

Dr. Mrinmoy Garai

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Date of Birth: 27/02/1988, Nationality: Indian, Marital Status: Unmarried, Sex: Male
Languages known: English, Hindi, Bengali, ORCID: 0000-0001-5605-1278; ResearcherID: F-3276-2017
Scopus Author ID: 55914484100

Education

- **Ph. D. (Chemistry):** Jadavpur University; June 2011 to May, 2016.
Thesis title: “Synthesis and Properties of Mica and Chalcogenide Based Glass and Glass-ceramics”
Supervisor: Prof. (Dr.) Basudeb Karmakar, Senior Principal Scientist, Head, Glass Science and Technology Section, CSIR-Central Glass and Ceramic Research Institute (CGCRI), Kolkata, W. B., India.
- **M. Sc. (Chemistry):** West Bengal State University, Kolkata, W. B., India, 75% marks (Topper in Physical Chemistry); November 2008 to February 2011.
- **B. Sc. (Chemistry, Physics, Mathematics):** University of Burdwan, W.B., India, June 2004 to July 2007.

Professional Experience

1. **Co-PI (DST-SERB National Post-Doctoral Fellow):** March, 2017 to February 2019; Indian Institute of Technology (IIT), Kharagpur – 721302, India (Area: Processing-Microstructure-Property of High Strength Mica and Leucite based Glass-ceramics for Dental Restoration Application).
2. **Research Associate (HBNI Post-Doctoral Fellow):** August, 2016 to February, 2017; Bhabha Atomic Research Centre (BARC), Mumbai – 400 085, India (Area: Structure-Processing-Property of Calcium Alumino-silicate Composite for radioactive waste immobilization in Th-fuel cycle).
3. **Senior Project Fellow:** January, 2016 to July, 2016; CSIR-Central Glass & Ceramic Research Institute, Kolkata - 700032, India (Area: Chalcogenide Materials for thermal imaging and night vision application).
4. **Project Fellow:** June, 2011 to December, 2015; CSIR-Central Glass & Ceramic Research Institute, Kolkata -700032, India (Area: Fluorophlogopite Mica based Glass-ceramic sealant for 500W SOFC application).

Technical Skills

Materials Synthesis & Methods: Oxide Glass and glass-ceramic Processing, Melt-quenching synthesis of oxide glass in high temperature furnace (1200-1700°C), Annealing, Casting, Controlled heat-treatment, Cutting, Grinding, Polishing, Glass-ceramic Composite, Non-oxide Glass Synthesis using Glove box and Rocking Furnace, Vacuum distillation. Sealing of glass powder with SOFC electrolyte and electrodes using binder, SOFC stack operation, FESEM sample mounting, Planetary ball milling, Hand-pressing powder pellet preparation, mortar grinding.

Experimental Skills: Powder XRD, FESEM, TEM, EDX, EXAFS, FTIR, DSC, HSM, XPS, Dilatometer, UV-visible, Raman spectroscopy, Optical Microscopy, Current density, Power density, Scratch testing, Micro and nano-indentation hardness, Particle size analysis, ion-beam irradiation.

Scientific Software awareness: Origin, X-Pert High Score, ImageJ, Peak Fit, MS Excel, JCPDS, CHEMDRAW.

Publication Summary

SCI Journal: 11; Patent: 01; Book Chapter/Proceedings: 05 *(Details in Annexure -1)*

LIST OF PUBLICATIONS

(A) Papers Published in SCI Journals

1. **Mrinmoy Garai**, Basudeb Karmakar, "Rare Earth Ion Controlled Crystallization of Mica Glass-ceramics", **Journal of Alloys and Compounds** (ISSN: 0925-8388), 678, 360-369 (2016), *Impact Factor* = 3.779.
2. **Mrinmoy Garai**, Nibedita Sasmal, Atiar Rahaman Molla, Anal Tarafder, Basudeb Karmakar, "Effects of in-situ Generated Coinage Nanometals on Crystallization and Microstructure of Fluorophlogopite Mica Glass-ceramics", **Journal of Materials Science & Technology** (ISSN: 1005-0302), 31, 110-119 (2015); *Impact Factor* = 3.609.
3. **Mrinmoy Garai**, T. S. R Ch. Murthy, Basudeb Karmakar, "Microstructural Characterization and Wear Properties of Silver and Gold Nanoparticle Doped K-Mg-Al-Si-OF Glass-ceramics" **Ceramics International**, 44 (18), 22308-22317 (2018); *Impact Factor* = 3.057.
4. **Mrinmoy Garai**, Nibedita Sasmal, Atiar R. Molla, Shiv Prakash Singh, Anal Tarafder, Basudeb Karmakar, "Effects of Nucleating Agents on Crystallization and Microstructure of Fluorophlogopite Mica-containing Glass-ceramics", **Journal of Materials Science** (ISSN: 1573-4803), 49, 1612-1623 (2014); *Impact Factor* = 2.993.
5. **Mrinmoy Garai**, Nibedita Sasmal, Atiar R. Molla, Basudeb Karmakar, "Structural Effects of Zn⁺²/Mg⁺² ratios on Crystallization Characteristics and Microstructure of Fluorophlogopite Mica-Containing Glass-ceramics," **Solid State Sciences** (ISSN: 1293-2558), 44, 10-21 (2015); *Impact Factor* = 1.861.
6. **Mrinmoy Garai**, Anoop K Maurya, Shibayan Roy, "Zn²⁺- Controlled Crystallization and Microstructure in K-Li-Mg-B-Si-Al-F Glass", **MRS Advances**, 3 (60), 3525-3533 (2018).
7. **Mrinmoy Garai**, Basudeb Karmakar, "Enhanced Thermal Expansion of Sintered Fluorophlogopite Mica-K₂O-MgO-SrO-B₂O₃-Al₂O₃-SiO₂ Glass Composite", **Asian Journal of Materials Chemistry** (ISSN: 2456-6225), 1 (2), 33-38 (2016).
8. **Mrinmoy Garai**, Nibedita Sasmal, Basudeb Karmakar, "Effects of M²⁺ (M = Ca, Sr and Ba) Addition on Crystallization and Microstructure of SiO₂-MgO-Al₂O₃-B₂O₃-K₂O-F Glass", **Indian Journal of Materials Science** (ISSN: 2314-7490), Article Id. 638341 (2015).
9. Nibedita Sasmal, **Mrinmoy Garai**, Atiar Rahaman Molla, Anal Tarafder, Shiv Prakash Singh, Basudeb Karmakar, "Effects of Lanthanum Oxide on the Properties of Barium-free Alkaline-earth Borosilicate Sealant Glass", **Journal of Non-Crystalline Solids** (ISSN: 0022-3093), 387, 62-70 (2014); *Impact Factor* = 2.488.
10. Nibedita Sasmal, **Mrinmoy Garai**, Basudeb Karmakar, "Preparation and Characterization of Novel Foamed Porous Glass-ceramics" **Materials Characterization** (ISSN: 1044-5803), 103, 90-100 (2015); *Impact Factor* = 2.892.
11. Nibedita Sasmal, **Mrinmoy Garai**, Basudeb Karmakar, "Influence of Ce, Nd, Sm and Gd Oxides on the Properties of Alkaline-earth Borosilicate Glass Sealant" **Journal of Asian Ceramic Societies** (ISSN: 2187-0764), 4, 29-38 (2015).

(B) Patent Filed

1. Basudeb Karmakar, Rajendra Nath Basu, Anal Tarafder, Nibedita Sasmal, **Mrinmoy Garai**, "Thermally Cyclable Glass Sealant Composition for Intermediate Temperature Solid Oxide Fuel Cell and A Process Thereof", Application No. 2110DEL2015 (Ref. No. 0278NF2014; Date of Filing 13-07-2015), India.

(C) Book Chapter/Proceedings

1. Basudeb Karmakar, Nibedita Sasmal and *Mrinmoy Garai*, “Nanoglass and Nanostructured Chalcogenide Glasses” Chapter 15 in “Glass Nanocomposite Synthesis, Properties and Applications” (ISBN: 978-0-323-39309-6) edited by Basudeb Karmakar, Klaus Rademann and Andrey L. Stepanov, Elsevier, Amsterdam, January 2016 (Pages 359-373).
2. *Mrinmoy Garai*, Basudeb Karmakar, “Development of Fluorophlogopite Mica Nanocrystals in Zn-Containing B₂O₃-Al₂O₃-SiO₂-K₂O-MgO-F Glasses” in conference edited book Nanospectrum: A Current Scenario (ISBN: 978-93-85926-06-8), edited by Sampa Chakrabarti, Prasun Mukherjee, Gobinda Gopal Khan, Arghya Adhikary, Prasun Patra and Jayanta Kumar Bal, Allied Publishers Pvt. Ltd., India, 2015 (Pages 99-107).
3. *Mrinmoy Garai*, Basudeb Karmakar, Zn²⁺-Substitution by Pb²⁺ in Alkaline-boroaluminosilicate Glass-ceramics: Microstructural Aspects”, **Advanced Materials Proceedings** (ISSN: 2002-4428), 3 (4), 206-212 (2018).
4. *Mrinmoy Garai*, Basudeb Karmakar, “Nucleating Agent Controlled Crystallization and Thermal Properties of K-Mg-B-Al-Si-F Glasses”, **Acta Crystallographica** (ISSN: 2053-2733), A73, C490 (2017).
5. *Mrinmoy Garai*, “TiO₂ and ZrO₂ Controlled Crystallization And Microstructure In SiO₂-MgO-Al₂O₃-B₂O₃-K₂O-F Glass”, Materials Science and Technology 2017 (MS&T17), October 8 – 12, 2017, Pittsburgh, Pennsylvania, USA, DOI 10.7449/2017/MST_2017_960_967.

Awards and Achievements

1. 'Best Oral Presentation Award'

“Microstructure and Wear Properties of Silver and Gold Nanoparticle Doped K-Mg-Al-Si-O-F Glass-ceramics” *Mrinmoy Garai*, T. S. R. S. Ch. Murthy, Basudeb Karmakar; in the **National Seminar Cum Workshop in Nanoscience (NSWN-2018)** organized by Dept. of Nanotechnology, North Eastern Hill University, Shillong, India, 29-31 May 2018.

2. 'HEAM Scientist Best Presentation Award'

“ZrO₂-Controlled Crystallization and Microstructure in SiO₂-MgO-Al₂O₃-K₂O-B₂O₃-F Glass-ceramic: SOFC Sealing Application” *Mrinmoy Garai*, Basudeb Karmakar; in the Annual meet of **Indian Association of Hydrogen Energy & Advanced Materials (IAHEAM)** organized by Dept. of Chemistry, University of Kerala, Trivandram, 16-17 March, 2017.

3. 'Best Poster Presentation Award'

“Processing and Properties of SiO₂-MgO-Al₂O₃-K₂O-B₂O₃-F Glass-ceramic Sealants for Solid Oxide Fuel Cells” *Mrinmoy Garai*, Basudeb Karmakar; in the **UGC-sponsored National Conference on Recent Trends in Functional Materials in Relation to Nanomaterials and Nanotechnology (RTFMNN)** organized by St. Paul Cathedral Mission College, Kolkata in collaboration with Indian Chemical Society, Kolkata, 4-5 February, 2016.

4. 'Best Oral Paper Presentation Award'

“Intensified Crystallization and Microstructure in ZnO, TiO₂ and ZrO₂ Doped Boroaluminosilicate Glasses: A Study on SOFC Sealing Performance”, *Mrinmoy Garai*, Basudeb Karmakar; **National Conference on Functional Glass and Glass-ceramics (NCFG-2015)**, organized by Materials Research Society of India (MRSI) Mumbai Chapter, Viswashreya National Institute of Technology, Nagpur, India, 10-12 December, 2015.

5. 'Young Scientist Award'

“ZrO₂ Controlled Crystallization and Microstructure in SiO₂-MgO-Al₂O₃-B₂O₃-K₂O-F Glass: Impact on SOFC Sealing Application” *Mrinmoy Garai*, Basudeb Karmakar; Proceedings of the **National Symposium on Recent Advances in Chemistry & Industry (2015)**, organized by The Indian Chemical Society at University of Calcutta, Kolkata, 31 July-01 August, 2015.

6. 'Best Oral Presentation Award'

“Effects of ZrO₂ on the Nucleation and Crystallization Behaviour of SiO₂-MgO-Al₂O₃-B₂O₃-K₂O-MgF₂ glass: Applicability as SOFC Sealing Material”, *Mrinmoy Garai*, Sanjib Samaddar, Basudeb Karmakar; **Ist International Conference on Alumina and Other Functional Ceramics (AOFC-2015)**, organized by

International Ceramic Foundation (ICF), Italy and Indian Ceramic Society, India at CSIR-Central Glass & Ceramic Research Institute, Kolkata (India), 11-13 March, 2015.

7. 'Young Scientist Poster Presentation Award'

"Influence of CaO, SrO and BaO on the Crystallization Characteristics, Microstructure and Thermal Properties of SiO₂-MgO-Al₂O₃-B₂O₃-K₂O-MgF₂ Glasses", *Mrinmoy Garai*, Basudeb Karmakar; **102nd Indian Science Congress (ISC-2015)**, University of Mumbai, Mumbai (India), 3-7 Jan, 2015.

8. 'Best Poster Presentation Award'

"Development of Fluorophlogopite Mica Nanocrystals on Controlled Heat-Treatment in SiO₂-Al₂O₃-B₂O₃-K₂O Glasses in Presence of Zinc Oxide", *Mrinmoy Garai*, Basudeb Karmakar; **National Conference on Nanoscience and Nanotechnology (NS & NT-2014)**, Centre for Research in Nanoscience and Nanotechnology (CRNN), University of Calcutta, Kolkata (India), 18-19 September, 2014.

9. 'Best Poster Presentation Award'

'Crystallization of SiO₂-MgO-Al₂O₃-B₂O₃-K₂O-MgF₂ System in Reducing Environment Catalyzed by Coinage Nanometal,' *Mrinmoy Garai*, Nibedita Sasmal, Basudeb Karmakar; **UGC-SAP National Seminar on Recent Advances in Chemistry (NSRAC-2014)**, Visva-Bharati University, Santiniketan (India), 9 March, 2014.

10. 'Best Poster Presentation Award'

"Effects of coinage nanometal on crystallization and microstructure of fluorophlogopite mica containing glass-ceramics", *Mrinmoy Garai*; **Research Scholars' Day (2nd Annual Workshop)**, CSIR-Central Glass & Ceramic Research Institute, Kolkata (India), 20 August, 2013.

11. 'Best Oral Presentation Prize'

in the Students Science Seminar-2001 organized jointly by Department of Youth Services, Govt. of West Bengal and Birla Industrial & Technological Museum, NCSM, Govt. of West Bengal (2001).

12. 'National Post-Doctoral Fellowship (N-PDF)'

Science and Engineering Research Board (SERB), DST, Govt. of India; Reference No. PDF/2016/003799, Dt. 13-01-2017.

13. EMSI Financial Support

to participate in IUCr Congress-2017, August 21-28, 2017 organized by International Union of Crystallography (IUCr) at Hyderabad, India.

14. Lectureship (LS) in Chemical Science – in National Eligibility Test (NET) 2012, conducted by Council of Scientific and Industrial Research (CSIR)-University Grants Commission (UGC), Govt. of India.

15. Graduate Aptitude Test for Engineering 'GATE-2013' (Chemistry) exam qualified, conducted by Indian Institute of Technology (IIT), India.

16. 'Best Citizens of India Award'

Best Citizen Publishing House, New Delhi, India; June 2017.

17. 'Certificate of Excellence in Reviewing'

Physical Science International Journal, SCIENCEDOMAIN INTERNATIONAL, Certificate No. SDI/HQ/PR/Cert/34113/MRI; 2017.

18. 'Rashtriya Gaurav Award',

India International Friendship Society (IIFS), New Delhi, India, 3rd April 2017.

Contributed Lecture/Talk in Conference:

1. *Mrinmoy Garai*, "ZrO₂ –Controlled Crystallization and Microstructure in SiO₂-MgO-Al₂O₃-K₂O-B₂O₃-F Glass: SOFC Sealing Application"; HEAM Scientist-2017 organized by the Indian Association for Hydrogen Energy and Advanced Materials (IAHEAM) at University of Kerala, Trivandram, 16-17 March 2017 (Oral Talk).
2. *Mrinmoy Garai*, Pranesh Sengupta, "CaO-Al₂O₃-SiO₂ based Glasses: Impact towards Sustainable Development and Future"; Humboldt Kolleg-2017 on Earth and Materials Science for Sustainable Societal Developments, organized by Alexander von Humboldt Foundation at Jadavpur University, Kolkata, January 13-15, 2017; Abstract Volume 000-999, pp. 24-25, ISBN-978-93-82549-29-1.

3. **Mrinmoy Garai**, “Controlled Crystallization of SiO₂-MgO-Al₂O₃-B₂O₃-K₂O-F Glass by CeO₂, TiO₂ and ZrO₂ Additives” **103rd Indian Science Congress (ISC-2016)**, University of Mysore, Mysore (India), 3-7 January, 2016 (Young Scientist Oral Presentation).
4. **Mrinmoy Garai**, Basudeb Karmakar, “Effect of CeO₂, Nd₂O₃, Sm₂O₃ and Gd₂O₃ on Crystallization and Microstructure of K-Mg-B-Al-Si-F Based Glasses” **103rd Indian Science Congress (ISC-2016)**, University of Mysore, Mysore (India), 3-7 January, 2016 (Contributory Oral Presentation).
5. **Mrinmoy Garai**, Basudeb Karmakar, “Enhanced Thermal Expansion in Interlocked Microstructure Containing Mica Glass-ceramic: Advances for SOFC Sealing Application”, **National Seminar on Nanoscience and Nanotechnology (NSNN-2015)**, organized by Haldia Institute of Technology, Haldia, West Bengal, 9-10 October, 2015 (Contributory Lecture).
6. **Mrinmoy Garai**, “Interlocking of Microstructure in Machinable Mica Glass-ceramic: Novel Fascia for SOFC Sealing Application”, **Research Scholars’ Day (4th Annual Workshop)**, CSIR-Central Glass & Ceramic Research Institute, Kolkata (India), 18 September, 2015 (Oral Presentation).
7. **Mrinmoy Garai**, Basudeb Karmakar, “Effects of Rare Earth on thermal and Mechanical Properties of Mica Glass-ceramics in SiO₂-MgO-Al₂O₃-K₂O-B₂O₃-F System”, **Indian Innovations in Materials Research: New Materials and Process (IIMR-15)**, organized by Indian Association for Productivity, Quality and Reliability (IAPQR) at CSIR-Central Glass & Ceramic Research Institute, Kolkata, 25-27 June, 2015 (Oral Presentation).
8. **Mrinmoy Garai**, “Ex-situ vs. In-situ Generated Silver & Gold Nanometal in SiO₂-MgO-Al₂O₃-B₂O₃-K₂O-MgF₂ Glass: Impact on Thermal and Mechanical Properties” **102nd Indian Science Congress (ISC-2015)**, University of Mumbai, Mumbai (India), 3-7 Jan, 2015 (Young Scientist Oral Presentation).
9. **Mrinmoy Garai**, Basudeb Karmakar, “Influence of M²⁺/ K⁺ Substitution (M = Ca, Sr and Ba) On Crystallization and Microstructural Properties of Boroaluminosilicate Glasses: Impact on SOFC Sealing Application,” **International Conference on Emerging Materials: Characterization & Application (EMCA-2014)**, CSIR-Central Glass & Ceramic Research Institute and National Institute of Technology (NIT), Durgapur, West Bengal, (India), 4-6 December, 2014 (Contributory Lecture).
10. **Mrinmoy Garai**, Nibedita Sasmal, Basudeb Karmakar, “Structural Effects of Zn²⁺/Mg²⁺ Ratios on Crystallization Characteristics and Microstructure of SiO₂-MgO-Al₂O₃-B₂O₃-K₂O-MgF₂ Glasses and Glass-Ceramics”, **National Conference on Recent Trends in Chemical and Allied Industries: Engineering, Economics & Environment**, organized by Indian Institute of Chemical Engineers (IICChE), Calcutta Regional Centre at Jadavpur University, Kolkata (India), 28 – 29 June, 2014 (Contributory Oral Presentation).

Membership & Other activities

- Reviewer: Asian Journal of Materials Chemistry, ASIAN PUBLICATION CORPORATION.
- Reviewer: Physical Science International Journal, SCIENCEDOMAIN international.
- Life Member- Indian Science Congress Association (ISCA), Kolkata, India (Membership No. L32598).
- Life Member- Indian Association for Hydrogen Energy and Advanced Materials (IAHEAM), Kerala, India.
- Life Member– Electron Microscopy Society of India (EMSI), India (Membership No. LM1281).
- Life Member– Materials Research Society of India (MRSI), India (Membership No. LMB2797).
- Life Member- Indian Ceramic Society, Kolkata, India (Membership No. EL691).
- Member of National Service Scheme (NSS), Ministry of Youth Affairs & Sports, Govt. of India.
- Member - Red Ribbon Club (A Youth Flagship on Campus College & University Students Programme of NACO), WBSAP & CS, West Bengal Voluntary Blood Donors’ Forum, NACO, Govt. of India.
- Member (Ex) of the Canteen Committee, CSIR-Central Glass and Ceramic Research Institute, Govt. of India.
- Active member in the organizing committee of three national and one international conference at CGCRI, Kolkata.
- Participated two times (2011 & 2013) for outdoor Volleyball play (National level inter CSIR institutes India) in CSIR-Santi Swarup Bhatnagar Memorial Tournament (SSBMT), CSIR, Govt. of India.
- Indian Union Driving License holder of 2-wheeler (Licence No. WB-4120130208194, Valid till 24/07/2033) and 4-wheeler (Licence No. WB-0120120957791, Valid till 12/12/2032) vehicles, National permit, Govt. of West Bengal, India.