knee arthroplasty (TKA) and dental implant application.

Level/Scale of Development: Commercialized product: Commercialized through Industry partner

Line Ministry/ User Sector: Ministry of Health & Family Welfare





Injectable Biodegradable Bone Cement (With/ Without Drug)

Salient Features

- The cement is biodegradable and self-setting at body temperature
- The unique feature of this cement is “non-exothermic” reaction, which provides complete safety to tissues
- Further, the cement can be used to carry drugs and deliver at site
- The product can be used to fill various bone, dental and other defects

Technology: Manufacturing Injectable biodegradable bone cement (with/ without drug)

Domain: Bioceramics

IPR:Patented

Specification: Composition – Calcium sulphate hemihydrate; Temp. generation – 37 to 40°C; Liquid/Powder ratio – 0.3 to 0.6; Liquid – Water/ normal saline; Injectability – 88% @ 16N; Compressive strength – 13 to 16 MPa; Setting time – 6to 9 min.

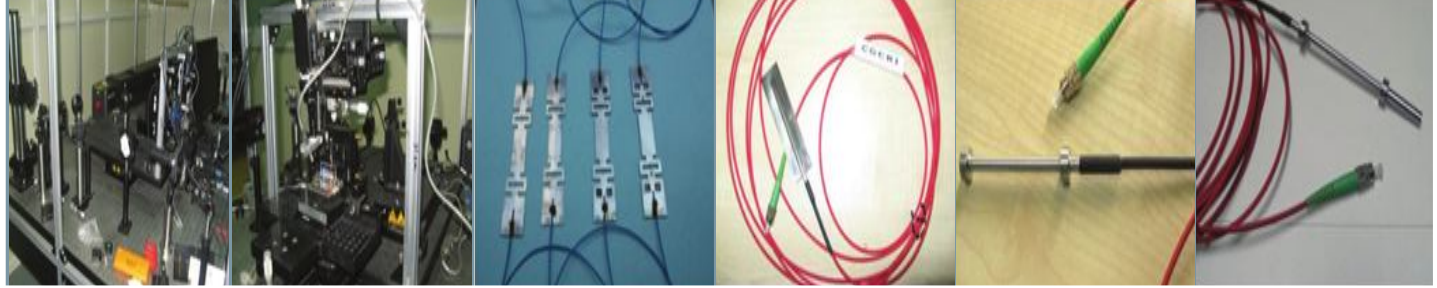
TRL: 7-8

Application/Uses: Healthcare; For fixation of several implants such as hip and knee, and also for defect filling; For treatment of osteomyelitis

Level/Scale of Development: Lab level

Line Ministry/ User Sector: Ministry of Health & Family Welfare





Optical Fiber Bragg Grating (FBG) based sensors

Salient Features

- Optical fiber based sensing devices.
- Free from electromagnetic interference.
- Operable in harsh environments where conventional sensors are unusable
- Can be used in distributed form i.e. over hundreds of sensors in a single optical fiber
- Tiny sensors so easily embeddable in structures during fabrication of structures leading to development of intelligent infrastructure

Technology: Optical Fiber Bragg Grating (FBG) based sensors for smart infrastructure and industrial process monitoring

Domain: Fibre Optics & Photonics

IPR: Patented

TRL: 6

Application/ Uses: Structural health monitoring and industrial process control

Level/Scale of Development: Prototypes of FBG based strain, temperature, pressure and vibration sensors developed and deployed.

Line Ministry Mapping/ User sector: Ministry of Telecommunications/ Ministry of railways/ Ministry of Urban Development





**Sensor dip in transformer oil
with data transmitter system**



**Sensor data receiver system
from transformer (500 m)**



Moisture Sensor in transformer oil (5-100 ppm moisture)

Salient Features

- Sol-gel derived cost-effective ceramic capacitive sensor
- Online detection of transformer oil trace moisture in the range of 5-100 ppm
- Wireless communication up to 800 m in free air

Technology: Moisture sensor (5-95%RH) Moisture meter (5-100 ppm moisture)

Domain: Functional Materials, Sensor

IPR: Patented

Specification:

| Description | Trace moisture sensor |
|---------------------------|----------------------------|
| Measuring Range | 5 -100 ppm |
| Accuracy(at 30°C) | ± 1 ppm |
| Temperature Limits | 10° – 100°C |
| Response Time (90%) | 10 s |
| Powder Supply/Consumption | 9 Volt DC, <10 mA |
| Weight | 200g |
| Options | Digital/LCD OR LED Display |

TRL: 6

Application/Uses:Moisture detection in any system or environment

Level/Scale of Development: Lab Scale

Line Ministry Mapping/ User sector: Ministry of Power/ Ministry of Steel/ Department of Commerce etc.



Thermally cyclable glass sealant composition

Salient Features

- Thermally cyclable between room temperature and 800°C (typical operating temperature for IT-SOFC)
- Devoid of any toxic raw materials like oxides of lead, cadmium etc which are often used in glass industry
- Co-efficient of thermal expansion matches well with cell and SOFC stack components
- Suitable for application as sealant in SOFC stack



Technology: Thermally cyclable glass sealant composition for intermediate temperature Solid Oxide Fuel Cell (IT- SOFC)

Domain: Energy Materials

IPR: Patented

Specification:

- CaO-SrO-Al₂O₃-TiO₂-B₂O₃-SiO₂-NiO-La₂O₃-P₂O₅ – BaO and Alkali free system;
- CTE of Glass in between: 8YSZ:
- $10.6 \times 10^{-6}/K$ & CROFER 22APU: $11.9 \times 10^{-6}/K$ – effective for Metal – Metal and Metal – Ceramic sealing;
- Capable of thermally cycling between RT to 800 °C

TRL: 4

Application/ Uses: High temperature sealant for application in SOFC stack

Level/ Scale of Development: Lab scale development upto 1kW

Line Ministry Mapping/ User Sector: Department of Atomic Energy, Ministry of New and Renewable Energy Sources, Ministry of Power, Defence, Transport



Pottery and Low Cost Earthen Wares

Salient Features

- Quality Assurance of Raw materials.
- Development of Lead-Free body, engobe and glaze for blue pottery.
- Development of Ultra High Strength & Leak-proof blue pottery.
- Waste Minimization & Cleaner Production.
- Product Diversification.
- Human Resource Development.
- International Market Promotion through RUDA.

Technology: Pottery and Low Cost Earthen Wares

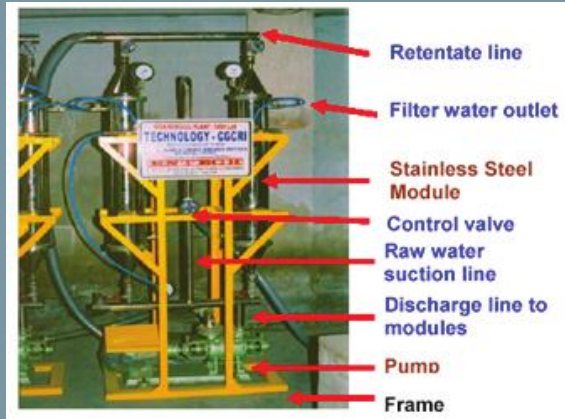
Domain: Rural Industrialization

IPR: NA

Application / Uses: High strength eco-friendly blue pottery glaze and the technology

Level/ Scale of Development: The technology led to high strength eco-friendly blue pottery glaze and the technology was transferred to the artisans in several clusters around Jaipur through series of T&D programs as well as implementation at units' level by CGCRI. The blue pottery technology was also highlighted in "TURNING POINT" programme of Door Darshan several times.

Line Ministry Mapping/ User sector: Ministry of skill development and entrepreneurship, Ministry of Rural Development, MSME



Water Purification through Ceramic membrane based process

Salient Features

- Technology is essentially a hybrid type comprising of two steps:
 - Adsorption of arsenic by the colloidal media particles suspended in water and
 - Application of membrane based separation technique for solid-liquid separation using ceramic micro-filtration membrane modules.
- The level of purification achieved is as per WHO recommended limits for arsenic (<0.01 ppm) and iron (<0.3 ppm) in Drinking Water.

Technology: Water Purification through Ceramic membrane based process

Domain: Membrane separation technologies

IPR: Off Patent

TRL: 8

Application/ Uses:

- ☐ Removal of arsenic and iron from contaminated groundwater for production of Quality Drinking Water
- ☐ Pretreatment of river water for removal of colloidal material to produce drinking water by Ceramic Membrane based process

Level/ Scale of Development: Developed and deployed through licensees at multiple locations

Line Ministry mapping/ User Sector: Department of Public Health Engineering/ Ministry of Rural Development etc.





Continuous Wave (CW) Thulium Fiber Laser (TFL)

Salient Features

- Thulium fiber laser at operating wavelength of $1.94\mu\text{m}$
- Average power: 30 W, Modulated for frequency 10-1000 Hz, Pulse width 40 μs -90 ms, Energy upto 2.7 J

Technology: 30 W Continuous Wave (CW) Thulium fiber laser(TFL) at 1.94 micron & 2 micron

Domain: Optoelectronics, Laser Surgery

Specification:

| | |
|------------------------|---------|
| CW Avg. Power | 30W |
| Cooling | Air |
| Operating Temp. | 20-25°C |
| Termination | SMA905 |

IPR: Indian Patent Filed

TRL: 6

Application/Uses: Lithotripsy Coagulation Thin tissue ablation

Level/Scale of Development: Ready tested Pilot Unit, Yet for certification and clinical validation

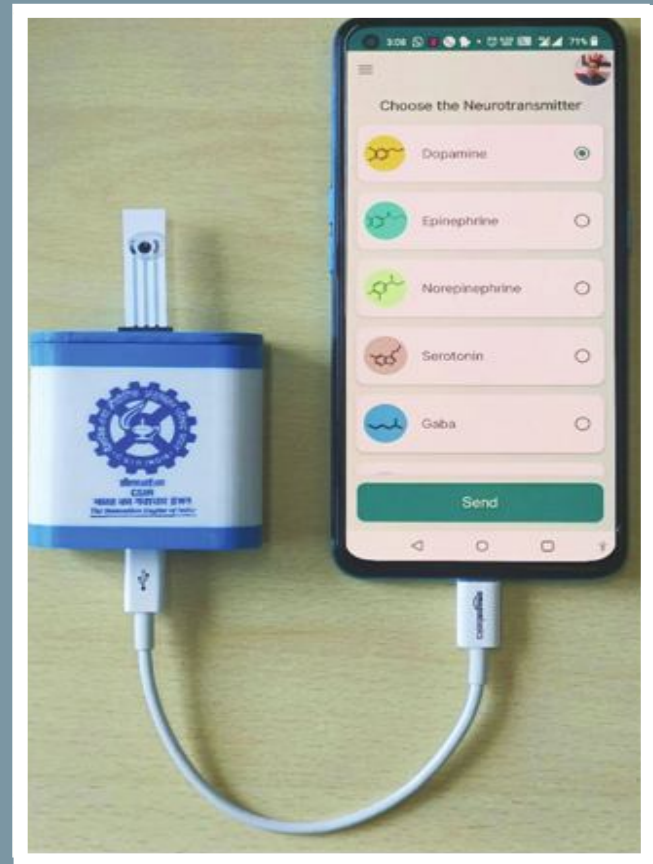
Line Ministry Mapping/ User Sector: Ministry of Health & Family Welfare (MoHFW)



Point-of-Care Sensor for Non-invasive Detection of Neurotransmitters

Salient Features

- IoT-enabled ultraportable Sensor device
- Rapid detection (<1 minute)
- User-friendly
- Point-of-care Testing



Technology: Point-of-Care Sensor for Non-invasive Detection of Neurotransmitters

Domain: Healthcare/ Point of care Diagnostics

IPR: Provisional Patent Filed

Specifications:

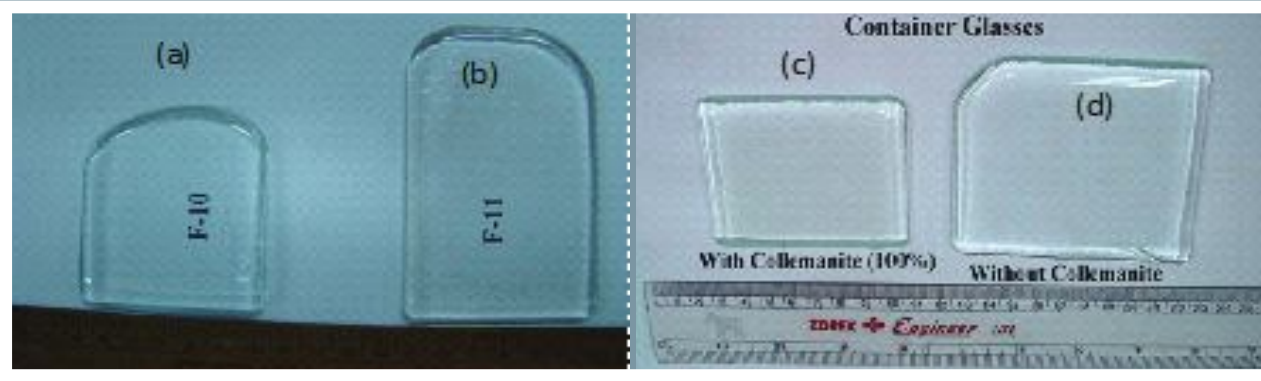
- Prototype dimension: 5.8 cm x 5.8 cm x 2 cm
- Interface type: USB OTG
- Test format: Non-enzymatic electrochemical detection
- Detection range: 1 μM – 200 μM
- Limit of detection (LoD): 1 μM
- Detection time: < 1 min

TRL: 3/4

Application/ Uses: Painless screening of Neurotransmitters from a drop of urine sample

Level/ Scale of development: Lab Prototype

Line Ministry mapping/ User sector: National Health Mission, Ministry of Health and Family Welfare



Soda Lime Silicate Glass Using Borax Pentahydrate and Colemanite

Salient Features

- Significant reductions in melting temperature of SLS glass, Colemanite only reduce melting temperature by 100°C while Borax PentaHydrate (BPH) only reduces by 200°C
- Lowering of melting temperature reduces combustion of either natural gas or oil thus reduction of production cost
- Environment friendly sustainable glass production, Carbon-free raw materials—minimization of the CO₂ emissions
- Faster melting process with higher production yields, Lower corrosion of furnace refractories due to lower melting temperature
- Lower volatilization losses and improvement in glass properties

Technology: Energy Efficient Technology For Manufacturing Of Soda Lime Silicate Glass Using Borax Pentahydrate And Colemanite

Domain: Specialty Glass

IPR: Patented

Specification:

BPH has been used as alternate source of raw material:

| Density, g.cm ⁻³ | CTE, x10 ⁻⁷ K ⁻¹ (50-300°C) | T _g (°C) | T _d (°C) | Transmission (%T), at 550 nm (t=2 mm) |
|-------------------------------|---|---------------------------|---------------------------|---------------------------------------|
| 2.312-2.575 (container glass) | 71.4-89.8 (container glass) | 506-589 (container glass) | 540-634 (container glass) | 83-89 (container glass) |
| 2.375-2.545 (Float Glass) | 74.3-90.6 (Float Glass) | 526-586 (Float Glass) | 562-632 (Float Glass) | 86-90 (Float Glass) |

Colemanite has been used as alternate source of raw material

| Density, g.cm ⁻³ | CTE x10 ⁻⁷ K ⁻¹ (50-300°C) | T _g (°C) | T _d (°C) | Transmission (%T), at 550 nm (t=2 mm) |
|-------------------------------|--|---------------------------|---------------------------|---------------------------------------|
| 2.501-2.557 (container glass) | 83-90 (container glass) | 582-587 (container glass) | 616-635 (container glass) | 91 (container glass) |
| 2.498-2.563 (float glass) | 84-91 (float glass) | 564-583 (float glass) | 614-626 (float glass) | 91 (float glass) |

TRL: 5

Application/ Uses: Container glass for packaging of medicines, beverages and float glass for use in housing construction, automobiles etc.

Level/ Scale of development: Soda lime silicate glass up to 500 g done, planned trial melting of glass up to 250 kg scale

Line Ministry mapping/ User sector: Ministry of Heavy Industries/MSME





Flat sensor for in-situ ammonia sensing



Low temperature ammonia sensing set-up

Sensing of Ammonia Gas at very low Temperatures

Salient Features

- Cheap chemiresistive material with reusability and long shelf-life;
- Can be made into sensors for detecting decay of meat-based food; robust and easy to use.

Technology: A Novel Metal Oxide-Polymer Nano Composite for Very Low Temperature Sensing Of Low ppm Ammonia Gas in a Range below Room Temperature to Sub-Zero °C

Domain: Sensor, Food Safety

IPR: Patented Filed

Specification:

- Extended microporous semiconductor metal oxide nanomaterial based chemiresistive sensor
- Selective ammonia sensor (with other VOCs generated during food decay like iso propanol, ethanol, etc.) with shelf-life of ~10 months.
- Suitable for ammonia sensing (sensitivity ~4 times) under sub-zero degree Celsius temperature (including dry ice sublimation temperature) with quick response and recovery
- Multiple use cost effective sensor with safe chemical components for use as handheld food decay sensors
- Both in-situ and ex-situ sensing feasible

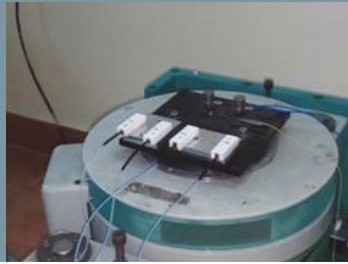
TRL: 4/5

Application/Uses: Detect meat and meat product spoilage under cold storage; decay of stored body organs/transplants

Level/ Scale of development: Lab level of material development

Line Ministry mapping/ User sector: Ministry of Food Processing Industries





Fiber Bragg Grating based vibration and temperature monitoring system

Salient Features

- Provide multipoint vibration and temperature measurement for stator end windings of a generator, over frequency range 30 Hz to 500 Hz, displacement range 10 μ (p-p) to 1 mm (p-p) at 100 Hz, and temperature upto 75 °C
- Sensors tested to withstand high voltage upto 60 KV and Hydrogen pressure upto 5 Bar

Technology: Fiber Bragg gratingbased vibration and temperature monitoring system for stator end windings of Generator

Domain: Fiber Optic Sensors

IPR: Patent Filed

Specification: Frequency range 30Hz to 500 Hz, displacement range 10 μ m (p-p) to 1 mm (p-p) at 100 Hz, temperature up to 75°C.

TRL: 6/7

Application/Uses: For health monitoring of electric generators

Level/ Scale of development: Field trial done

Line Ministry mapping/ User sector: Ministry of Power/ Power industry





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