



Overview of CGCRI Activities on Glass

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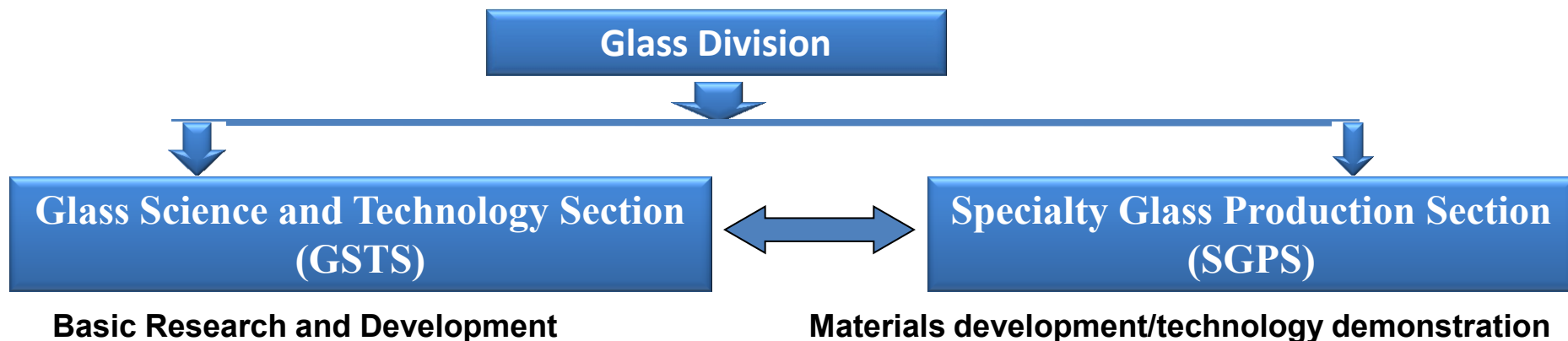
June 25, 2016

सी एस आई आर- सी जी सी आर आई में वैज्ञानिक अनुसंधान – एक झलक

RESEARCH AT A GLANCE IN CSIR-CGCRI



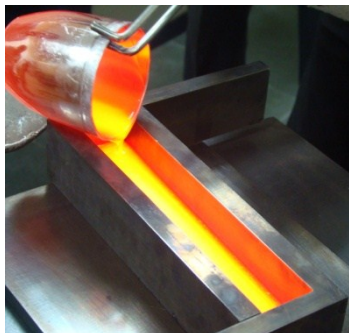
Glass Division (CSIR-CGCRI)



Objective/Mandate of the division:

- Development of specialty glass and glass-ceramics for engineering, medical and strategic applications
- Basic research to explore new areas for futuristic applications: both product and process development.
- Indigenous technology development in strategic fields.
- Moderate to pilot scale production to meet country's demand.
- Teaching/ Training of students and researchers.

Melting Facility



Melting Furnaces (Raising Hearth) : 5 Nos. (Maximum 1400 °C)
2 No. (Maximum 1500 °C)
2 No (Maximum 1700 °C)

Induction furnace: 2 No. (1400-1450 °C) (5 lit and 40 lit. capacity)

High Temperature Observation furnace: 1 No. (Maximum 1600 °C)

Annealing/ Ceramization Furnaces : 8 Nos.

Microwave Melting Furnace: 3 No.

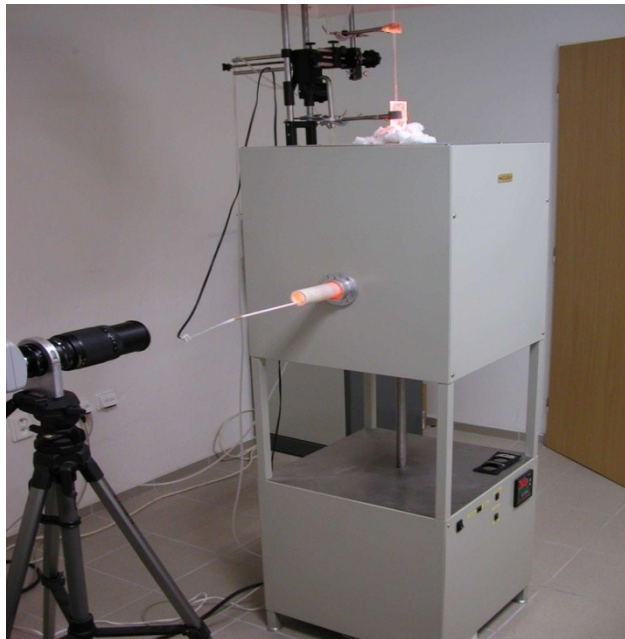
Specialized Furnaces



5 lit Induction furnace



6 kW Microwave Furnace

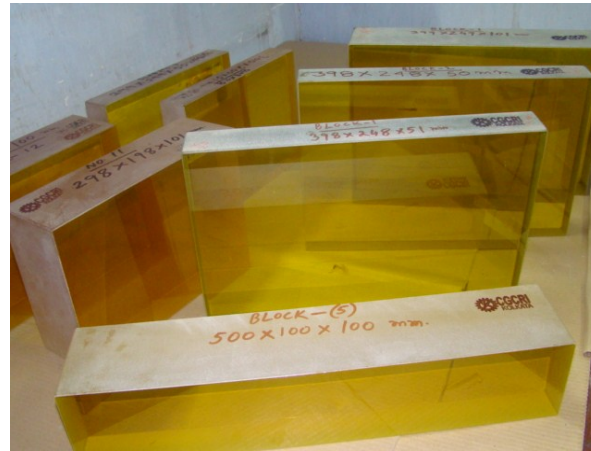
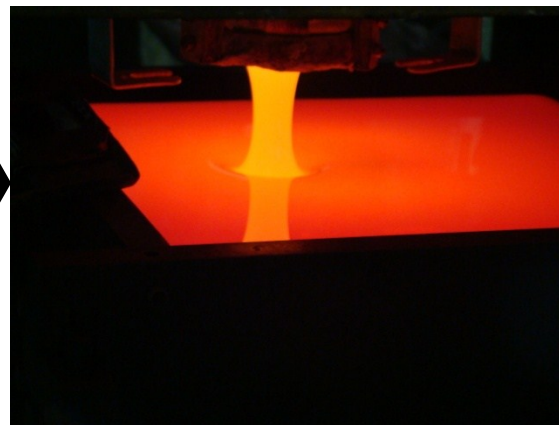
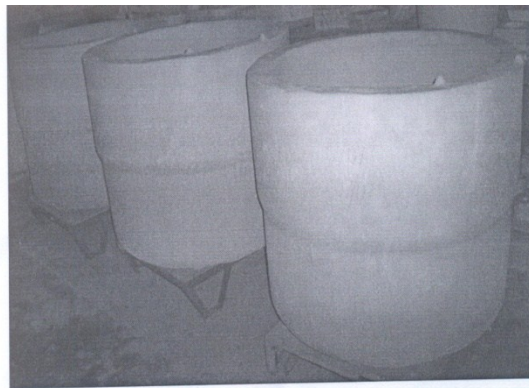


High temperature observation furnace



Rocking furnace

PILOT SCALE FACILITY



Characterization

➤ **Thermal Properties:**

Simultaneous Thermal Analysis (DSC, DTA, TGA) (STA 449, Jupiter)
Dilatometer (Netzsch DIL402PC)

➤ **Spectroscopic Characterization:**

Fluorescence spectrophotometer (Quantum Master-enhanced NIR
from Photon Technologies International)
FTIR spectrometer (Perkin Elmer, IRL 1280119, Frontier)
Raman Spectrometer (HORIBA JobinYvon, France; Model: Lab Ram
HR 800 EV)

➤ **Optical Properties:**

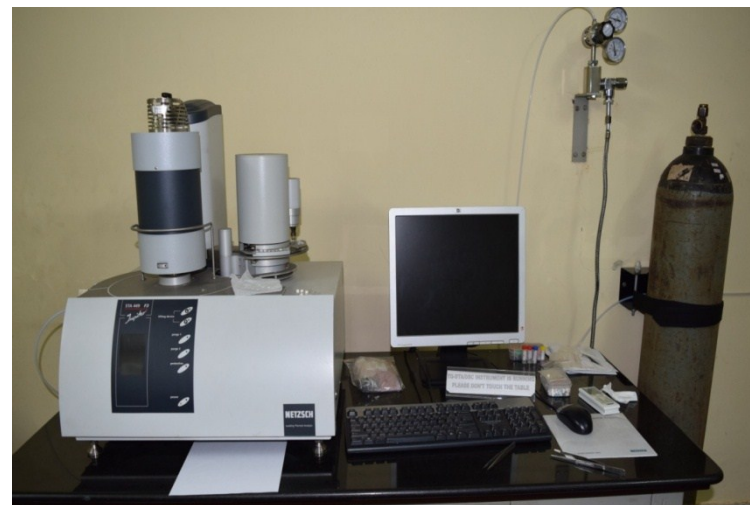
Prism Coupler (Metricon Model-2010),
UV–Vis-NIR spectrophotometer (LAMDA 950, Perkin Elmer),
Polarimeter (M/s Strainoptics Inc., USA, Model :DIAS-1600)
Interferometer (Zygo corporation, USA, Model: GPI system-XP/D)

➤ **Mechanical Properties:** Microhardness Tester (Mastuzawa, MMT-X7B)

Characterization Facilities



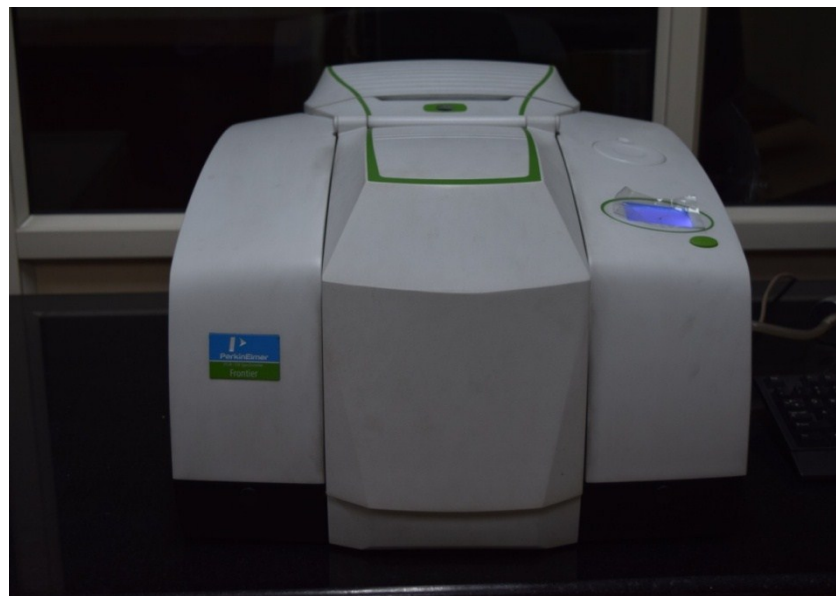
Raman Spectrometer (HORIBA, Lab Ram HR 800 EV)



STA (DSC, DTA, TGA) (NETZSCH, Jupiter)



**UV-Vis-NIR Fluorescence Spectrophotometer
(M/s Photon Technology International)**



**FTIR Spectrometer (Perkin Elmer,
Frontier FT-IR/FIR Spectrometer)**

Services towards Testings of Glass/Glass products

➤ Optical properties:

Refractive Index and Abbe number
Dispersion curve
Visible Light transmission (VLT)
Reflectance
Absorption
Yellow Index etc

➤ Mechanical Properties

Micro Hardness

Residual stress/toughened glass test

➤ Total chemical analysis

➤ Thermal Properties:

Coefficient of thermal expansion (CTE)
sagging temperature
DSC/DTA
Thermal shock resistance

➤ Optical Homogeneity

➤ Identification of types of glasses

Laboratory scale trail melting; specific problem solving tests

Initiative taken for establishing facility for :

- Energy Performance testing of Architectural Glass and DGU.
- Safety and Structural Performance testing of Architectural Glass

Serving for

- Reliance Infra
- Areva T & D India limited, Hosur
- Alpha Design Technologies Pvt. Ltd., Bangalore
- Bharat Electronics Ltd., Taloja
- Borosil Glass Works Ltd, Ahmedabad
- Customs Office, Govt. of India
- EO2 Systems, Hyderabad
- Goa Glass fiber Ltd., Goa
- IFB, Goa
- Instrumentation Ltd., Kota
- Lensel Optics, Pune
- Hindustan Opticals
- Ajay Scientific Industries
- Prism India Pvt. Ltd
- Saint Gobain
- Several R&D Organizations

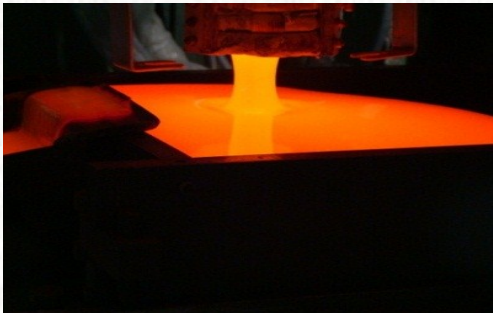
High Density Glass for Radiation Protection

- An essential item for Glove Boxes/ Cells used for nuclear material processing.
- Only 4 countries in the world are known to have the technology.
- Indigenous technology successfully demonstrated
- 20 MT of high density RSW glass blocks produced for DAE.

Applications

- Nuclear power plants
- Waste treatment facilities
- Isotope production facilities
- Nuclear research centers

Annual Demand: 100 MT
(for low to high density
RSW glass)



Pouring of melt into pre -
heated mould



Glass blocks of 400 × 400 ×
100 mm sizes



Biggest glass block of
700 × 700 × 35 mm size

Special Glass Beads For Nuclear Waste Immobilization

The material ensures confinement of the radio isotopes in a stable matrix and safe disposal with no threat to the environment.

Process technology developed by CGCRI and transferred to M/s H. R. Johnson, Mumbai for manufacturing

Model: Production by HRJ with direct order from DAE + Certification of the quality by CSIR-CGCRI

Till date 44 MT of glass beads produced and supplied to DAE
The technology is of significant importance for the country's nuclear power program.

Annual requirement: 40-50 MT (likely to increase)

NRDC Innovation Award -2013



Borosilicate glass nodules developed at CGCRI, Kolkata



Exchange of Technology Transfer document with M/s H R Johnson



Glass Nodules produced by M/s H R Johnson

Nd doped Phosphate Glass

Technological Achievements

- ★ First ever development of solid state laser material in the country.
- ★ All stipulated properties achieved.
- ★ The raw materials developed indigenously.
- ★ Melting in 5 lit scale standardized and glass blocks provided to DAE.
- ★ Melting in 15 lit scale to be initiated.

Long term requirement by DAE for future programs



USES

- ❖ High energy laser system for civil applications
- ❖ Inertial confinement fusion for clean energy, material processing, range finder etc.

- A closely guarded technology. Only 3-4 countries in the world have the capability.
- The technology has long term implication for country's civil and strategic sectors.

Chalcogenide Glass for IR Optics/ Photonic/ Sensor Applications

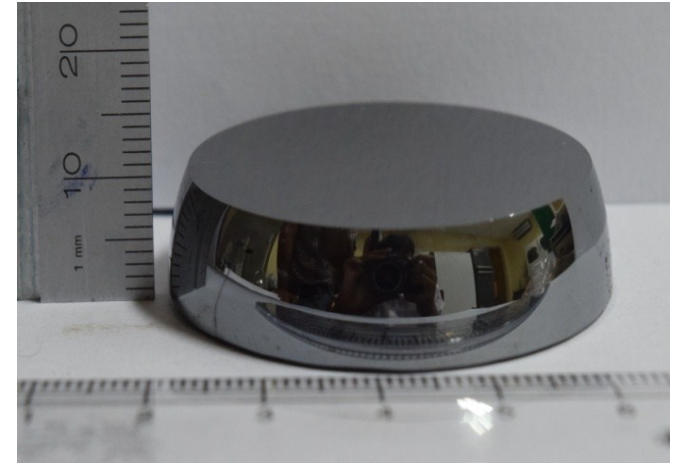
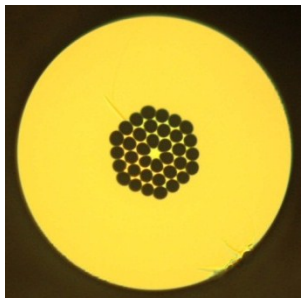
Glass developed in different compositions up to 200g. scale

Application and Product development work initiated

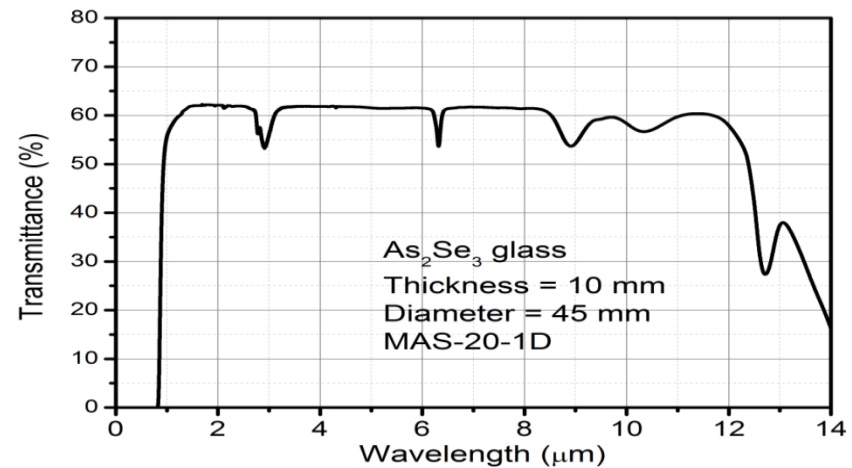
Civil and Strategic Applications

Technology development for undoped and RE doped Chalcogenide Glasses

Applications:
Thermal Imaging
Supercontinuum
Sources
Lasers/ Amplifier
Gas/ Chemical Sensors



Processed bigger As_2Se_3 glass (10 mm thick & 45 mm dia)



Transmission Spectrum

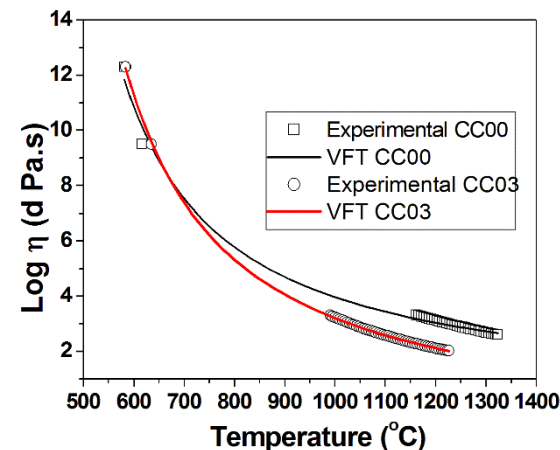
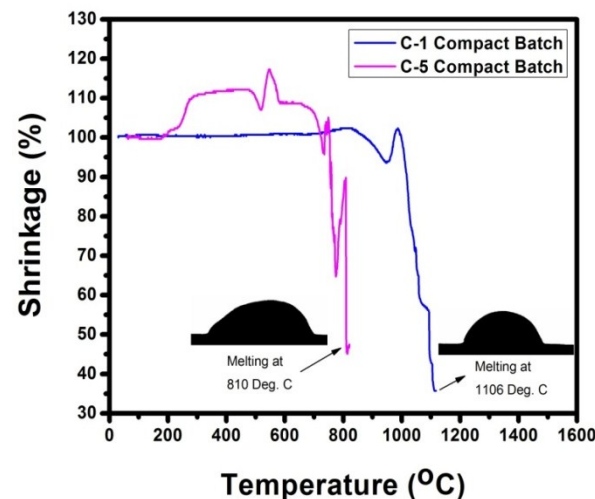
INVESTIGATION ON THE INCORPORATION OF *BORAX PENTAHYDRATE* AND *COLEMANITE* IN DIFFERENT GLASSES

M/s Borochemie (India) Pvt. Ltd., Mumbai

Feasibility study carried out on using borate minerals such as Borax pentahydrate ($\text{Na}_2\text{B}_4\text{O}_7 \cdot 5\text{H}_2\text{O}$) and Colemanite ($\text{CaB}_3\text{O}_4(\text{OH})_3 \cdot \text{H}_2\text{O}$) as the alternate sources for soda and calcia (lime) in glass melting and establishing process technology for two types of commercial glasses (soda lime silica based Float glass and Container glass) in the lab scale

Salient findings:

- Substantial reduction in melting temperature.
- Improvement in physical, optical, thermal and mechanical properties.
- Discussions are going on to take up industrial scale trial meltings



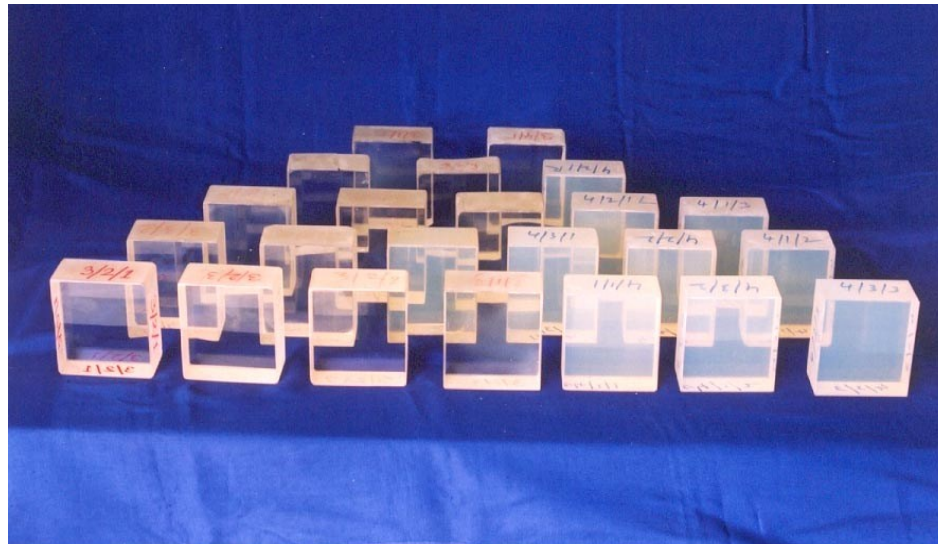
Patents filed:

- ENERGY EFFICIENT SODA LIME SILICATE GLASS COMPOSITIONS USING BORAX PENTAHYDRATE, PCT/IN2014/000027, WO/2014/128714
- NOVEL SODA LIME SILICATE GLASS COMPOSITION COMPRISING COLEMANITE AND A PROCESS FOR THE PREPARATION THEREOF, PCT/IN2013/000554, WO/2014/195960

Ultra-low thermal Expansion Transparent (ULET) Glass-Ceramic

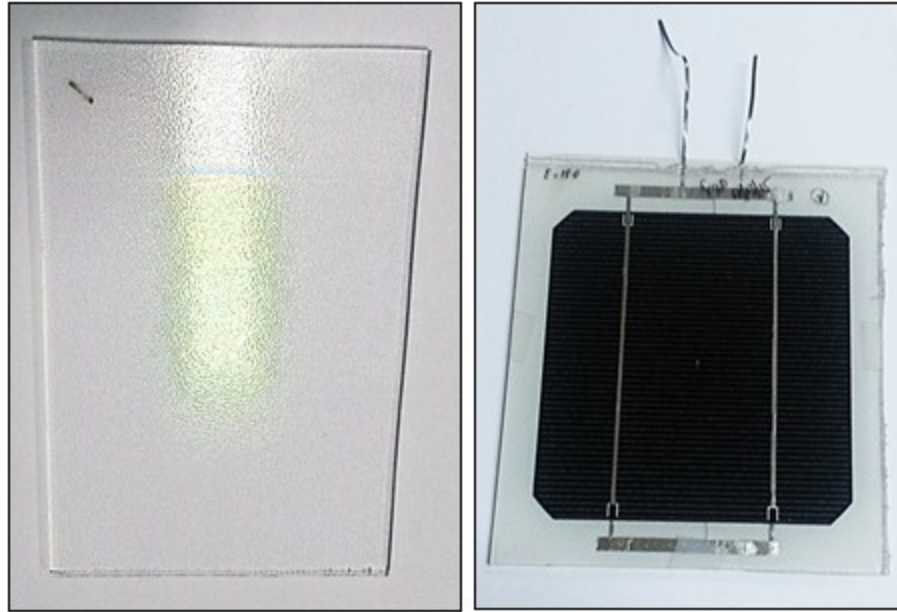
Material used for making laser gyroscope

**ULET GC has both vitreous and crystalline phases.
Coefficient of thermal expansion is $0.13 \times 10^{-6} \text{ K}^{-1}$ (0-50 °C)**



**ULET glass ceramic blocks of dimension $90 \times 90 \times 40 \text{ mm}^3$
produced at CGCRI**

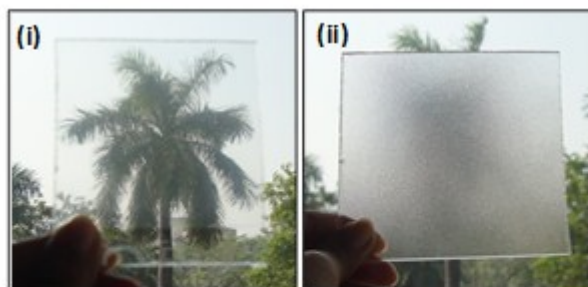
AR coating on Solar Cell Cover Glasses with hydrophobic surfaces



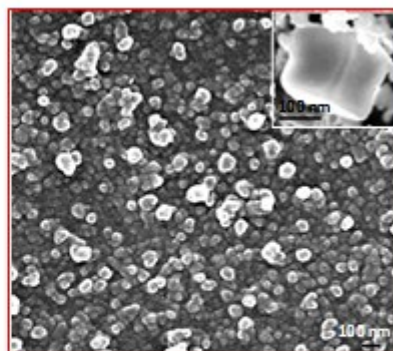
Salient features:

- **Single layer AR coating with mesoporous structure**
- **Pencil Hardness >5-6H (ASTM D 3363)**
- **Passed Adhesion test (ASTM D 3359)**
- **Reflection decreases 4-5% in the wavelength range 380-1000 nm in comparison to the uncoated solar cover glass**
- **Photo-current (I_{sc}) increased 3–4% in compare to the uncoated solar cover**
- **After application of thin hydrophobic coating water contact angle can be achieved up to 125° with contact angle hysteresis $10 \pm 2^\circ$**

Zeolite crystals embedded nanotextured coating with hydrophobic surface: An innovation towards next generation solar cover glass for efficient light-harvesting



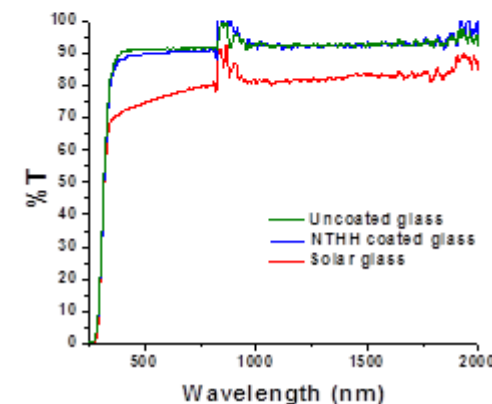
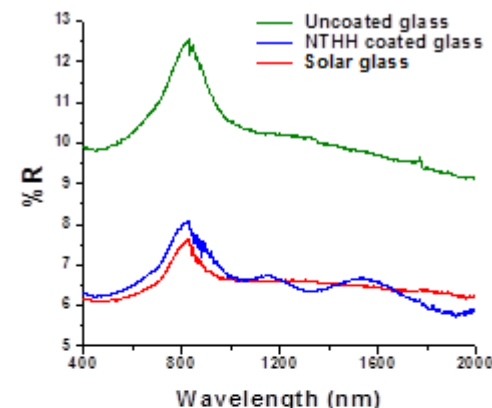
Nano-textured hydrophobic (NTH) coated ordinary glass (i) and millimeter-scale textured solar cover glass (ii)



Surface morphology of the NTH coated glass

Salient features:

- Zeolite crystals embedded hard and hydrophobic nano-textured coating
- Pencil Hardness >7H (ASTM D 3363)
- Passed Adhesion test (ASTM D 3359)
- Anti-dazzle and positive temperature effect
- Higher solar transmittance and visibility
- Photo-current (I_{sc}) increased 3% compared to the millimeter-scale textured cover glass



Percentages of total reflectance and solar transmittance of the uncoated, NTH coated and textured cover glass substrates

Alternate Glass melting using Microwave heating

Advantage of Microwave heating:

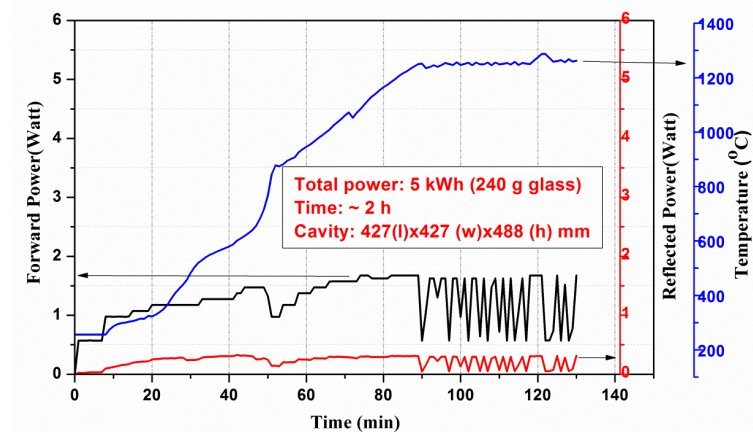
- ❖ Shorter processing times ; Time saving (60-70 %)
- ❖ Energy saving (50-60 %) ; Eco-friendly
- ❖ Improved properties.
- ❖ Less evaporation, less contamination from crucible wall, improved chemical durability
- ❖ Development of new properties; Higher Fe-redox ratio/ retention of more ferrous ion in glass.



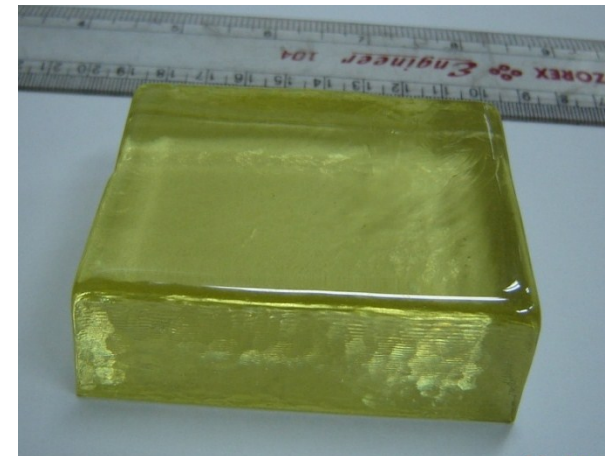
Raising hearth furnace



Microwave heating

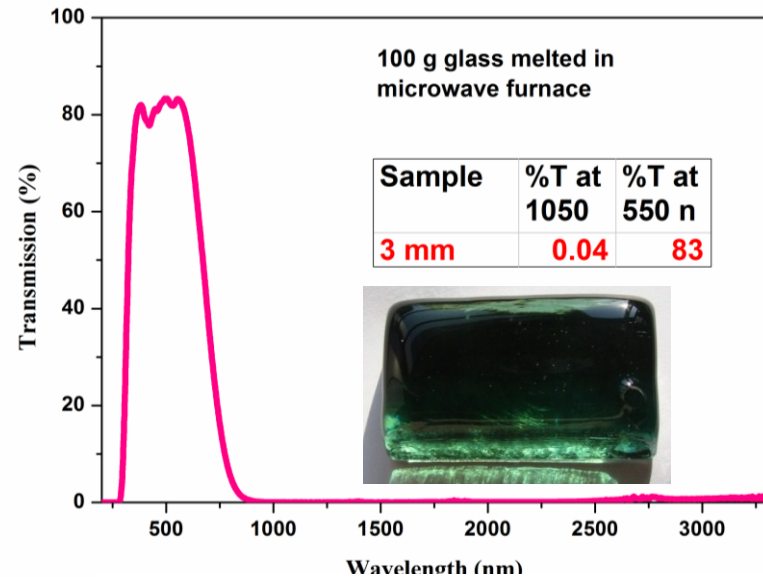
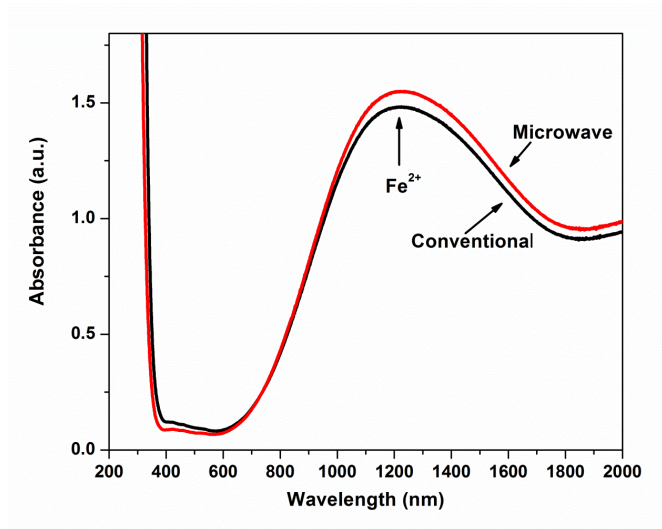


240 g RSW Glass:
Power: 5-6 kWh; Time: 2 h



500 g glass RSW Glass

Microwave heating yield Higher Fe[II] in glass



Patent Filed:

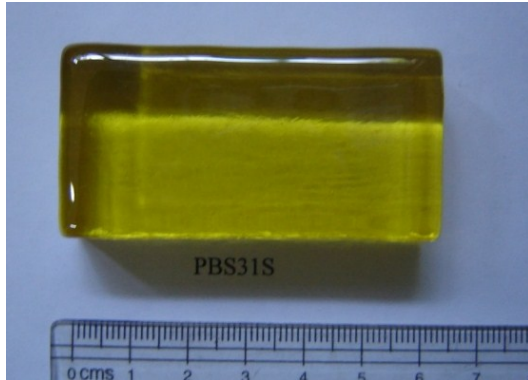
Indian Patent :0022NF2016 ; Process for preparation of iron-doped aluminophosphate glass using microwave energy in air atmosphere for heat absorbing application. Date of filing : 16-03-2016



Manufactured in the U

IR Protective goggles Can be made by this glass

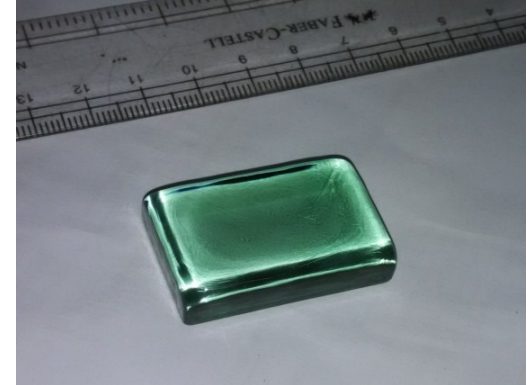
Preparation of Bulk Glasses



RSW Glass @1250°C



**Zinc Borate glass
@ 1200 °C**



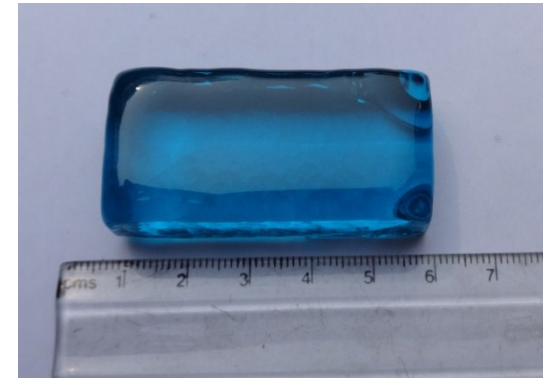
**Cu-doped phosphate glass
@ 1200° C**



**Barium-boro-silicate glass
@1200° C**



**IR absorbing glass
@ 1450° C**



**Phosphate Glass
@ 1250°C**

Manufacturing Partner for Specialty Glasses

CGCRI plans to work jointly with interested industrial partners for upscaling the process and production of the following varieties of glass:

- **RSW Glass**
- **Laser Glass**
- **Specialty Glass beads**
- **Boron containing Float and Container Glasses**

Providing the Technology as well as Certification will be CGCRI responsibility.



FIRST
ANNOUNCEMENT

ICAGST 2017

International Conference on Advances in Glass Science and Technology 2017



ICG Steering Committee Meeting 2017

January 23 - 25, 2017
(Tutorial: January 19 - 21, 2017)
CSIR-CGCRI, Kolkata, India

ICAGST-2017

January 23-25, 2017

*(International Conference on Advances in Glass
Science and Technology)*

ICG-CGCRI Tutorial: January 19-21, 2017)

Thank You