

Bankim Chandra Ray | Curriculum Vitae

Location: Rourkela, India

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R^G Scopus[®]

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Present Positions

Senior Professor (Higher Administrative Grade)	Metallurgical & Materials Engineering Department, National Institute of Technology, Rourkela, Odisha-769008 INDIA.
Technical Advisor	Tata Steel (New Materials Business)
Editor	Transactions of the Indian Institute of Metals – Springer

Bio Sketch

Dr. Bankim Chandra Ray is a Professor of the Department of Metallurgical and Materials Engineering at National Institute of Technology, Rourkela, India. Prof. Ray's research centers on the impact of extreme environmental conditions in FRP composites. He is at present pursuing the mechanistic origin of environmental damage phenomena of the engineered FRP materials. He has also worked on non-destructive evaluation of FRP materials during his academic visit to UK University. Professor Ray intends to further his expertise in the field of polymer nanocomposites. He and his group have started an investigation on the effect of ultra-low temperatures on synthesis of nanoparticles by sono-electro-chemical principle. He has also worked on solidification behaviour and structure-property relationship of especially Al-Si alloys. He is also investigating micro-examinations of interfaces and its implications on nano-composites in metal matrix systems. He has an experience on computer modeling of phase transformation of ferrous materials. His recent investigations have emphasized the role of carbon nanotube on the low temperature performance of FRP nano-composites. Dr. Ray has recently been selected by UNESCO based on Science Citation Index. He is the authored around 160 scientific papers out of which 127 in International Journals and regular reviewer of many high impact Journals of Composites and Materials Science areas. Prof. Ray's research has been funded by different governmental agencies. Further, he has more than 33 years of teaching experience in one of the premier institutes of India.

Currently he is the Technical Advisor to the TATA Steel New Materials Business and the editor of Transactions of the Indian Institute of Metals (TIIM) - Springer. He is also mentoring as a Coordinator of multi-crores integrated Research and Development proposal for the setting-up of Steel Technology Centre at National Institute of Technology, Rourkela

Education

Ph.D.	Indian Institute of Technology, Kharagpur, India (1993)
M. Tech	Indian Institute of Technology, Kharagpur, India (1988)
B. Tech	Jadavpur University, Calcutta, India (1986)

Areas of Specialization

- FRP Composites,
- Mechanical Behaviour, Heat Treatments,
- Phase Transformations, Thin films,
- Metal Joining and Nano Science and Technology

Patents

Ramesh Ch. Sahu, Dr. Raj Kishore Patel and Dr. Bankim Chandra Ray, Process for extraction of fine iron from red mud, Grant date 12/02/2013, Indian Patent no. 255321. <http://www.allindianpatents.com/patents/255321>

Scholarships

- Government of India Merit Scholarship
- Steel Authority of India Merit Scholarship (Dr. B.C. Roy Scholarship)
- Overseas Development Agency (ODA) Fellowship (UK)

Past Positions

30 years Teaching and Research experience as a faculty in the Department of Metallurgical and Materials Engineering at National Institute of Technology (Deemed University), Rourkela, India.

1. Dean (Faculty Welfare) (July 2017- June 2019)
2. PIC-Examination (July 2014 - June 2017)
3. Head of the Department (July 2011- June 2014)
4. Professor HAG (February 2019 to till date)
5. Professor (July 2006 to January 2019)
6. Assistant Professor (June 2002 to June 2006)
7. Senior Lecturer (February 1995 to May 2002)
8. Lecturer (June 1989 to January 1995)

Overseas Experience

- One-week academic programme in Paris, France 2018.
- One-week academic programme in Instron USA 2013.
- One-week academic programme in Singapore 2011.
- One-week academic assignment to New Zealand (University of Auckland) 2011.
- One-week academic exposure to Mauritius (University of Mauritius), 2010.
- One-week Training Programme in Shimdzu, Singapore. 2007.
- 6-months Research and Training experience at Sheffield Hallam University, UK (1997).

Recognition and Achievements

1. Appointed as the editor of Transactions of the Indian Institute of Metals (TIIM) Journal.
2. Listed in the world's top 2 % scientists, consecutively for two years (2020,2021) in a list prepared by the researchers of Stanford University.
3. Coordinator of two-Day Workshop on FRP Composites: An Introduction from Definition to Development” A Customized Short-Term Course for TATA Steel Ltd. (New Materials Business) (2018), 17 – 18 May 2018 at The Bengal Club, Kolkata. Also, delivered lectures on FRP Composites: Joining, Repair, Recycle and Environmental issues.
4. Delivered a talk on “Technical and Tangible Benefits of Fiber Reinforced Polymer composites” at Indian Ceramic Society, Annual Day, 17th April 2018.
5. Delivered keynote lecture on” Environmental Durability of FRP Composites” at National Seminar on Composites: Metals and Polymers organized by NIST Berhampur on 1st August 2015.
6. Delivered a series of lectures on Environmental Degradation of Composites and mechanical Behaviour and Damage Assessment of FRP Composites at Indian Railways’ Institute of Mechanical and Electrical Engineering, Jamalpur on 11/03.10.
7. Delivered an invited talk on “Characterization of Interfacial Chemistry and an Assessment of Failure Behaviour of FRP Composites” in National Seminar on Deformation, Wear and Fracture-2010 (24-25 March 2010) at Jadavpur University, Kolkata.
8. Delivered few invited talks in the following areas at Jadavpur University in School of Materials Science and Nanotechnology (8th December 2008);
 - Implication of Environmental and Experimental Variations on Composite Materials.

- Modern Trends in Fiber/Polymer Interface Characterization and A Brief of Polymer Nanocomposites
- 9. Conducted a workshop on “Mechanical Behaviour of Engineering Materials” at New Delhi and Mumbai organized by International Business Conferences (13-14 October 2008, New Delhi and 15-16 Oct., 2008, Mumbai).
- 10. Delivered an invited technical talk on “FRP composites: Present status and future prospect” in Metallurgical Alumni Industry Academia-2007 at Jadavpur University, Kolkata (11th September, 2007).
- 11. Effects of thermal spikes and thermal shocks on hygrothermal behaviour of GFRP composites: Guide of The BEST B.Tech PROJECT of the INSTITUTE- 2004.
- 12. Delivered a talk on “Environmental Degradation of FRP Composites” in the Department of Materials at Oxford University, UK (10th June 1997).
- 13. Selected by UNESCO and Australian Expert Committee for Industries in the Asia- Pacific region based on Science Citation Index.
- 14. Three Journal articles were included in the Faraday Technology Alerts as new and innovative research.
- 15. Co-convenor and Chairman of different National level technical Conferences

Memberships

- Indian Institute of Metals (No: 23629)-1996.
- The Institute of Engineers (India) (No: 119439)-1995.
- The Indian Institute of Chemical Engineers (No: 17738)-1998.
- The Computer Society of India (No: 00080956)-2002.
- The Indian Society of Technical Education (No: 27572)-1999.

Distinguished Chairs

- Chairman of National Education Policy (2020) at NIT Rourkela
- Expert committee member of UPSC, New Delhi.
- Faulty selection committee members of NITs.
- Technical project review committee of Government of Switzerland.
- An empowered board expert of DST, GOI, New Delhi.
- An expert of CSIR project review committee.

Professional Service

- Journal of Advanced Research in Manufacturing, Material Science & Metallurgical Engineering (Editor in chief)
- Journal of Materials and Metallurgical Engineering
- The scientific world Journals (Materials Science)
- Journal of polymer and composites
- Advisory Board member of STM Journals
- Advisory Board member of ADR Journals

Regular Reviewer

- Scientific Reports (Nature)
- Composites (Elsevier)
- Journal of Applied Polymer Science (Wiley)
- Journal of Composite Materials (Sage)
- Journal of Materials Science (Springer)
- Composites Science and Technology (Elsevier)
- Polymer Bulletin (Springer)
- Chemical Engineering Journal (Elsevier)
- Carbon (Elsevier)
- Journal of Adhesion Science and Technology (Elsevier)
- Tata Search

- Bulleting of Materials Science (Springer)
- Journal of Reinforced Plastics and Composites (Sage)
- Journal of Hazardous Materials (Elsevier)
- Metallurgical and Materials Transaction A (Springer)
- Material Science and Engineering A (Elsevier)
- Polymer composites (Wiley)
- Water, Air and Soil pollution Springer)
- Tribology - Materials, Surfaces & Interfaces (Maney)

Sponsored Projects

1. Development of effective technical solutions for recycling of industrial FRP wastes and end-of-life FRP components, TATA Steel, 2022
2. Moisture uptake kinetics and its subsequent effect on mechanical performance of nano- phased fibrous polymeric composites. CSIR, 2017.
3. Effect of Hygrothermal conditioning and cycling on CNT embedded GFRP composite: A Study on marine environment durability", NRB, DRDO, 2016.
4. The effect of shock wave, moisture and sea water on de-bonding of multilayer in FRP composite systems- Experimental and multi-scale modelling based investigation, NRB, DRDO, 2015.
5. A 1.75 crore INR project under Fund for Improvement of Science & Technology Infrastructure in Universities and Higher Educational Institutions (FIST) Program-2014 from Department of Science & Technology (DST), Ministry of Science & Technology, Government of India.
6. Prodding the magnetic behaviour of sono-electroplated nano-structured Co/Cu and Ni/Cu alloy thin films by scanning probes, CSIR, 2013.
7. Analysis and manipulation of structures and properties of sono- electrochemically deposited nano-structured metallic thin films synthesized at low bath temperatures, DST.
9. Failure assessment of FRP composite materials at low and high temperatures under different loading speeds, CSIR (2596/NS-EMR II) 2012.
10. Characterization of interfacial chemistry and integrity of fiber/polymer composites at different loading rates and temperatures: An emphasis on failure modes, DST (Submitted SR/S3/ME/0020/2010).
8. Utilization of materials after extraction from red mud, Vedanta Aluminum 2010.
9. Pilot plant study of extraction of fine iron from red mud, Vedanta Aluminum 2010.
10. Parametric Instability of woven fiber composite panels, DST, 2008.
11. Inerting red-mud through cost-effective methods and its utilization, CSIR. 2007,
12. Preparation and characterization of SiO₂ and TiO₂ hollow nanospheres in reverse micro emulsion system, DST (NSTI), 2007.
13. Thermal shocks on polymerization and de-polymerization of polymer composites (Completed) Ministry of Human Resources and Development, Government of India. 2004.
14. Effects of mixed mode overload on mode-I fatigue crack (Completed) Council of Scientific and Industrial Research, Government of India, 2004.
15. Study of wear behaviour of firm implements in soil slurry and its control, MHRD, Government of India (Completed) 2002.

Consultancy Work

1. Quality upgradation and unprecedented failure analysis of FRP composite products, especially pipelines and pressure vessels, TATA Steel (2020 -2022)
2. Development of honeycomb structure for Railway application and related FRP application in mobility sectors. TATA Steel (2022-2023)
3. Internal Advisory Board Member Project - Development of biocompatible glass fiber composite for healthcare application - Ministry of Textile, Government of India under the national technical textile mission.
4. A study of FRP (focus on Carbon, Glass, and polymer fibre reinforcements) composites for structural applications in modern India: Feasibilities and opportunities, TATA-INAE, 2016

5. Assessment of Mechanical behavior of CFRP and GFRP at different hygrothermal environments, DRDO, ADE, 2012.
6. Product upgradation and quality control of tooth points J K Steels, Asansol.
7. Development and upgradation of steel shots, Utkal ferro Alloys, Rourkela.
8. Time to time sharing of knowledge to Rourkela Steel Plant.

Teaching

Undergraduate

- Phase Transformations of Materials
- Physical Metallurgy of Ferrous and Non-ferrous Alloys
- Heat treatments and Phase Transformations
- Metal Joining and Powder Metallurgy
- Composite Materials

Post Graduate

- Mechanical Behavior of Materials
- Experimental Techniques
- Dislocation Theory
- Phase Transformations and Heat Treatments
- Metal Joining and Powder Metallurgy

Books/Book Chapters Authored

1. **B C Ray**, R K Prusty, D K Rathore, "Micro and Nanophased Polymeric Composites: Durability Assessment in Engineering Applications", Elsevier-Woodhead, ISBN 9780128189559 June 2021 Forthcoming
2. **B C Ray**, R K Prusty, D Nayak, Phase transformations and heat treatments of steels, CRC Press, Taylor & Francis Group, FL USA. ISBN 9780367028688, June 24, 2020.
3. S Pal, B C Ray, "Molecular Dynamics Simulation of Nanostructured Materials: An Understanding of Mechanical Behavior", CRC Press, Taylor & Francis Group, FL USA. ISBN 9780367029821, May 13, 2020.
4. R K Nayak, **B C Ray**, D Rout, K K Mahato, Hydrothermal Behavior of Fiber-reinforced Polymer Nanocomposites, CRC Press, Taylor & Francis Group ISBN 9780367254421, April 23, 2020.
5. **B C Ray**, R K Prusty, D K Rathore, (2018), Fibrous Polymeric Composites: Environmental Degradation and Damage, 2018, CRC Press, Taylor & Francis Group, 2017, ISBN 9780429013959.
6. Kishore Kumar Mahato, Pavan Kumar Gangineni, Krishna Dutta and **Bankim Chandra Ray**, New materials in civil engineering (Elsevier), June 2020 Forthcoming.
7. **B C Ray**, S Sethi, Mechanical Behavior of Polymer Composites at Cryogenic Temperatures. In: Polymers at Cryogenic Temperatures, edited by Shusheel Kalia, Shao-Yun Fu, Springer Berlin Heidelberg, Germany 2013, Print ISBN 978-3-642- 35334-5.
8. N Sharma, S N Alam, **B C Ray** (2018), Spark Plasma Sintering of Materials, Advances in Processing and Applications; Process Fundamentals; Fundamentals of Spark Plasma Sintering (SPS): An Ideal Processing Technique for Fabrication of Metal Matrix Nanocomposites, Pages-21-59 Springer Nature Publishers, New York, USA.
9. Ramesh Kumar Nayak, Kishore Kumar Mahato and **Bankim Chandra Ray**, Processing of polymer-based nanocomposites, Wiley-VCH, Germany, which is part of the Wiley publishing group, USA.
10. N Sharma, S N Alam, **B C Ray** (2018), "Development of ceramic nanocomposites using Carbonaceous Nanofillers like Graphene and Carbon nanotubes for tribological applications" in Properties and Applications of Polymer Nanocomposites, Part B: Ceramic Based Polymer Nanocomposites, Springer, New York, USA.

Journal Publications

1. Shubham, Chandra Sekher Yerramalli, Chinmay Sumant, Rajesh Kumar Prusty, and Bankim Chandra Ray. "Finite element modelling and experimentation of plain weave glass/epoxy composites under high strain-rate compression loading for estimation of Johnson-Cook model parameters." *International Journal of Impact Engineering* 167 (2022): 104262.
2. Shubham, Rajesh Kumar Prusty, and Bankim Chandra Ray. "In-Situ Elevated Temperature Interlaminar Shear Response and Thermal Behavior of Graphene Nanoplatelet Reinforced Kevlar/Epoxy Laminated Composites." *Polymer Science, Series B* (2022): 1-14.
3. Shubham, Rajesh Kumar Prusty, and Bankim Chandra Ray. "High Strain-Rate Through-Thickness Compression Testing of Symmetrical Inter-ply Hybrid Polymer Composites Reinforced with Carbon/Glass and Carbon/Kevlar Fibers." *Transactions of the Indian Institute of Metals* (2022): 1-10.
4. Shubham, Chandra Sekher Yerramalli, Rajesh Kumar Prusty, and Bankim Chandra Ray. "Through-Thickness High Strain Rate Compressive Response of Glass/Epoxy-Laminated Composites Embedded with Randomly Oriented Discontinuous Carbon Fibers." In *Advances in Structural Integrity*, pp. 103-111. Springer, Singapore, 2022.
5. Shubham, Amrit Jena, Rajesh Kumar Prusty, and Bankim Chandra Ray. "Thermal behaviour and Vickers indentation response of random discontinuous Carbon/Epoxy composites with Nano-Alumina fillers." *Materials Today: Proceedings* (2022).
6. Pavan Kumar Gangineni, BNVS Ganesh Gupta K, Satyaroop Patnaik, Rajesh Kumar Prusty, and Bankim Chandra Ray. "Recent advancements in interface engineering of carbon fiber reinforced polymer composites and their durability studies at different service temperatures." *Polymer Composites* (2022).
7. Pavan Kumar Gangineni, Soumya Sumit Dash, B. N. V. S. Ganesh Gupta K, Rajesh Kumar Prusty, and Bankim Chandra Ray. "Effect of Post-Cathodic EPD Acetone Washing of Carbon Fibres on the Mechanical Properties of Graphene Carboxyl Embedded CFRP Composites." *Transactions of the Indian Institute of Metals* (2022): 1-7.
8. Shubham Ramesh Rao Maske, Rajesh Kumar Prusty, and Bankim Chandra Ray. "Effect of MWCNT/Nanosilica reinforcement on the mechanical and thermal behaviour of polymer composite." *Materials Today: Proceedings* (2022).
9. Nidhi Sharma, Tuhina Saxena, Syed Nasimul Alam, Bankim Chandra Ray, Krishanu Biswas, and Shikhar Krishn Jha. "Ceramic-Based Nanocomposites: A Perspective from Carbonaceous Nanofillers." *Materials Today Communications* (2022): 103764.
10. R. N. Kar, A. O. Fulmali, R. K. Prusty, and B. C. Ray. "Effect of in-situ temperature and loading rate on the out-of-plane performance of carbon nanofiber embedded glass fiber/epoxy composite." *Materials Today: Proceedings* (2022).
11. Abhinav Omprakash Fulmali, B. Arnimesh Nayak, Srinivasu Dasari, Rajesh Kumar Prusty, and Bankim Chandra Ray. "Effect of 1D carbon nano-tube and fiber reinforcement on the long-term creep performance of glass fiber/epoxy composite using the time-temperature superposition principle." *Materials Today: Proceedings* 47 (2021): 3263-3268.
12. Srinivasu Dasari, Shiny Lohani, Soumya Sumit Dash, Abhinav Omprakash Fulmali, Rajesh Kumar Prusty, and Bankim Chandra Ray. "A novel study of flexural behavior of short glass fibers as secondary reinforcements in GFRP composite." *Materials Today: Proceedings* 47 (2021): 3370-3374.
13. Shiny Lohani, Srinivasu Dasari, Soumya Sumit Dash, Rajesh Kumar Prusty, and Bankim Chandra Ray. "An Assessment of Wettability of Glass/Epoxy Composites Modified with CNT and MLG." In *Processing and Characterization of Materials*, pp. 147-155. Springer, Singapore, 2021.
14. Supreet Mohanty, Shubham, Rajesh Kumar Prusty, and Bankim Chandra Ray. "Investigation of Elastic Properties of Rutile Titanium Dioxide from First Principles." In *Processing and Characterization of Materials*, pp. 203-210. Springer, Singapore, 2021.
15. Pavan Kumar Gangineni, Satyaroop Patnaik, BNVS Ganesh Gupta K, Rajesh Kumar Prusty, and Bankim Chandra Ray. "Interfacial behavior of graphene carboxyl-grafted carbon fiber reinforced polymer

composites at elevated temperatures: Emphasis on the effect of electrophoretic deposition time." *Polymer Composites* 42, no. 11 (2021): 5893-5903.

16. Gangineni Pavan Kumar, Satyaroop Patnaik, Rajesh Kumar Prusty, and Bankim Chandra Ray. "Mechanical behavior of electrophoretically modified CFRP composites at elevated temperatures: An assessment of the influence of graphene carboxyl bath concentration." *Journal of Applied Polymer Science* 138, no. 46 (2021): 51365.
17. Sharma, Nidhi, and Bankim Chandra Ray. "Carbon Nanotube Composites: Critical Issues." In *Handbook of Carbon Nanotubes*, pp. 1-30. Cham: Springer International Publishing, 2021.
18. B.N.V.S.Ganesh Gupta K, Bhaskar Sen, Mritunjay Maharudrayya Hiremath, Rajesh Kumar Prusty, and Bankim Chandra Ray. "Enhanced creep resistance of GFRP composites through interpenetrating polymer network." *International Journal of Mechanical Sciences* 212 (2021): 106728.
19. B.N.V.S. Ganesh Gupta K, Kishore Kumar Mahato, Rajesh Kumar Prusty, Bankim Chandra Ray. "Challenges of Adhesively Bonded Joints and Their Advantages over Mechanical Fastening." In *Failure of Fibre-Reinforced Polymer Composites*, pp. 53-79. CRC Press, 2021.
20. Sujasha Gupta, and Bankim Chandra Ray. "Self-Healing and Shape Memory Effects of Carbon Nanotube Based Polymer Composites." In *Handbook of Carbon Nanotubes*, pp. 1-34. Cham: Springer International Publishing, 2021.
21. Shubham, Chandra Sekher Yerramalli, Chinmay Sumant, Rajesh Kumar Prusty, and Bankim Chandra Ray. "Finite element modelling and experimentation of plain weave glass/epoxy composites under high strain-rate compression loading for estimation of Johnson-Cook model parameters." *International Journal of Impact Engineering* 167 (2022): 104262.
22. Shubham, Rajesh Kumar Prusty, and Bankim Chandra Ray. "In-Situ Elevated Temperature Interlaminar Shear Response and Thermal Behavior of Graphene Nanoplatelet Reinforced Kevlar/Epoxy Laminated Composites." *Polymer Science, Series B* (2022): 1-14.
23. Shubham, Rajesh Kumar Prusty, and Bankim Chandra Ray. "High Strain-Rate Through-Thickness Compression Testing of Symmetrical Inter-ply Hybrid Polymer Composites Reinforced with Carbon/Glass and Carbon/Kevlar Fibers." *Transactions of the Indian Institute of Metals* (2022): 1-10.
24. Shubham, Chandra Sekher Yerramalli, Rajesh Kumar Prusty, and Bankim Chandra Ray. "Through-Thickness High Strain Rate Compressive Response of Glass/Epoxy-Laminated Composites Embedded with Randomly Oriented Discontinuous Carbon Fibers." In *Advances in Structural Integrity*, pp. 103-111. Springer, Singapore, 2022.
25. Shubham, Amrit Jena, Rajesh Kumar Prusty, and Bankim Chandra Ray. "Thermal behaviour and Vickers indentation response of random discontinuous Carbon/Epoxy composites with Nano-Alumina fillers." *Materials Today: Proceedings* (2022).
26. Pavan Kumar Gangineni, BNVS Ganesh Gupta K, Satyaroop Patnaik, Rajesh Kumar Prusty, and Bankim Chandra Ray. "Recent advancements in interface engineering of carbon fiber reinforced polymer composites and their durability studies at different service temperatures." *Polymer Composites* (2022).
27. Pavan Kumar Gangineni, Soumya Sumit Dash, B. N. V. S. Ganesh Gupta K, Rajesh Kumar Prusty, and Bankim Chandra Ray. "Effect of Post-Cathodic EPD Acetone Washing of Carbon Fibres on the Mechanical Properties of Graphene Carboxyl Embedded CFRP Composites." *Transactions of the Indian Institute of Metals* (2022): 1-7.
28. Shubham Ramesh Rao Maske, Rajesh Kumar Prusty, and Bankim Chandra Ray. "Effect of MWCNT/Nanosilica reinforcement on the mechanical and thermal behaviour of polymer composite." *Materials Today: Proceedings* (2022).
29. Nidhi Sharma, Tuhina Saxena, Syed Nasimul Alam, Bankim Chandra Ray, Krishanu Biswas, and Shikhar Krishn Jha. "Ceramic-Based Nanocomposites: A Perspective from Carbonaceous Nanofillers." *Materials Today Communications* (2022): 103764.

30. R. N. Kar, A. O. Fulmali, R. K. Prusty, and B. C. Ray. "Effect of in-situ temperature and loading rate on the out-of-plane performance of carbon nanofiber embedded glass fiber/epoxy composite." *Materials Today: Proceedings* (2022).
31. Abhinav Omprakash Fulmali, B. Arnimesh Nayak, Srinivasu Dasari, Rajesh Kumar Prusty, and Bankim Chandra Ray. "Effect of 1D carbon nano-tube and fiber reinforcement on the long-term creep performance of glass fiber/epoxy composite using the time-temperature superposition principle." *Materials Today: Proceedings* 47 (2021): 3263-3268.
32. Srinivasu Dasari, Shiny Lohani, Soumya Sumit Dash, Abhinav Omprakash Fulmali, Rajesh Kumar Prusty, and Bankim Chandra Ray. "A novel study of flexural behavior of short glass fibers as secondary reinforcements in GFRP composite." *Materials Today: Proceedings* 47 (2021): 3370-3374.
33. Shiny Lohani, Srinivasu Dasari, Soumya Sumit Dash, Rajesh Kumar Prusty, and Bankim Chandra Ray. "An Assessment of Wettability of Glass/Epoxy Composites Modified with CNT and MLG." In *Processing and Characterization of Materials*, pp. 147-155. Springer, Singapore, 2021.
34. Supreet Mohanty, Shubham, Rajesh Kumar Prusty, and Bankim Chandra Ray. "Investigation of Elastic Properties of Rutile Titanium Dioxide from First Principles." In *Processing and Characterization of Materials*, pp. 203-210. Springer, Singapore, 2021.
35. Pavan Kumar Gangineni, Satyaroop Patnaik, BNVS Ganesh Gupta K, Rajesh Kumar Prusty, and Bankim Chandra Ray. "Interfacial behavior of graphene carboxyl-grafted carbon fiber reinforced polymer composites at elevated temperatures: Emphasis on the effect of electrophoretic deposition time." *Polymer Composites* 42, no. 11 (2021): 5893-5903.
36. Gangineni Pavan Kumar, Satyaroop Patnaik, Rajesh Kumar Prusty, and Bankim Chandra Ray. "Mechanical behavior of electrophoretically modified CFRP composites at elevated temperatures: An assessment of the influence of graphene carboxyl bath concentration." *Journal of Applied Polymer Science* 138, no. 46 (2021): 51365.
37. Sharma, Nidhi, and Bankim Chandra Ray. "Carbon Nanotube Composites: Critical Issues." In *Handbook of Carbon Nanotubes*, pp. 1-30. Cham: Springer International Publishing, 2021.
38. B.N.V.S.Ganesh Gupta K, Bhaskar Sen, Mritunjay Maharudrayya Hiremath, Rajesh Kumar Prusty, and Bankim Chandra Ray. "Enhanced creep resistance of GFRP composites through interpenetrating polymer network." *International Journal of Mechanical Sciences* 212 (2021): 106728.
39. B. N. V. S. Ganesh Gupta K, Kishore Kumar Mahato, Rajesh Kumar Prusty, Bankim Chandra Ray. "Challenges of Adhesively Bonded Joints and Their Advantages over Mechanical Fastening." In *Failure of Fibre-Reinforced Polymer Composites*, pp. 53-79. CRC Press, 2021.
40. Sujasha Gupta, and Bankim Chandra Ray. "Self-Healing and Shape Memory Effects of Carbon Nanotube Based Polymer Composites." In *Handbook of Carbon Nanotubes*, pp. 1-34. Cham: Springer International Publishing, 2021.
41. Soubhik De, Abhinav Omprakash Fulmali, Krishna Chaitanya Nuli, Rajesh Kumar Prusty, B Gangadhara Prusty, Bankim Chandra Ray "Improving delamination resistance of carbon fiber reinforced polymeric composite by interface engineering using carbonaceous nanofillers through electrophoretic deposition: An assessment at different in-service temperatures." *Journal of Applied Polymer Science* 138.15 (2021): 50208.
42. Gupta, S, Prusty, R. K., Ray, B. C., & Pal, S. (2021). Strength degradation and fractographic analysis of carbon fiber reinforced polymer composite laminates with square/circular hole using scanning electron microscope micrographs. *Journal of Applied Polymer Science*, 138(8), 49878.
43. Gupta, B. N. V. S., Ganesh, K., Hiremath, M. M., Ray, B. C., & Prusty, R. K. (2021). Improved mechanical responses of GFRP composites with epoxy-vinyl ester interpenetrating polymer network. *POLYMER TESTING*, 93, 107008
44. Yandrapu, S., Gangineni, P. K., Ramamoorthy, S. K., Ray, B. C., & Prusty, R. K. (2020). Effects of electrophoretic deposition process parameters on the mechanical properties of graphene carboxyl-grafted carbon fiber reinforced polymer composite. *Journal of Applied Polymer Science*, 137(31), 48925.

45. Ganesh Gupta K, B. N. V. S., Hiremath, M. M., Prusty, R. K., & Ray, B. C. (2020). Development of advanced fiber-reinforced polymer composites by polymer hybridization technique: Emphasis on cure kinetics, mechanical, and thermomechanical performance. *Journal of Applied Polymer Science*, 137(43), 49318.
46. Kattaguri, R., Fulmali, A. O., Prusty, R. K., & Ray, B. C. (2020). Effects of acid, alkaline, and seawater aging on the mechanical and thermomechanical properties of glass fiber/epoxy composites filled with carbon nanofibers. *Journal of Applied Polymer Science*, 137(10), 48434.
47. Abhinav O. Fulmali, Bhaskar Sen, Bankim C. Ray, Rajesh K. Prusty" Effects of carbon nanotube/polymer interfacial bonding on the long-term creep performance of nanophased glass fiber/epoxy composites" *Polymer COMPOSITES* (2019).
48. P K Gangineni, S Yandrapu, S K Ghosh, A Anand, R K Prusty, BC Ray, Mechanical behavior of Graphene decorated carbon fiber reinforced polymer composites: An assessment of the influence of functional groups, *Composites Part A: Applied Science and Manufacturing* 122, 36-44, (2019).
49. K Dash, S Gupta, B C Ray, Analysis of Properties of Copper-Alumina Composites Produced by Various Processing Routes: A Review, *Journal of Material & Metallurgical Engineering* 2 (1-3), 30-42(2019).
50. S.S.R. Nomula, D.K. Rathore, B.C. Ray, R.K. Prusty, Creep performance of CNT reinforced glass fiber/epoxy composites: Roles of temperature and stress, *J. Appl. Polym. Sci.* 136 (2019) 47674.
51. K. K. Mahato, K. Dutta, B. C. Ray, Assessment of mechanical, thermal and morphological behavior of nano-Al₂O₃ embedded glass fiber/epoxy composites at in-situ elevated temperatures, (2019) *Composites Part B: Engineering*, 166, 688-700.
52. N Sharma, S N Alam, B C Ray, S Yadav, K Biswas, Alumina–MWCNT composites: microstructural characterization and mechanical properties: *Journal of Asian ceramic society* Vol-7,(2019) <https://doi.org/10.1080/21870764.2018.1552235>
53. N Sharma, S N Alam, B C Ray, S Yadav, K Biswas, Wear behavior of silica and alumina-based nanocomposites reinforced with multi walled carbon nanotubes and graphene nanoplatelets, (2018), *Wear*, 418, 290-304.
54. A Anand, P Banerjee, D Sahoo, D K Rathore, R K Prusty, B C Ray, Effects of temperature and load on the creep performance of CNT reinforced laminated glass fiber/epoxy composites, (2019), *International Journal of Mechanical Sciences*, 150, 539-547.
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21. K. K. Mahato, K. Dutta, B. C. Ray, Mechanical and thermal behavior of nano-Al₂O₃ enhanced glass fibre reinforced polymeric composites at various crosshead speeds, 9th ACAM (Australasian congress on applied mechanics), Sydney, 27th-29th November 2017.
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23. K. K. Mahato, K. Dutta, B. C. Ray, Symbiotic Effects of Thermal Cycling and Loading Rates on the Tensile Response of Glass/Epoxy Composite 12-14 February, (ICAPM 2016), CIPET, Ahmedabad.
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42. B C Ray; Influence of aqueous medium on the interfacial strength of glass/epoxy composites, Int.
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44. B C Ray; Environmental effects on the interlaminar shear failure of FRP composites; Int. Conf. On Deformation and fracture of Composites; Manchester (U.K.).
45. B C Ray; Evaluation of interfacial adhesion of hygrothermally conditioned carbon/epoxy composites by tensile tests; TMS Annual Meeting California, (USA) March 2003 Submitted.
46. B C Ray; Thermal shock at the fiber/matrix interface: An overview, Materials Congress2004, 30th March – 1st April London (UK).
47. B C Ray; Influence of aqueous solutions on mechanical behavior of GFRP composites at room temperature and at High Temperature, 11th European Conf. On Composite Materials, 2004, May 31-June 3, Rhodes, Greece.
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49. A.O. Fulmali, R Kattaguri, K. K Mahato, R. K. Prusty and B. C. Ray, Effect of CNT addition of cure kinetics of glass fiber epoxy composite, 7th National Conference on Processing and Characterization of Materials, 8-9th December (NCPCM 2017) NIT Rourkela.
50. K. K. Mahato, A.O. Fulmali, R Kattaguri, K. Dutta, R. K. Prusty and B. C. Ray, Effect of severely thermal shocked MWCNT enhanced glass fibre reinforced polymer composite: An emphasis on tensile and thermal responses, 7th National Conference on Processing and Characterization of Materials, 8-9th December (NCPCM 2017) NIT Rourkela.
51. K. K. Mahato, D. K. Rathore, R.K. Prusty, K. Dutta and B. C. Ray, Tensile behavior of MWCNT enhanced glass fiber reinforced polymeric composites at various crosshead speeds, 6th National Conference on Processing and Characterization of Materials, (NCPCM 2016) NIT Rourkela.
52. K.K. Mahato, M. Biswal, D. K. Rathore, R.K. Prusty, K. Dutta and B.C. Ray, Effect of loading rate on tensile properties and failure behavior of glass fibre/epoxy composite, 5th National Conference on Processing and Characterization of Materials, (NCPCM 2015) NIT Rourkela.
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54. S. C. Mohanty, B. P. Singh, K. K. Mahato, D. K. Rathore, R. K. Prusty, B. C. Ray, Water absorption behavior and residual strength assessment of glass/epoxy and glass- carbon/epoxy hybrid composite, 5th National Conference on Processing and Characterization of Materials (NCPCM-2015), held at National Institute of Technology, Rourkela during 12-13 December 2015.
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60. B C Ray, A study on the mechanical performance of corrosive medium treated GRP composites, Maintenance, Inspection, Corrosion Management and Plant Reliability, MICMAP-91, Baroda, India (Feb.'91).
61. B C Ray, Environmental effects on mechanical behavior of glass fibre-epoxy composites, 5th National Convention of Aerospace Engineer and All India Seminar of New Materials in Aerospace, Chandigarh, India, (Feb.'90).
62. B C Ray; Hygrothermal effects on the degradation of GRP composites, Symposium on Advances in Materials: New Materials, TAC, Madras, India (May'90).
63. B C Ray; Variation of shear values of glass/epoxy composites in H₂SO₄ and NaCl solution; The SEM investigation, Symposium on Advances in Materials: New Materials, TAC, Madras, India, (May'90).
64. B C Ray; Hygrothermal effects on the mechanical behavior of fibre-reinforced polymeric composites, ATM, IIM, Calcutta, India, (Nov.'90).
65. B C Ray and A. Biswas; The mathematical modelling of continuous-cooling transformation, ATM, IIM, Calcutta (Nov.'89).
66. B C Ray; Influence of aqueous medium on the interfacial strength of glass/epoxy composites, Int.
67. Conf. On Deformation and fracture of composites, Guildford, U.K. (March'95).
68. B C Ray; Failure Mechanism of FRP composites: An overview; 37th Congress of the Indian Society of Theoretical and Applied Mechanics, Pantnagar, India (Jan. 14-17, 1993).
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70. B C Ray; Effect of centrifugal on the refinement of eutectic morphology for Al-9% Si alloy. ATM, IIM, Calcutta (Nov.'95).
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73. B C Ray, Thermal Stress on shear strength of glass fiber/epoxy composites, NMD- ATM-2003, Kolkata, November 2003.
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78. K K Mahato, A O Fulmali, R Kattaguri, K Dutta, R K Prusty, BC Ray, Effect of severely thermal shocked MWCNT enhanced glass fiber reinforced polymer composite: An emphasis on tensile and thermal responses, IOP Conference Series: Materials Science and Engineering (2018), 338 (1), 012057
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81. K K Mahato, M Biswal, D K Rathore, R K Prusty, K Dutta and B C Ray, Effect of loading rate on tensile properties and failure behavior of glass fibre/epoxy composite, IOP Conf. Series: Materials Science and Engineering 115, (2016), 012017.
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85. B C Ray, A Biswas & P K Sinha; On the evaluation of interlaminar shear – a critical design parameter, Proceedings on Sci. and Tech. Composites, Adhesives and Sealants, Bangalore, India (Sept.' 89) 321-325.
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87. B C Ray, A Biswas & P K Sinha; Characterization of hygrothermal diffusion parameters in fibre- reinforced polymeric composites, Proceedings on Aircraft Propulsion, Mesra, India (Jan.89) S-22.
88. B C Ray; Environmental degradation of FRP composites, International Conference on Advances in Materials and Materials Processing (February, 2002) Tata-MacGraw-hill, ND181-184.
89. Pradhan, R.N. Lal, B. Sahu, A.K. Panda and B C Ray, Degradative effect of environmental Parameters on fiber reinforced composites, CHEMCON-2003, Bhubaneswar, December-2003.
90. P.K. Mishra and B C Ray, Effect of thermal shock on interfacial behavior of glass fiber reinforced epoxy laminates, CHEMCON-2003, Bhubaneswar, December-2003.
91. P K Ray, A. Bhusan, T Bera, R Ranjan, U Mohanty, S Vadhera and B C Ray; Mechanical behavior of hygrothermally conditioned FRP composites after thermal spikes, Emerging Trends in Structural mechanics and Composites, 2003, November 1-2, NIT Rourkela 322- 332.

Ph.D. Supervision

Current Scholars

- | | |
|-------------------------|---|
| 1. Satyaroop Patnaik | FRP Composites Recycling (Continuing from July 2022) |
| 2. Shubham | Development of hybrid FRP composites for ballistic applications. (Continuing from July 2018) |
| 3. BNVS Ganesh Gupta K | Design and Development of Advanced Composite Materials for Aerospace, Marine and Superstructure Applications by Various Techniques. (Continuing from July 2018) |
| 4. A O Fulmali | Mechanical and Thermal Characterization Of Polymer Composites Through CNT alignment. (Continuing from July 2018) |
| 5. Pokula Narendra Babu | Investigation behaviour of CNT reinforced metal matrix composites. (Continuing from January 2018) |
| 6. Srinivasu Dasari | Assessment of Micro and Nano scaled FRP composites at various environment conditions. (Continuing from January 2018) |

7. Pavan Kumar G Fiber/Polymer interfacial engineering by graphene. (Continuing from January 2017)
8. Savita Gupta The effect of shock wave, moisture, and sea water on de-bonding of multilayer in FRP composite systems - Experimental and multi-scale modelling-based investigation. (Continuing from May 2016)

Previous Scholars

9. Kishore Kumar Mahato Environmental durability of multi scale glass fiber/epoxy Composites: Assessment of mechanical behavior and microstructural evaluation. (2019)
10. Nidhi Sharma Fabrication and characterization of graphene/polymer nanocomposites. (2019)
11. Rajesh Kumar Prusty Implication of CNT Fillers on Environmental Durability of GFRP Composites: An Evaluation of Microstructural Features and Mechanical Properties. (2017)
12. Dinesh K. Rathore Flexural behaviour of nano-filler enhanced and inter-ply hybrid FRP composites at different in-situ elevated temperatures. (2017)
13. Anil K.S. Bankoti Effect of combine addition Ca+Sb on microstructure and properties of AZ91D Magnesium alloy (2017)
14. Sumanta K. Sahoo Fabrication and characterization of nano-structured thin film. (2017)
15. Ramesh Kumar Nayak Assessment of Hydrothermal Durability of Nano Al₂O₃ and TiO₂ Enhanced Glass Fiber Reinforced Polymer Composite. (2016)
16. Sanghamitra Sethi A study on environmental degradation of FRP composites through interfacial and microstructural characterization. (2015)
17. Khushbu Dash Fabrication and characterization of metal matrix composites: an emphasis on micro and nano particulate reinforcement. (2014)
18. Ramesh Chandra Sahu Neutralization of red mud using CO₂ and their utilization. (2011)
19. Archana Mallik Effects of temperature and ultrasound on nucleation behavior during electrochemical synthesis of copper thin films. (2010)

Research Work

Post-doctoral Study (Topic: Advanced Composites, NDT Evaluation of FRP,

Supervisors: Prof. D W Clegg and Dr. T K Hassan, UK)

Research was carried out on Kevlar and carbon fibres reinforced polymer composites to evaluate and characterize their properties and behaviour under cryogenic temperatures and also under severe thermal shock. An effort has also been made to assess the defects of these composites by NDT techniques like thermal imaging, A-Scan and C-Scan, Ultrasonic, SEM and photo-microscopy etc.

Research at Doctoral Level (Topic: Environmental Degradation of FRP Composites,

Supervisors: Prof. A Biswas and Prof. P K Sinha, IIT, Kharagpur)

The investigation was essentially an experimental one involving glass- and carbon fiber composites. The resin used was the epoxy system. One important area of the investigation concerns with the absorption and desorption of moisture in these composites. The major emphasis was laid on evaluating the interlaminar shear strength (ILSS) of laminated composites, which is the weakest structural link and forms an important design criterion. The ILSS values were found to be highly sensitive to deterioration due to such absorbed moisture. The strain rate effects on the hygrothermally conditioned ILSS specimen has also been carried out.

The work focused in the area of effects of freezing and thermal spikes on the hygrothermally conditioned glass/epoxy composites to investigate the deleterious effect on ILSS values. An investigation was also carried out with glass/epoxy composites to find out the behaviour of ILSS values by immersing the materials in sulphuric acid and sodium chloride solution of water.

M.Tech (Topic: Computer Modelling of Transformation Kinetics),

Supervisor: Prof. A. Biswas, IIT, Kharagpur)

The kinetics of austenite-to-pearlite transformation was measured under isothermal and continuous cooling conditions on 1080 steel. The isothermal transformation kinetics was analysed in terms of Avrami Equation. The mathematical modelling was formulated to predict the progress of Austenite- to-pearlite transformation during continuous cooling. The kinetics are characterized by subdividing the cooling curve into a series of isothermal steps. The need to develop such computer model is that steel industries are rapidly adopting continuous processes includes continuous casting, continuous heat treatments to minimize process cost and to improve quality of the products. The findings revealed that there is a close proximity and a reasonably good agreement between calculated and experimental data

Continuing Education

1. Course on C++ at NIT, Rourkela (2003).
2. Art of Programming- NIT, Rourkela, India GOI, World Bank, Swiss Development Corporation (2001).
3. Educational technology-IIT, Delhi, India (1997).
4. Professional standard and quality in engineering-Sheffield Hallam University, UK (1997).
5. AGM-on Composite Materials- Nottingham University, UK (1997).
6. Workshop on educational infrastructures- Manchester Metropolitan University, UK (1997).
7. Welding technology for engineers-Sheffield Hallam University, UK (1997).
8. Alloy cast irons- Recent development and applications- IIT, Kharagpur, India (1992).
9. Recent advances in physics of amorphous materials-IIT Kharagpur, India (1992).
10. Electronic materials technology-IIT, Kharagpur, India (1991).
11. Principles and technology for processing of advanced materials-IIT, Kharagpur, India (1990).

Present Research Activities

The institute has facilities like, Instron Tensile Testing Machine, Cryogenic and other environmental chambers, UV chambers, dynamic mechanical thermal analyzer (DMTA), DSC, and SEM to carry out the work. Atomic Force Microscopy (AFM) and Fourier Transform Infrared Spectroscopy (FTIR) Imaging techniques will certainly be meaningful and effective additions to perform critical and micro-characterization of very small interactions and chemical structural gradient at the interphase of polymer composites.

The **FRP Composite Materials Research Lab** at NIT Rourkela focuses research trends in the evaluation of FRP composite materials by various techniques.

- Carbon and Graphene-based polymer composites
- Multiscale analysis of composites
- Study of Environmental degradation behavior effects on composites
- Hybrid composites
- Development of failure models and criteria for composites
- Study of Elevated and subzero temperature effects on composites
- Composite Inspection and Characterization
- Development of Lightweight structure materials
- Development of multifunctional composite materials