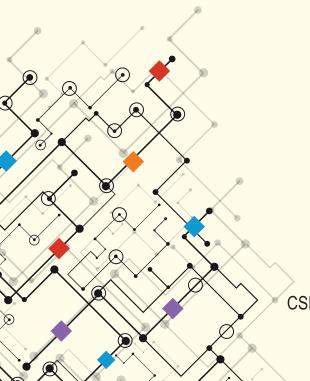


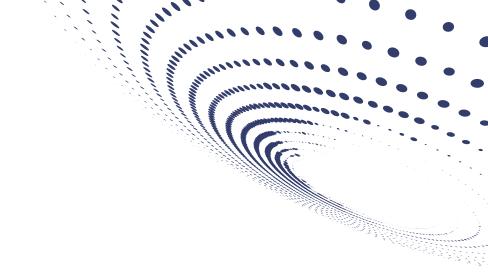
## CSIR-CGCRI TECHNOLOGY COMPENDIUM







CSIR-Central Glass & Ceramic Research Institute
Kolkata



## CSIR-CGCRI TECHNOLOGY COMPENDIUM





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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 healthcare, 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 snapshot 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 overview 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 knowledgebase.

Dr(Mrs) S.K. Mishra Director





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## **TECHNOLOGIES**









## **Specialty Optical Fibre**

## IPR STATUS Patented

#### APPLICATION/USES

Optical Fibre Amplifier/Laser, Supercontinuum Source

#### SALIENT FEATURES

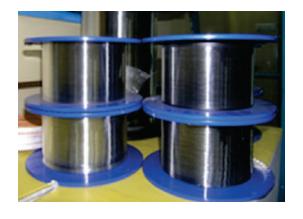
- Er-doped fibre for CATV
- C-band optical amplifier
- Non-Linear Photonic Crystal Fibre (PCF) for Supercontinuum Source (500 – 2200nm)
- Double-clad Yb-doped fibre for laser application@1 micron regime

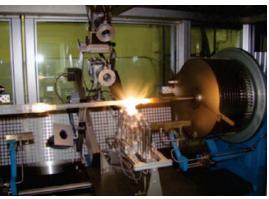
#### LEVEL/SCALE OF DEVELOPMENT

- Commercialized product
- Commercialized through industrial partner

## LINE MINISTRY MAPPING/USER SECTOR

- Department of Telecommunications, MeitY
- Telecommunication and IT sector





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









### **Er-doped Fibre Amplifier (EDFA)**

#### **IPR STATUS**

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

#### APPLICATION/USES

Cable-TV, Optical communication system

#### **SALIENT FEATURES**

- 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

#### LEVEL/SCALE OF DEVELOPMENT

- Commercialized product.
- Commercialized through Industry partner

## LINE MINISTRY MAPPING/USER SECTOR

Department of Telecommunications, MeitY/Telecommunication and IT sector



Commercial EDFA for Cable TV (CATV) Network











## Specialty Borosilicate Glass Bead: An Innovative Material for Nuclear Safety

## IPR STATUS Patented

#### 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.
- Has a strong impact on sustaining country's ambitious three-stage nuclear recycle program and significant contribution to power requirement

#### 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 throughout 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.

#### LEVEL/SCALE OF DEVELOPMENT

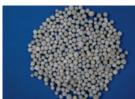
- Commercialized product
- Commercialized through industrial partner

## LINE MINISTRY MAPPING/USER SECTOR

Department of Atomic Energy/ Nuclear Power establishments



Borosilicate Glass Frit



Borosilicate Glass Bead







# High Density Radiation Shielding Window Glass for Nuclear Hot Cell Application

#### **IPR STATUS**

Trade Secret

#### APPLICATION/USES

Nuclear Hot cell, X-ray room, Operation theatre, Radiation therapy room

#### 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 x 425 x 130mm³), annealing and final processing.
- Windows of dimensions 550 x

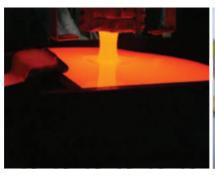
 $550 \times 50$  mm and  $700 \times 700 \times$  35mm from the same melt size through slumping technique in order to increase the viewing area has been developed

#### LEVEL/SCALE OF DEVELOPMENT

• Pilot scale facility established. Technology for producing homogeneous and defect free high density RSW glass blocks up to 400 x 400 x 100 mm<sup>3</sup> sizes successfully demonstrated.

## LINE MINISTRY MAPPING/USER SECTOR

Department of Atomic Energy





Bottom-Pouring-Flow-Casting and Radiation Shielding Window (RSW) Glass blocks







### Low moisture castable (45-75% Al<sub>2</sub>O<sub>3</sub>)

### IPR STATUS

Off patent

#### APPLICATION/USES

High temperature refractory for steel, cement, petrochemicals, thermal power plants etc.

## SALIENT TECHNICAL FEATURES INCLUDING COMPETING FEATURES

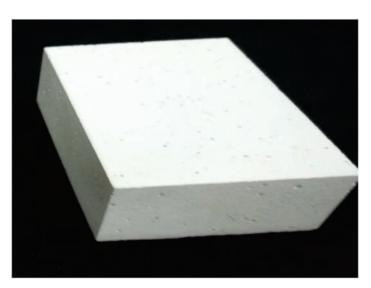
- No special mixing required
- Less inventory
- Easy installation

#### LEVEL/SCALE OF DEVELOPMENT

Technology transferred and commercialized

## LINE MINISTRY MAPPING/USER SECTOR

Ministry of Steel / Steel Industry, cement industry / Refractory industry/ Ministry of Power



Low moisture castable block









## Mag-Chrome Refractory Aggregates from Friable Chrome Ore

IPR STATUS
Patented

#### APPLICATION/USES

Refractory for steel ladle, copper smelter, cement rotary kiln

#### SALIENT FEATURES

- High corrosion resistance
- High RUL

#### LEVEL/SCALE OF DEVELOPMENT Commercialized

## LINE MINISTRY MAPPING/USER SECTOR

Ministry of Steel / Steel Industry, cement industry / Refractory industry/ Copper Industry



Sintered Mag-chrome aggregates produced at a refractory plant









## Mullite Refractory Aggregates from Bauxite

## IPR STATUS Patented

#### APPLICATION/USES

Refractory for Blast furnace stove, Bosh, Shuttle kiln lining, Rotary kiln, Tunnel kiln

#### SALIENT FEATURES

Mullite aggregates from inferior quality Bauxites of Indian origin

#### 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



Sintered mullite aggregates form bauxite









### **Mag-Al Spinel Refractory Aggregates**

IPR STATUS
Patented

#### APPLICATION/USES

Refractory for steel ladle, burning zone of cement rotary kiln

#### SALIENT FEATURES

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

#### 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 / steel industry / cement industry



Synthetic Magnesium aluminate spinel aggregate









## **Lime Refractory**

## IPR STATUS Patented

#### APPLICATION/USES

Refractory for AOD vessel for secondary steel refining, Rotary kiln

#### SALIENT FEATURES

• Thermodynamic stability at high temperature

- Improved hydration resistance
- High corrosion resistance at moderate basicity

## LEVEL/SCALE OF DEVELOPMENT Successful plant trial (100 Tons)

## LINE MINISTRY MAPPING/USER SECTOR

Ministry of Steel / steel industry



Lime refractory brick









# 70-90% Alumina cement free dense self flowing castable

IPR STATUS
Patented

#### APPLICATION/USES

High temperature refractory for steel, cement, petrochemicals, thermal power plants etc

## SALIENT TECHNICAL FEATURES INCLUDING COMPETING FEATURES

- Easy installation
- Self flow -no vibration during application

- Less inventory
- Quicker and controlled cold setting property

#### LEVEL/SCALE OF DEVELOPMENT

Technology transferred and commercialized

## LINE MINISTRY MAPPING/USER SECTOR

Ministry of Chemicals & Fertilizer/ Ministry of Steel/ Ministry of Power









## Manufacture of Plasma spray grade Hydroxyapatite (HAp) granules

IPR STATUS
Patented

#### 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.

#### SALIENT FEATURES

Phase pure HAp with spherical shape,

sizes can be tailor-made depending on the exact requirement. Freely flowable. Composition of HAp is as per ASTM spec., cost-effective, affordable.

LEVEL/SCALE OF DEVELOPMENT Lab scale

## LINE MINISTRY MAPPING/USER SECTOR

Ministry of Health & Family Welfare



Free Flowing spherical Hap granules









## Ceramic biomedical implants (hip joint prosthesis)

IPR STATUS
Patented

#### APPLICATION/USES

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

#### SALIENT FEATURES

Product is at per ISO spec., low wear, suits Indian patients, equivalent metallic implants has been discarded world-wide, ceramic THR is gaining importance, thus huge market potential, long service life, superior

quality implant with better patient compliance eliminating chances of revision surgery

#### LEVEL/SCALE OF DEVELOPMENT

- Commercialized product
- Commercialized through industry partner

## LINE MINISTRY MAPPING/USER SECTOR

Ministry of Social Justice & Empowerment/ Ministry of Health & Family Welfare



Total hip joint replacement with Ceramic (Al<sub>2</sub>O<sub>3</sub>) head









# Bioactive glass coating for dental application

IPR STATUS
Patented

#### APPLICATION/USES

Healthcare; Bioactive glass/ hydroxyapatite coating on metallic tooth root part (total dental implant)

#### SALIENT FEATURES

Cement-less fixation compared to the polymer cement fixation of bare metallic dental implants and gives rise to many advantages that include absence of heat generation during implantation, non-requirement of secondary surgery to remove the bone cement after some time, faster bone resorption, etc.; more adherent bioactive coating by using suitable bonding oxide, mechanically strong,

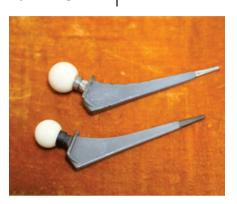
adherent bioactive coating on metallic implant substrates including titanium and its alloys, novel recipe of a suitable blend of oxides to produce more chemically adherent bioactive glassy coating on surgical grade stainless steel, Co-Cr-Alloy, titanium and its alloy surface in orthodontic application

#### LEVEL/SCALE OF DEVELOPMENT

- Commercialized product
- Commercialized through industry partner

## LINE MINISTRY MAPPING/USER SECTOR

Ministry of Health & Family Welfare



Typical bioactive glass coated hip stems with ceramic head









### Synthetic bone graft material

## IPR STATUS Patented

#### APPLICATION/USES

Porous scaffolds, granules, powders for bone development/ faster augmentation, dental filler, periodontic applications.

#### 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, freely flowable

granules can also be used for plasma spray purposes, effective for intramedullary bone development either. The scaffolds would replace lost bone which otherwise substituted by analogous or autologous bones resulting in additional wounds and transmission of AIDS infections.

#### LEVEL/SCALE OF DEVELOPMENT

- Commercialized product
- Commercialized through Industry partner

## LINE MINISTRY MAPPING/USER SECTOR

Ministry of Health & Family Welfare



CaP based bone graft material









# Optical Fibre Bragg Grating (FBG) based sensors for smart infrastructure and industrial process monitoring

IPR STATUS
Patented

#### APPLICATION/USES

Structural health monitoring and industrial process control

#### **SALIENT FEATURES**

- Optical fibre 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 fibre

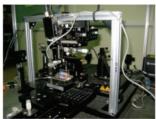
 Tiny sensors so easily embeddable in structures during fabrication of structures leading to development of intelligent infrastructure

#### 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





FBG sensor fabrication system







Packaged FBG strain and temperature sensors











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

IPR STATUS
Patented

#### APPLICATION/USES

Moisture detection in any system or environment

#### SALIENT FEATURES

Moisture detection in transformer oil useful for improving the dielectric

break down voltage of transformer oil and a process of preparation thereof.

#### LEVEL/SCALE OF DEVELOPMENT

• Lab Scale of Development

## LINE MINISTRY MAPPING/USER SECTOR

Ministry of Power/ Ministry of Steel/ Department of Commerce etc.



Moisture Meter and Sensor Head







### Thermally Cyclable Glass Sealant Composition For Intermediate Temperature Solid Oxide Fuel Cell (IT-SOFC)

IPR STATUS
Patented

#### APPLICATION/USES

High temperature sealant for application in SOFC stack

#### **SALIENT FEATURES**

- User Sector: Stationary power, Defence, Transport
- Thermally cyclable between room temperature and 800oC (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

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



1kW SOFC Stack fabricated and demonstrated at CSIR-CGCRI wherein the developed sealant has been used as one of the components







### **Pottery and Low Cost Earthen Wares**

#### APPLICATION/USES

High strength eco-friendly blue pottery glaze and the technology

#### 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.

## IMPLEMENTATION STATUS AND SCALE OF IMPLEMENTATION

This lead-free high strength ecofriendly 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





Shaping and finishing of the articles









## **Pottery and Low Cost Earthen Wares**







Decorative blue pottery articles









## Water Purification through Ceramic membrane based process

IPR STATUS
Off Patent

#### 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

#### 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 solidliquid 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.

#### 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.











# Water Purification through Ceramic membrane based process



Retentate line

Filter water outlet

Stainless Steel Module

Control valve Raw water suction line

Discharge line to modules

Pump

Frame

Components of water purification plant













Installation at different locations











## 30 W Continuous Wave (CW) Thulium Fiber Laser (TFL) at 1.94µm & 2µm

IPR STATUS
Indian Patent Filed

#### APPLICATION/USES

- Lithotripsy
- Coagulation
- Thin tissue ablation

#### SALIENT FEATURES

• Thulium fiber laser at operating wavelength of 1.94µm

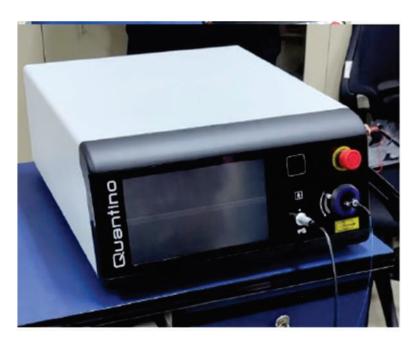
Average power: 30 W,
 Modulated for frequency 10-1000
 Hz, Pulse width 40 μs-90 ms,
 Energy upto 2.7 J

#### LEVEL/SCALE OF DEVELOPMENT

Ready tested Pilot Unit, Yet for certification and clinical validation

## LINE MINISTRY MAPPING/USER SECTOR

Ministry of Health and Family Welfare



Pilot Unit after Technology Transfer to Industry











## **PATENTS**







	Title of Patent	Application No./ Patent No.	First Filing Date
1.	Energy Efficient Soda Lime Silicate Glass Compositions Using Borax Pentahydrate	301394	19/02/2013
2.	Plasmonic Silver-Glass Nanocomposite Coating On Silica And Silicon Substrates And Its Preparation By Screen Printing Technique	201611026485	03/08/2016
3.	A Process For Making Rare Earth Doped Optical Fibre	223566	02/02/2001
4.	A Process of Making Rare Earth Doped Optical Fibre	1839DELNP2003	18/10/2001
5.	An Equipment For The Manufacture Of Thin Multifilament Fused Quartz Fibre Strands And A Process Thereof	231611	19/03/2001
6.	An Improved Method For Fabricating Rare Earth Doped Optical Fiber Using A New Codopant	0609DEL2009	27/03/2009
7.	Process & Fabrication Of Silica Based Index- Guided Nonlinear Micro Structural Optical Fibers With Optimized Suspension Of Innermost Air Holes	1560DEL2013	24/05/2013
8.	A Process For The Fabrication Of Ytterbium- Doped Cladding-Pumped Air-Clad Fiber For Use As High Power Laser Source	3814DEL2013	30/12/2013
9.	A Process Of Fabrication Of Erbium And Ytterbium-Codoped Multi-Elements Silica Glass Based Cladding Pumped Fiber	201811021507	06/08/2018
10.	Device For Online Monitoring Of Temperature Of High Voltage Power Conductors With Fibre-Optic Sensors	0891DEL2010	13/04/2010





Title of Patent	Application No./ Patent No.	First Filing Date
11. Air-Cooled Diode-Pumped All-Fiber CW/QCW thulium Laser For Operating Wavelength Of 1.94µm	201911001722	15/01/2019
12. Method And Apparatus For The Generation Of Gaussian Shaped Temporal Optical Pulses For Laser Based Material Processing	201611028763	24/08/2016
13. A Process For Fabrication Of Ytterbium (Yb) Doped Optical Fiber	1306DEL2013	05/03/2013
14. A Process For Making Anode Supported Planer Solid Oxide Fuel Cell	267662	12/04/2016
15. Improved Process For The Prepartion Of Planar Anode-Supported Solid Oxide Fuel Cell	302932	17/08/2010
16. Thermally Cyclable Glass Sealant Composition For Intermediate Temperature Solid Oxide Fuel Cell And A Process Thereof	2110DEL2015	13/07/2015
17. A Solid Oxide Fuel Cell Stack	0536DEL2015	25/02/2015
18. Ceramic Coated Paper-Based Separator For Lithiumion Batteries And A Process Thereof	201611041207	02/12/2016
19. A Process Of Manufacturing Inorganic- Organic Hybrid Sol And Sol Coated Scratch Resistant Polycarbonate Sheets And Lenses And Other Related Plastics	228274	29/05/2003
20. A Process Of Making Thermally Curable Inorganicorganic Hybrid Coating Sol For Providing Antiscratch Coating On Plastics	196846	09/02/2003
21. UV Curable Methacrylate-Silica Based Nanocomposite Sol Useful For Anti Scratch Coatings And A Process Thereof	264741	07/03/2007





Title of Patent	Application No./ Patent No.	First Filing Date
22. A Process Of Making Inorganic-Organic Hybrid Sols For The Deposition Of Antireflective (AR) Coatongs On Plastic Substrates	287049	15/09/2009
23. A Process For The Prepartion Of Inorganic- Organic Hybrid Sols For Hard Coating Deposition	296621	08/12/2014
24. A Process Of Making Sols Useful For Refractive Index Controlled Coatings On Plastics For Scratch Healing Purpose	3601DEL2014	12/09/2014
25. Antireflective (Ar) Cum Hydrophobic Coatings Composition For Ordered Mesoporous Silica On Textured Solar Cover Glasses To Increase Photocurrent With Easy Maintenance	201811023896	27/06/2018
26. Spongy Tin Doped Indium Oxide(ITO) And Process For The Preparation Thereof	299031	15/05/2012
27. A Microwave Assisted Sol Gel Dip Process Of Coating Indium Tin Oxide Films On Soda Lime Silica Glass Substrates	302149	19/02/2013
28. An Inorganic Base Antacid Compound With Improved And Novel Properties	201711020405	06/12/2017
29. A Process For The Manufacture Of Dense High Alumina Refractory Aggregate From Sillimanite Sand Based Minerals	235106	03/05/2003
30. A Novel Process For The Preparation Of Hydration Resistant Lime	269921	05/02/2008





Title of Patent	Application No./ Patent No.	First Filing Date
31. A Process For The Production Of Value Added Refractory Aggregates From Low Grade Bauxite And Value Added Refractory Aggregates Produced Thereby	281457	26/03/2008
32. An Improved Process For Production Of Dense High Alumina Refractory Aggregates From Sillimanite Sand	201611027427	11/8/2016
33. A Process For The Production Of High Alumina Containing Self Flow Castable & Cast Product Thereof	230546	15/02/2002
34. Process For The Production Of Rice Husk Ash Nodule Useful As Heat Insulating Material	244579	30/01/2002
35. A Process For The Production Of Plasma Fused Magnesia Rich Magnesium Aluminate Spinel Useful As Refractory Aggregates	3952DEL2015	04/12/2005
36. A Synergistic Composition Useful For Making Porous Bioactive Scaffold, Bone Filler Material And Bioactive Coating On Implants	276209	27/03/2009
37. A Process Of Making Porous Bioactive Scaffolds Nano Sized Calcium Hydroxy Apatite Powder	268374	27/03/2009
38. A Process For The Production Of Improved Porous Ocular Implants & Improved Porous Ocular Implants Produced Thereby	197588	19/09/2001
39. Bioceramic Materials As Bone Graft Substitute And Process For The Preparation Thereof	288878	31/03/2008
40. An Injectable Biodegradable Bone Cement Composite And A Process For The Preparation Thereof	1979DEL2015	07/01/2015





Title of Patent	Application No./ Patent No.	First Filing Date
41. Novel Soda Lime Silicate Glass Composition Comprising Colemanite And A Process For The Preparation Thereof	1657DEL2013	06/03/2013
42. An Improved Process For The Preparation Of Boron Nitride Coated Carbon Fibre	270978	19/05/2008
43. A Method Of Manufacturing Dense And Warpage Free Lead Zirconate Titanate Wafers	0672DEL2006	03/10/2006
44. A Process Of Making Lead Zirconate Titanate (PZT) Ceramics Showing Relaxor Behaviour And Relaxor PZT Based Moisture Sensor Made Therefrom	301180	13/11/2007
45. A Method Of Manufacturing Dense And Warpage Free Lead Zirconate Titanate Wafers	292979	26/02/2007
46. An Improved Method For Preparation Of KNN Tapes	0771DEL2010	31/03/2010
47. An Improved Sensor Composition For Acetone Detection In Breath For Diabetic Diagnostics	1313DEL2012	30/04/2012
48. An Improved Process For The Preparation Of Organophilic Nanoclay	2384DEL2014	22/08/2014
49. A Process For The Preparation Of An Impervious Palladium Membrane Over Ceramic Substrate	324557	08/12/2014
50. A Process Of Making Bimetallic Palladium Based Nanoporous Alloy	0622DEL2015	03/05/2015
51. A Process For The Preparation Of Ceramic Compositions With Enhanced Mullite Content	3498DEL2015	28/10/2015





Title of Patent	Application No./ Patent No.	First Filing Date
52. A Process For The Continuous Production Of Sinteractive Lanthanum Chromite Based Oxides	283758	30/06/2004
53. Sensor Compositions For Detection Of Linalool, Geraniol, Methyl Salicylate And Trans-2-Hexenal With An Intention To Classify Black Tea Aroma	0537DEL2015	25/02/2015
54. A Process For Preparation Of Iron-Doped Aluminophosphate Glass Using Microwave Energy In Air Atmosphere For Heat Absorbing Application	201611009089	16/03/2016
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Title of Patent	Application No./ Patent No.	First Filing Date
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63. A Synergistic Composition For The Preparation Of Silicon Nitride Powder	230986	28/02/2002
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66. A process for preparation of thin film moisture sensor for determination of trace moisture in gaseous phase	201911043026	23/10/2019
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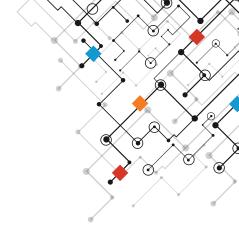


Title of Patent	Application No./ Patent No.	First Filing Date
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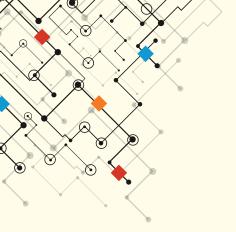
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