

RAHUL MITRA

CURRICULUM VITAE

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Birth:

May 8, 1966
Dhurwa, Ranchi
INDIA

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RESEARCH INTEREST

Basic principles governing processing - microstructure - mechanical property relationships in metal-, ceramic- and intermetallic matrix composites, mechanical behaviour of high temperature materials such as superalloys, intermetallics, and ultrahigh temperature ceramics, nano-crystalline materials, processing of thin films, microstructural and mechanical characterization methods, Electron Microscopy, high temperature oxidation.

EDUCATION

Ph.D. in Materials Science and Engineering	Northwestern University, GPA= 3.83/4 Evanston, IL60208, U.S.A.	December, 1992
B. Tech (Honours) in Metallurgical Engineering	Indian Institute of Technology, GPA= 9.11/10 Kharagpur 721 302, India.	May, 1988

RESEARCH AND WORK EXPERIENCE

Professor (HAG)	Indian Institute of Technology, Kharagpur Department of Metallurgical and Materials Engineering	Aug 15 – Present
Head	Department of Metallurgical & Materials Engineering	Apr 17 – Dec 20
Head	School of Nano-Science and Technology	Oct 16 – Dec 20
Professor	Indian Institute of Technology, Kharagpur Department of Metallurgical and Materials Engineering Teaching: Deformation Behaviour of Materials (UG), Mechanical Working of Materials (UG), Creep, Fatigue and Fracture (UG) Materials Characterization (UG) Advanced Materials and Processes (PG) Advanced Electron Microscopy and Analysis (PG) (New course developed) Deformation Behaviour of Materials (UG) (Course developed for Pedagogy) Research Scholar Coordinator (2008 – 2017) UG Course Coordinator (2009-2014)	Dec 08–Aug 15

Chairman	Materials Science Division, Central Research Facility	Dec 09 – Nov 17
Vice-Chairman	Materials Science Division, Central Research Facility	Dec 06 - Nov 09
Visiting Professor (On leave from IIT)	University of Southern California, Los Angeles Mork Family Department of Chemical Engineering And Materials Science, Research on Al alloy-B ₄ C trimodal nanocomposites	Jan 01 – May 15, 08
Associate Professor	Indian Institute of Technology, Kharagpur Department of Metallurgical and Materials Engineering	Aug., '04 –Dec. '08
Professor-In-Charge	High Resolution Transmission Electron Microscope Dual Beam FIB-FEG Microscope and Scanning Electron Microscope, Central Research Facility	August 05- Present
Assistant Professor	Indian Institute of Technology, Kharagpur Department of Metallurgical and Materials Engineering	Sept., '02 - Aug. '04
Scientist “E”	Defence Metallurgical Research Lab, Hyderabad Development of Mo-Si-B Based Alloys and Composites	July '02 – August, '02
Post-Doctoral Fellow (onLeave from DMRL) Prof. J.R. Weertman	Northwestern University, Evanston, Illinois, U.S.A. Processing-microstructure-property relationships in nanocrystalline metals. Magnetron sputtering of Nanocrystalline thin films (nickel) and characterization of grain size, residual stress and Nanoindentation hardness. In-situ TEM straining studies performed on free standing films to study the deformation mechanisms. Annealing studies on Al-Ti Multilayered films & Nanocomposites.	July '98 – June '00
Scientist “D”	Defence Metallurgical Research Lab, Hyderabad Development of MoSi ₂ matrix composites: Effect of alloying, effect of ductile and brittle phase reinforcements, room and elevated temperature mechanical behaviour, intermediate and high temperature oxidation behaviour.	July '97 – June '02
Scientist “C”	Defence Metallurgical Research Lab, Hyderabad (i) Processing-microstructure-property relationships in MoSi ₂ and Ti ₅ Si ₃ based composites for high temperature applications. (ii) Liquid phase sintering of metal matrix composites. (iii) Processing and characterization of zirconia-mullite composites.	April '93-June '97
Research Assistant Profs. M.E. Fine and J.R. Weertman	Northwestern University, U.S.A. Dissertation: Microstructure and Interfaces in XD Al/TiC Composites Atomic scale characterization, thermodynamic stability and structure-property relationship of interfaces in-situ Al/TiC composites	September '88 – December '92
Teaching Assistant Prof. M. Meshii	Northwestern University, U.S.A. Laboratory instructor for transmission electron microscopy	Winter Quarter 1991-1992
B. Tech. Project Prof. K. K. Ray	Indian Institute of Technology, Kharagpur Study of fracture behaviour of flake graphite cast iron by profilometric analysis	July 1987-May 1988

LABORATORIES DEVELOPED

Department of Metallurgical and Materials Engineering

Creep Testing Laboratory:	Source of funds - Projects Tensile creep testing machine (up to 1000 °C) and Compression creep testing machine (up to 1500 °C); Creep crack growth and fatigue pre-cracking machines
Oxidation Laboratory:	Source of funds – Sponsored Projects Horizontal and Vertical furnaces with microbalance for tests in dry air and humid air
Thin Film Processing and Characterization Laboratory:	Source of funds – Mr. Arun Sarin & Institute DC/RF Magnetron Sputtering, Electron Beam Evaporation, Instron Electropulse 1 kN capacity, Contact type stylus profilometer

Central Research Facility:

Order has been placed for procuring a Probe-Corrected Ultra-high Resolution Transmission Electron Microscope with EDS. As Chairman, procured and set up major characterization facilities like Field Emission Scanning Electron Microscope, Dual Beam FIB-FEG Microscope, Cryo-Analytical High Resolution Transmission Electron Microscope, Analytical Transmission Electron Microscope, High Resolution Raman Spectroscopy facility, Scanning Auger Nanoprobe, Atomic Force Microscope, Nano-triboindenter, Small angle X-Ray Scattering facility, Nuclear Magnetic Resonance (NMR-600 MHz), Single Crystal X-Ray Diffractometer, X-Ray Micro-Computed Tomography facility, 3-D Non-Contact Optical Surface Profilometer, Table-top X-Ray Diffractometer, Vibrating Sample Magnetometer, and Pulsed Electron Paramagnetic Resonance facility along with a 380 kVA Silent Diesel Generator have been procured and installed during my tenure at the Central Research Facility. Total cost of these equipments procured through standard procedure of the Institute is around Rs. 85 crores. In addition, Electron Beam Lithography and Spark Plasma Sintering facilities of School of Nano-Science and Technology have been installed at CRF. These facilities not only serve the needs of researchers from different departments of IIT Kharagpur, but also other academic institutions, industries and R&D laboratories from all over the country. The slot-booking has been made fully transparent by introducing on-line booking with display of slot allotment as well as waiting list.

SATHI:

Established the laboratory for Time of flight – Secondary Ion Mass Spectrometer as Professor-In-Charge

AFFILIATIONS WITH PROFESSIONAL SOCIETIES

Life Member	Materials Research Society of India, The Indian Institute of Metals, The Indian Ceramic Society, Electron Microscopy Society of India
Chairman	Electron Microscope Society of India, East Zone Chapter (2020 – Present)
Chairman	Indian Institute of Metals, Kharagpur Chapter (2020 - 2023)
Council Member	Materials Research Society of India (2016 – Present)

Chairman	Metals and Alloys Group, Materials Research Society of India	(2016 Onwards)
Executive Committee Member	Electron Microscopy Society of India	(2018 – Present)
Council Member	Indian Institute of Metals	(2017 – 2018) (2020 – Present)
Member of the Editorial Advisory Board	Transactions of the Indian Ceramic Society	(2019 – 2022)
Editor	Transactions of the Indian Institute of Metals	(2010 – 2016)
Associate Editor	Transactions of the Indian Institute of Metals	(2001-2003)
Associate Editor	Bulletin of Materials Science (Springer/Indian Academy of Sciences)	(2015-16)
Associate Editor	Sadhana (Springer/Indian Academy of Sciences)	(2017 onwards)

OTHER PROFESSIONAL RESPONSIBILITIES

Member	Member of the Expert Review Panel, Gas Turbine Materials Advancement Programme (Coatings), Aeronautical Research & Development Board, DRDO, Ministry of Defence, Govt. of India, New Delhi	(2022 onwards)
Member	Programme Advisory and Review Committee, Gas Turbine Materials Advancement Programme (Coatings), Aeronautical Research & Development Board, DRDO, Ministry of Defence, Govt. of India, New Delhi	(2019-22)
Research Advisor	Nan Yang Academy of Sciences (Singapore)	(2018 Onwards)
Member	Materials Panel, Naval Research Board, Defence Research and Development Organization, Ministry of Defence, Govt. of India, New Delhi	(2016 -22)
Member	Programme Advisory Committee of Minerals, Metals and Materials Science and Engineering Research Board, Ministry of Science and Technology, Govt. of India, New Delhi	(2018-21)
Member	FIST Review Committee-Department of Science and Technology, Ministry of Science and Technology, Govt. of India	(2019-20)
Member	Committees for Early Career Award, Start-up Research Grant, and National Post-Doctoral Fellow, Science and Engineering Research Board, Ministry of Science and Technology, Govt. of India, New Delhi	(2018-24)
Member (Co-opted)	Programme Advisory Committee of Minerals, Metals and Materials Department of Science and Technology, Govt. of India, New Delhi	(2015-18)
Member	Programme Advisory Committee of Minerals, Metals and Materials Department of Science and Technology, Govt. of India, New Delhi	(2012-15)

Member	Subject Expert Committee (SEC) on Engineering and Technology under Women Scientists Scheme-A (WOS-A), Flagship program of Department of Science and Technology, Ministry of Science and Technology, Govt. of India, Govt. of India (2016-19)
Member	Technical Advisory Group for Centre for Ceramic Processing (CCP), Centre for Non-Oxide Ceramics (CNOC) and Centre for Sol-Gel Coatings (CSOL), International Advanced Research Centre for Powder Metallurgy and New Materials (ARC-I), Hyderabad. (2017-20)
Convenor	Swarna Jayanti Endowment Fellowship, Indian Institute of Metals (2013 onwards) (For providing partial travel support to PhD students and young scientists for visits to foreign conferences)
Coordinator (IIT Kharagpur)	National Facility for Atom Probe Tomography at IIT Madras (2017 onwards)
Member (past/present) (Board of Studies)	National Institute of Technology Jamshedpur, National Institute of Technology Rourkela, National Institute of Technology Raipur, Indian Institute of Engineering Science and Technology Shibpur
Reviewer	Acta Materialia, Metallurgical and Materials Transactions, A, Philosophical Magazine, Materials Science and Engineering, A, Intermetallics, Surface and Coatings Technology, Applied Surface Science, Materials and Manufacturing Processes, Journal of Alloys and Compounds, International Journal of Cast Metals, Journal of Materials Science, Transactions of the Indian Institute of Metals, Transactions of the Indian Ceramic Society, Diamond and Related Materials, Tribology Letters, Physical Review Letters, Journal of American Ceramic Society, Journal of the European Ceramic Society, Ceramic International, Materials Characterization, Materials Letters, International Journal of Refractory and Hard Materials, Corrosion Science, Materials Lettersm Journal of Phase Equilibria.

AWARDS AND HONOURS

Fellow	Indian Institute of Metals (FIIM)	2022
G D Birla Gold Medal	Indian Institute of Metals (Recognition of research accomplishments in the area of materials)	2021
Fellow	Electron Microscope Society of India (FEMSI)	2017
Fellow	Indian National Academy of Engineering (FNAE)	2016
Metallurgist of the Year (Metal Science Category)	Ministry of Steel, Government of India	2014
MRSI Medal	Materials Research Society of India	2003
In top 2% of Materials Scientists of the World (Whole career, 2019, 2020, 2021)	Publication by Stanford University Analyst Group PLoS Biol 18(10): e3000918. https://doi.org/10.1371/journal.pbio.3000918 https://elsevier.digitalcommonsdata.com/datasets/btchxktzyw/4	2020-21

Outstanding Review	Judged among the top reviews by the Metallurgical and Materials Transactions, A (Several times)	2003-2015
Best Oral/Poster Paper	Several National and International Conferences	
Best DMRL Tech. Report	Defence Metallurgical Research Laboratory Processing, microstructure and properties of MoSi ₂ /SiC _p composites	1995
Vidya Bharati Award	Indian Institute of Metals Academic excellence	1989
Institute Silver Medal	Indian Institute of Technology, Kharagpur Topper among students graduating in Metallurgical Engg.	1988 1988
Indranil Award (Silver Medal)	Mining, Geological and Metallurgical Institute of India Academic excellence	1988
Bengal Ingot Award (Silver Medal)	Institute of Indian Foundryman Best Project Work in Foundry	1988
First Prize in All India Essay Competition	Vishwesvaraiya Regional Engineering College, Nagpur Topic: Processing of complex Cu-Pb-Zn ores for extraction of metallic values.	1987
National Talent Search Scholarship (NTS)	National Council of Educational Research & Training (NCERT) One of the 250 recipients selected through nation-wide competitive tests	1982-88

RESEARCH ACCOMPLISHMENTS

Prof. Rahul Mitra's research has involved processing of metallic, ceramic and intermetallic matrix composites by innovative routes, and fundamental studies on their structure-property relations with emphasis on mechanical behavior. During the last ten years, his major contribution is in developing heat-resistant materials for applications in aerospace and automotive sectors to achieve operating temperatures greater than that of Ni-based superalloys (i.e. >1100 °C). The materials investigated include multiphase alloys based on molybdenum silicides, titanium silicides, and niobium silicides as well as zirconium and hafnium diboride based composites with emphasis on microstructural evolution, mechanical property evaluation, and high temperature oxidation behavior. In addition, he has pioneered development of mushy state (semi-solid) rolling process to tailor microstructural refinement, enhanced age-hardening kinetics as well as desirable mechanical and tribological properties in cast in-situ metal matrix composites. Significant research has also been carried out on processing and structure-property correlation of reactively sputtered in-situ nanocomposite thin films. Furthermore, collaborative research through PhD work of sponsored students, has been carried out on fracture and wear behavior of carbon-carbon composites, processing and structure-property relations of silica foams. Prof. R. Mitra has worked on sponsored projects worth about 16 crores as the Principal Investigator. Moreover, he has supervised/co-supervised 24 Ph.D. theses to completion during his stay at IIT Kharagpur (Sept. 2002 to present), and is presently guiding 10 PhD students as Supervisor, and another 8 as Joint-Supervisor.

- A. **Silicide based intermetallic alloys and composites:** The work on silicides can be considered as pioneering, in India as it was initiated from scratch during his stay at DMRL, and subsequently followed

up at IIT Kharagpur. The role of dispersed ductile phase in toughness enhancement, as well as the effects of matrix grain size, grain boundary purity and hard phase volume fractions on high temperature deformation behavior (up to 1300 °C) of alloys and composites based on MoSi₂, Ti₅Si₃, Mo-Si-B and Nb-Si-Mo ternary systems have been investigated. The dislocation based mechanisms and influence of interfacial purity and grain size on high temperature deformation and creep of MoSi₂ and Ti₅Si₃ have been investigated. Studies on oxidation behavior of these materials under non-isothermal, isothermal and cyclic conditions have helped to understand the mechanisms of environmental degradation and formation of protective scale. For the first time, it has been demonstrated that prior exposure of Mo-Si-B alloys at 1150 °C leads to the formation of a stable scale for protection against accelerated degradation at intermediate temperatures (700-800 °C). Studies on the initial transient stage of oxidation of the Mo-Si-B alloys have shown evidence for formation and viscoplastic flow of the borosilicate scale. Furthermore, the contribution of Mo addition to Nb-Si based intermetallic alloy to strength enhancement and formation of a protective scale at high temperatures (up to 1200 °C) has been impressive. Presently, work is going on to examine the effect of humid air on high temperature oxidation behavior. The results in these areas have led to several international journal publications along with a comprehensive review, which are very well-cited. Very recently, he has authored a research monograph on structural intermetallics and intermetallic matrix composites, being published by CRC press in May 2015.

- B. **Ultrahigh Temperature Ceramic Composites:** Studies on zirconium and hafnium diboride based ultrahigh temperature ceramic (UHTC) composites with SiC, ZrC and Si₃N₄ reinforcements have been carried out with financial support from DRDO aiming at developing materials for extreme environments faced by nose-cones and leading edges of hypersonic vehicles during re-entry into earth's atmosphere. The milestones reached in through such studies include optimization of pressureless sintering for near-net shaping, understanding the relationship of thermophysical and mechanical properties with microstructure, as well as the mechanism of protection against oxidation and ablation up to 2000 °C. The mechanisms of compression creep (1300 – 1425 °C) with emphasis on the role of grain boundary and interface sliding on damage and role of reinforcement phases have been analyzed on the basis of stress exponents, activation volumes and energies for the first time. A significant portion of this work has been published in reputed journals, and is regularly cited.
- C. **Mushy state rolled in-situ Al alloy matrix composites:** As a major pioneering innovation, mushy state rolling of cast in-situ Al-4.5Cu-5TiB₂ composites with liquid content between 10 and 30% has been optimized as a process to achieve grain size gradient, refined microstructure with bimodal grain size distribution, greater chemical homogeneity, and particle redistribution starting from initial dendritic microstructure. A higher volume fraction of finer grains formed near the surface due to dynamic recrystallization and rapid solidification of liquid phase during mushy state rolling cause surface hardening along with enhancement of wear resistance. It has also been observed that excellent uniformity of solute atom distribution through mushy state rolling leads to accelerated aging with the time for peak aging of the composite being reduced by nearly 90% compared to that of the as-cast alloy. The redistribution of reinforcement particles during mushy state rolling has been quantified by multi-scalar analysis of area-fractions in micrographs to estimate homogeneous length scales. Both strength and ductility are enhanced on mushy state rolling, whereas the crack propagation path changes from interface to matrix as observed through in-situ tensile straining experiments inside the SEM. These results suggest a novel method to industry for near net shape forming of the discontinuously reinforced Al alloy matrix composites. Further work is in progress to examine the microtexture developed during the course of mushy state rolling.

- D. **Interfaces in Aluminium Matrix Composites**: It has been shown that in-situ Al-TiC or Al-TiB₂ composites have particle-matrix interfaces exhibiting misfit-strain localization, and excellent bond integrity. The primary contribution in this area is evaluation of the effect of particle-matrix interfaces on mechanical behavior. It has been shown that interfaces with higher purity in the in-situ composites are resistant to damage and undergo strain-hardening on thermal cycling, whereas those having segregation of alloying elements show cracking. As a pioneering contribution in this area, it has been shown that increase in dislocation density due to plastic deformation near particle-matrix interfaces due to coefficient of thermal expansion mismatch between Al and SiC as well as decrease in subgrain size on thermal cycling of Al-SiC composites leads to increase in creep resistance. The related journal publications are well-cited.
- E. **Nanocomposites (Bulk materials and thin films)**: Bulk amorphous-nanocrystalline composites have been developed by mechanical alloying followed by consolidation of Al-Cu-Ti and Al-Ti-Si powders. These composites have exhibited very high compressive strength and wear resistance, and the results have been published in several reputed journals. Furthermore, his publications on processing and in-situ tensile straining of nanocrystalline thin films in transmission electron microscope, as well as correlation of their deformation behavior with grain size distributions have been highly cited. Recently, research has been carried out on structure-property correlations in nanocomposite thin films (such as Ni-TiN) processed by reactive RF/DC magnetron sputtering of Ni and Ti targets in Ar+N₂ atmosphere. It has been shown that volume fraction and stoichiometry of TiN can be altered by controlling either the substrate bias or the Ar:N₂ ratio, which in turn affect stress, roughness and scratch resistance. These coatings have hardness exceeding the predictions based on rule of mixture, as well as superior corrosion resistance, and are of interest for use as protective coatings.

PUBLICATIONS

Books authored: 01; Books edited: 01; Book chapters: 10

Journal publications: 198 (Published or in press)

Conference Proceedings: 37 (Published)

Patents granted: 02

Total citations: 5499+, h-Index: 39, i10 index: 126

(Source: <https://scholar.google.co.in/citations?user=8uhvxucAAAAJ>)

H-index: 35 (Scopus), 34 (Web of Science), 35 (Research-gate)

Citations (Google scholar):

>400: 01

>200: 03

>100: 07

≥80: 11

≥60: 22

≥40: 38

≥20: 83

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Scopus ID: 56225235900

Web of Science ID: 300134

Book (Author):

R. Mitra, “*Structural Intermetallics and Intermetallic Matrix Composites* (ISBN 9781466511866-CAT# K14856),” IIT Kharagpur Research Monograph Series, CRC Press - Taylor and Francis Group, Boca Raton, Florida, USA, Published on April 28, 2015.

Book (Editor):

R. Mitra (Editor), *Intermetallic Matrix Composites - Properties and Applications* (ISBN 9780857093462), Woodhead Publishers-Elsevier, Published on June 5, 2017.

Book Chapters:

1. **R. Mitra**, “Advanced techniques for characterization of structure, composition and mechanical behaviour,” in *Future Landscape of Structural Materials in India*, edited by Debashish Bhattacharjee and Shantanu Chakrabarti, Springer, Chapter 13, pp. 309-353, July 2022 (ISBN: 978-9811685224) <https://doi.org/10.1007/978-981-16-8523-1>
2. S. Maitra, **R. Mitra**, T.K. Nath, “Chapter 9 - Metal Organic Framework based nanomaterials as suitable electrocatalysts for evolution of Hydrogen”, in *Metal Organic Framework-based Nanomaterials for Energy Conversion and Storage: Micro and Nano Technologies*, edited by Ram Gupta, Tuan Anh Nguyen, Ghulam Yasin, Elsevier, New York, USA, pp 185-203 (May, 2022) <https://doi.org/10.1016/B978-0-323-91179-5.00008-5>.
3. **R. Mitra**, “Silicides and Silicide Matrix Composites for High Temperature Structural Applications,” in *Handbook of advanced ceramics and composites*, edited by Yashwant R. Mahajan and Roy Johnson, Springer Nature Switzerland AG 2020, Volume 2, pp. 1167-1220 (2020). https://doi.org/10.1007/978-3-319-73255-8_40-1
4. **R. Mitra**, M. Mallik, and Sunil Kashyap, “High Temperature Environmental Degradation Behavior of Ultra-High Temperature Ceramic Composites: Case examples of Zirconium and Hafnium Diboride,” in *Handbook of advanced ceramics and composites*, edited by Yashwant R. Mahajan and Roy Johnson, Springer Nature Switzerland AG 2020, Volume 2, pp. 1221-1256 (2020). https://doi.org/10.1007/978-3-319-73255-8_41-1
5. **R. Mitra**, “Oxidation behavior of silicides,” in *Diffusion Controlled Growth and Oxidation of Metal-Silicides*,” *Diffusion Foundations*, Vol. 21, edited by Aloke Paul, Trans Tech Publications Ltd, Reinhard strasse 18, 8008 Zurich, Switzerland, pp. 127-156 (2019).
6. **R. Mitra**, “Oxidation and environmental degradation of intermetallic matrix composites,” in *Intermetallic Matrix Composites - Properties and Applications*, Elsevier-Woodhead Publishers, pp. 321-358 (2018).
7. **R. Mitra**, “Molybdenum Silicide-based Composites,” in *Intermetallic Matrix Composites - Properties and Applications*, Woodhead Publishers-Elsevier, pp. 95-146 (2018).
8. **R. Mitra**, “Structural Intermetallics and Intermetallic Matrix Composites: An Introduction.” in *Intermetallic Matrix Composites - Properties and Applications*, Woodhead Publishers-Elsevier, pp. 1-18 (2018)
9. **R. Mitra**, “Development of composite materials for high temperature and light weight structural applications,” *Annals of INAE*, Vol. XIV, pp. 107-121 (2017)

10. **R. Mitra**, R.J.H. Wanhill, "Structural Intermetallics," in Aerospace Materials and Materials Technologies, Part of the [Indian Institute of Metals Series](#), Volume 1: Aerospace Materials, Edited by N. Eswara Prasad and R.J.H. Wanhill, pp 229-245 (2016).

Journal papers:

Year: 2023

1. Ramya Krishna, Vamsi Krishna Parimi, A. Udayakumar, **Rahul Mitra**, "Evaluation of elastic constants and high temperature tensile behaviour with damage assessment of the SiC seal-coated 2.5D C_f/SiC composites having multilayered interphase and Si-B-C added matrix," *J. Eur. Ceram. Soc.*, Vol. 43(6), pp. 2388-2401 (2023).
<https://doi.org/10.1016/j.jeurceramsoc.2022.12.066>
2. Sunil Kumar Kashyap and **Rahul Mitra**, "Effect of LaB₆ addition on compressive creep behavior with simultaneous oxide scale growth of spark plasma sintered ZrB₂-SiC composites," *Journal of the American Ceramic Society*, Vol. 106(2), pp. 1424-1442 (2023).
<https://doi.org/10.1111/jace.18799>
3. Ankita Bhattacharyaa, Rakesh Kumar Barik, Supriya Nandy, Mainak Sena, T.S. Prithiv, Sudipta Patra, **Rahul Mitra**, Debalay Chakrabarti, Abhijit Ghosh, "Effect of martensite twins on local scale cleavage crack propagation in a medium carbon armor grade steel," *Materialia*, Vol. 30, 101800 (2023) <https://doi.org/10.1016/j.mtla.2023.101800>
4. R. Rejeesh, Sankalp Biswal, Rahul Mitra, Debalay Chakrabarti, C.R. Das, Shaju K. Albert, "The relative effect of boron and nitrogen concentrations on microstructure and creep resistance of weld simulated heat-affected zones of modified 9Cr-1Mo steel," *Materials Science and Engineering A*, Vol. 881, 145417 (2023) <https://doi.org/10.1016/j.msea.2023.145417>
5. Sumanta Bagui, Bibhu Prasad Sahu, Bhupeshwar Mahato, Monalisa Mandal, Soumitra Tarafder and **Rahul Mitra**, "Effect of microstructural evolution on creep and rupture behavior of Inconel 617 alloy," *Journal of Materials Engineering and Performance*, Vol. 32(3), pp. 1292-1309 (2023) <https://doi.org/10.1007/s11665-022-07162-z>
6. Pranabananda Modak, Kushagra Tyagi, Debalay Chakrabarti, **Rahul Mitra**, Sudipta Patra, "Recrystallization kinetics, precipitate evolution and grain refinement of Nb stabilized ferritic stainless steel for producing thicker plate/strip industrially," *Metallurgical and Materials Transactions A*, Vol. 54A, pp. 1024-1041 (2023) <https://doi.org/10.1007/s11661-023-06979-0>
7. Ravindran Rejeesh, Rakesh Kumar Barik, Rahul Mitra, Andrii Kostyryhev, Chitta R. Das, Shaju K. Albert and Debalay Chakrabarti, "Effect of B and N Content and Austenitization Temperature on the Tensile and Impact Properties of Modified 9Cr-1Mo Steels," *Metals*, 13, 1124 (2023) <https://doi.org/10.3390/met13061124>
8. Manojit Das, Rajat Mishra, Palash Das, Sunil Kumar Kashyap, Sushanta Kumar Panda, **Rahul Mitra**, Peter Samora Owuor, Amit Arora, Chandra Sekhar Tiwary, "Controlled directionality in 3D printing of graphite-reinforced polymer composite with enhanced mechanical properties," *Composite Science and Technology*, Vol. 235, 109955 (2023)
<https://doi.org/10.1016/j.compscitech.2023.109955>

9. Arijit Jana, Manojit Das, Shivam Tiwari, Shaik Salam Basha, Abhay Raj Singh Gautam, Sushanta Kumar Panda, **Rahul Mitra**, Shobhit Kumar, Renjith Devasia, Chandra Sekhar Tiwary, "Effect of particle size on additive manufacturing of complex architecture of silicon carbide," *Ceramic International*, Vol. 49(11) pp. 903-911 (2023) <https://doi.org/10.1016/j.ceramint.2023.02.108>
10. Manojit Das, Arijit Jana, Rajat Mishra, Swapan Maity, Pralay Maiti, Sushanta Kumar Panda, **Rahul Mitra**, Amit Arora, Peter Samora Owuor, Chandra Sekhar Tiwary, 3D Printing of Biocompatible Nano-ink Derived from Waste Animal Bones, *ACS Applied Bio Materials*, Vol. 6(4), 1566-76 (2023) <https://doi.org/10.1021/acsabm.2c01075>.

Year: 2022

11. Sunil Kumar Kashyap, Kasturi Sala and **Rahul Mitra**, "Oxidation resistance and evolution of multi-layered oxide scale during isothermal and cyclic exposure of ZrB₂-SiC-LaB₆ composites at 1300°C-1500°C," *Metallurgical and Materials Transactions A*, Vol. 53, pp. 147-171 (2022) <https://doi.org/10.1007/s11661-021-06501-4>.
12. Kasturi Sala and **Rahul Mitra**, "Effect of Zr or Ga addition and annealing on microstructural evolution, deformation and fracture behavior of Nb-19Si-5Mo-20Ti based hypereutectic alloy," *Metallurgical and Materials Transactions A*, Vol. 53, pp. 1717-1737 (2022) <https://doi.org/10.1007/s11661-022-06626-0>
13. Sumanta Bagui, Monalisa Mandal, Biraj Kumar Sahoo, Kinkar Laha, Soumitra Tarafder, **Rahul Mitra**, "Investigation of non-classical creep behavior of Inconel 617 alloy at 700°C and 800°C through interrupted tests and microstructural characterizations," *Materials Science and Engineering A*, Vol. 832, 142474 (2022) <https://doi.org/10.1016/j.msea.2021.142474>.
14. Swarnalata Behera, Rakesh Kumar Barik, Sk. Md. Hasan, **Rahul Mitra**, Debalay Chakrabarti, Tailoring the processing route to optimize the strength-toughness combination of pearlitic steel, *Metallurgical and Materials Transactions A*, Vol. 53A, pp. 3853-3868 (2022) <https://doi.org/10.1007/s11661-022-06789-w>
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10. Mervin A. Herbert, R. Maiti, **R. Mitra**, and M. Chakraborty, "Evolution of microstructure in Al-4.5Cu-5TiB₂ composite processed by multiple roll passes in mushy state," International Conference on Advances in Materials and Materials Processing (ICAMMP-2006), Indian Institute of Technology, Kharagpur, 149-155, Cygnus, Kolkata (2006).
11. Sharmilee Pal, R. Maiti, **R. Mitra**, and V.V. Bhanuprasad, "Aging behaviour of Al-Cu-Mg alloy-SiC composites," International Conference on Advances in Materials and Materials Processing (ICAMMP-2006), Indian Institute of Technology, Kharagpur, 156-162, Cygnus, Kolkata (2006).
12. K. Chattopadhyay, **R. Mitra**, G. Balachandran, and K.K. Ray, "Room temperature mechanical behaviour of cast arc-melted Nb-Si-Mo alloys," International Conference on Advances in Materials

- and Materials Processing (ICAMMP-2006), Indian Institute of Technology, Kharagpur, 273-280, Cygnus, Kolkata (2006).
13. S. Paswan, **R. Mitra**, and S.K. Roy, "Isothermal and cyclic oxidation of Mo-Si-B and Mo-Si-B-Al alloys in the temperature range of 400°-1300°C," International Conference on Advances in Materials and Materials Processing (ICAMMP-2006), Indian Institute of Technology, Kharagpur, 392-399, Cygnus, Kolkata (2006).
 14. **R. Mitra**, K. Chattopadhyay, N. Eswara Prasad, and K.K. Ray, "Structure-property relations in molybdenum and niobium silicide based composites," Proceedings of the International Conference on Advanced Materials Design and Development (ICAMDD), Goa Marriott Resort, Goa, 14-16 December, 2005, CD-ROM, Paper No. ADM11.
 15. Mervin A. Herbert, R. Maiti, **R. Mitra**, and M. Chakraborty, "Evolution of microstructure in Al-4.5Cu-5TiB₂ composite processed in mushy state," Proceedings of the International Conference on Advanced Materials Design and Development (ICAMDD), 14-16 December, 2005, Goa Marriott Resort, Goa, CD-ROM, Paper No. ADM9.
 16. **R. Mitra**, W.-A. Chiou and J. R. Weertman, "In-situ TEM studies of tensile deformation of free standing nanocrystalline nickel films," in *Proceedings of the International Symposium on Advanced Materials and Processing (ISAMAP2K4)*, 6-8 December, 2004, IIT, Kharagpur, pp. 1472-1479.
 17. Sharmilee Pal, R. Maiti, **R. Mitra** and V. V. Bhanuprasad, "Integrity of Interfaces in P/M/ 2124 Al-SiC and In-Situ Al-TiC Composites Subjected to Thermal Cycling," in *Proceedings of the International Conference on Recent Advances in Composite Materials (ICRACM – 2004)*, 17-19 December, 2004, BHU, Varanasi, edited by V. K. Srivastava and M. Singh, Allied Publishers Pvt. Ltd., 2004, pp. 332-335.
 18. P. L. Gai, **R. Mitra** and J. R. Weertman, "Structural Variations in Nanocrystalline Nickel Films," in *Proc. Microscopy and Microanalysis Conference (CD-ROM)*, Microscopy Society of America, Quebec City, Canada (2002).
 19. **R. Mitra**, Y. R. Mahajan, Y. S. Rao, N. Eswara Prasad and S. Kumari, "Molybdenum Silicides: Processing-Structure-Property Relationships and Future Trends," in *Proc. Nonferrous Meet - 2002*, Nonferrous Materials Technology Development Corporation, June 28-29, 2002, Hyderabad, pp. 170-177 (2002).
 20. **R. Mitra**, N. Eswara Prasad, Sweety Kumari, A. Venugopal Rao and K. Sadananda, "High temperature mechanical properties of MoSi₂-based materials," in *Proc. International Conference on Advances in Materials and Materials Processing*, Indian Institute of Technology, Kharagpur, February 1 – 3, 2002, pp. 316-320 (2002).
 21. A. Chakraborty, **R. Mitra**, S. V. Kamat, K. K. Ray and S. B. Bhaduri, "Effect of SiC morphologies on the structure-property behaviour of Al₂O₃-SiC composites," in *Advances in Ceramic Matrix Composites VI*, Vol. 124, pp. 97-114, edited by J. P. Singh, N. P. Bansal and E. Ustundas, The American Ceramic Society, Westerville, Ohio, U.S.A. (2001).
 22. A. Chakraborty, **R. Mitra**, S. V. Kamat, M. K. Jain, J. Subrahmanyam and K. K. Ray, "Structure-property relations for MoSi₂ and Nb Particle reinforced Al₂O₃ matrix composites," in *Proc. Third Inter. Conf. on "Advances in Composites" ADCOMP-2000*, August 24 - 26, HAL Convention Centre, Bangalore, India, pp. 547-559 (2000).
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24. **R. Mitra**, W.-A. Chiou and A. Venugopal Rao, "Grain boundaries and interfaces in MoSi₂ and MoSi₂-SiC composites and their effect on high temperature strength," in *Proc. Microscopy and Microanalysis Conference, 2000*, Vol. 6, Suppl. 2, Microscopy Society of America (August 13-17, 2000, Philadelphia, PA, USA) pp. 424-25 (2000).
25. **R. Mitra**, A. Madan, R. A. Hoffman, W.-A. Chiou and J. R. Weertman, "Effect of annealing on microstructure and properties of Al-Ti multilayered films," in *Thin Films, Stresses and Mechanical Properties VIII, Mater. Res. Soc.*, Vol. 594, edited by R. Vinci, O. Kraft, N. Moody, P. Besser and E. Shaffer II, pp. 43-48 (2000).
26. **R. Mitra**, T. Ungar, T. Morita, P.G. Sanders, and J.R. Weertman, "Assessment of grain size distributions in nanocrystalline copper and their effect on mechanical behaviour. In: Advanced Materials for 21st Century: The 1999 Julia R. Weertman Symposium, Eds. Y.-W. Chung, Dunand, D.C., Liaw, P.K., and Olson, G.B. (Warrendale, PA, U.S.A.: TMS) 553-563 (1999).
27. **R. Mitra**, W.-A. Chiou, A. Madan, R. Hoffman and J. R. Weertman, "Microstructural evolution in Al-Ti multilayered film with annealing," in *Proceedings of the Microscopy and Microanalysis, 1999* Vol. 5, Suppl. 2 (August 1-5, 1999, Portland, Oregon, U.S.A.), pp. 836-37 (1999).
28. **R. Mitra**, W. A. Chiou, J. R. Weertman and R. Hoffman, "TEM study of nanocrystalline Ni films grown by dc magnetron sputtering," in *Proceedings of the Microscopy and Microanalysis, 1999* Vol. 5, Suppl.2, (August 1-5, 1999, Portland, Oregon, U.S.A.) pp. 834-35 (1999).
29. **R. Mitra**, N. Eswara Prasad, A. Venugopal Rao and Y. R. Mahajan, "Molybdenum and titanium silicide based composites and alloys," in *Second International Symposium on Structural Intermetallics*, Seven Springs Mountain Resort, Champion, PA, USA, September 21-25 (1997), M. V. Nathal, R. Darolia, C. T. Liu, P. L. Martin, D. B. Miracle, R. Wagner and M. Yamaguchi (eds.), pp. 959-968.
30. Y. R. Mahajan, B. V. R. Bhat, **R. Mitra**, Y. S. Rao, V. V. Bhanuprasad and M. K. Jain, "Metal matrix composites via innovative processing routes," in *Proc. 3rd Japan-India Joint Seminar on Manufacturing Science of Advanced Composites*, Tokyo, Japan, March 17-22 (1997), pp. 73-85.
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32. B. V. R. Bhat, V. V. Bhanuprasad, **R. Mitra**, M. K. Jain, A. B. Pandey and Y. R. Mahajan, "Discontinuously reinforced PM processed MMCs activity at the Defence Metallurgical Research Laboratory," in *Inorganic Matrix Composites*, M. K. Surappa (ed.), TMS, Warrendale, PA, U.S.A., pp. 269-303 (1996).
33. **R. Mitra**, N. Eswara Prasad and Y. R. Mahajan, "Reaction hot pressed silicides and silicide matrix composites," in *Proceedings of the Technical Sessions, 59th Annual Session, Indian Ceramic Society, Madras, January 10 - 11*, pp. 474-480 (1996).
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36. **R. Mitra**, M. E. Fine and J. R. Weertman, "Effect of deformation and recrystallization on microstructure and interfaces in XD Al/TiC metal matrix composites," in *Mechanical Properties and Phase Transformations of Multiphase Intermetallic Alloys*, A.F. Giamei, K. Inoue and Y. Mishima (eds.), TMS, pp.199-206 (1995).
37. **R. Mitra**, J. R. Weertman, M. E. Fine and R. M. Aikin, Jr. "Modification of microstructure and mechanical properties in XDTM Al/TiC metal matrix composites by 913 K exposure," in *Development of Ceramic and Metal Matrix Composites*, K. Upadhy (ed.), TMS, pp. 125-142 (1992).
38. **R. Mitra**, W.-A. Chiou, J.R. Weertman, M. E. Fine and R. M. Aikin, Jr. " Study of interfaces in XDTM Al/TiC_p metal matrix composites," in *Structure and Properties of Interfaces in Materials, MRS Symposium Proceedings*, U. Dahmen, W.A.T. Clark and C.L. Briant (eds.), Vol. 238, pp. 871-877 (1992).

PATENTS

1. **R. Mitra**, M.K. Jain and Y.R. Mahajan, "A process for making near net shaped metal matrix composites", Indian Patent No. 191071 granted on May 05, 2004.
2. **R. Mitra** and Y.R. Mahajan, "Reaction hot pressing technique for processing of Ti₅Si₃ based materials", Indian Patent No. 197166 granted on June 06, 2006.

DISSERTATION GUIDANCE

Ph.D. Guidance (Submitted: 25; Completed: 25)

1. **Pranabananda Modak** (Roll No. 14MT92R01 – Institute) Evolution of grain structure, texture, and precipitate during recrystallization of ferritic steel (Supervisor: D. Chakrabarti and Joint Supervisor: R. Mitra).
2. **Pallabi Bhuyan** (Roll No.16MT91R04-Institute, 2022) Enhancing the high-temperature hot corrosion resistance in Alloy 617 through microstructure engineering approaches (Supervisor: Prof. S. Mandal, Joint Supervisor: Prof. R. Mitra).
3. **Sunil Kumar Kashyap** (Roll No. 15MT91R16-Institute, 2021) Densification behavior and structure-property relations of LaB₆-added ZrB₂-SiC based ultra-high temperature ceramic composites (Supervisor: Prof. R. Mitra).
4. **Sumanta Bagui** (Roll No.13MT91S02-Sponsored, 2022) Deformation behavior and microstructural evolution during creep of Inconel 617 alloy at advanced ultra-supercritical temperatures (Supervisor: Prof. R. Mitra, Joint Supervisor: Dr. S. Tarafder, CSIR-NML, Jamshedpur).
5. **Kasturi Sala** (Roll No.15MT91R09-Institute, 2022) Microstructure-property correlation of as cast and annealed Nb-Si-Mo alloys with selected alloying additions (Supervisor: Prof. R. Mitra)
6. **Chinmaya Kumar Sarangi** (Roll No.12MT92S01-Sponsored, 2022): Influence of graphene oxide reinforcement and alloying with Cu on structure and properties of pulse electrodeposited nanocrystalline Ni-W alloy (Supervisor: Prof. R. Mitra, Joint Supervisor: Prof. B.K. Mishra, CSIR-IMMT, Bhubaneswar).
7. **Shuvodip Maitra** (Roll No. 15NT92R02-Institute, 2021): Development of Magnesium metal

- oxide electrodes for aqueous supercapacitor and alkaline electrocatalyst application. (Supervisor: Prof. T.K. Nath, Joint Supervisor: Prof. R. Mitra).
8. **Krishna Guguloth** (Roll No.12MT91S01-Sponsored, 2021): Creep and high temperature tensile properties of Zr-2.5Nb alloy (Supervisor: Prof. R. Mitra, Joint Supervisor: M. Swaminathan, CSIR-NML Jamshedpur)
 9. **Bibhu Prasad Sahu** (Roll No. 14MT92R06, Institute, 2020): Structure-property relationship of DC magnetron sputtered amorphous/nanocrystalline Ni-Zr alloy thin films (Supervisor: R. Mitra, Joint Supervisor: A. Dutta)
 10. **Nand Kishor Kumar** (Roll No.13MT92P02, Project/Institute, 2020): Effect of Zr and Fe addition on oxidation behavior of arc-melted or spark plasma sintered Mo-Si-B alloys in dry or moist air (Supervisor: R. Mitra, Joint Supervisor: J. Das, IIT Kharagpur)
 11. **Monalisa Mandal** (Roll No. 13MT91R01, 2019): Evolution of microstructure and microtexture in thermomechanically processed Al-4.5Cu-5TiB₂ in-situ composite and its impact on mechanical and wear behavior (Supervisor: R. Mitra).
 12. **Arya Chatterjee** (Roll No. 12MT92P02, 2018): Effect of Microstructure and Crystallographic Texture on Mechanical Properties of Modified 9Cr-1Mo Steel (Supervisor: D. Chakrabarti and Joint Supervisor: R. Mitra).
 13. **Prasenjit Barick** (Roll No. 11MT92S01, Sponsored, 2018): Processing and structure-property relationship of nanocrystalline silicon carbide (Supervisor: R. Mitra and Joint Supervisor: Bhaskar Saha, ARC-I, Hyderabad).
 14. **Jitendra Verma** (Roll No. 08MT9505, Sponsored, 2016): Processing, structure, and properties of silica foams (Supervisor: R. Mitra and Joint Supervisor: M. Vijayakumar, DMRL, Hyderabad)
 15. **Poulami Maji** (Roll No. 08MT9702, Scheme, 2016), Structure-property Relationships in Nb-Si-Cr and Nb-Si-Ti alloys (Supervisor: R. Mitra and Joint Supervisor: K.K. Ray)
 16. **Mukesh Kumar** (Roll No. 09MT9409, Institute, 2014), Processing and structure-property relations of Ni-TiN nanocomposite thin films deposited by reactive magnetron cosputtering (Supervisor: R. Mitra)
 17. **Manab Mallik** (Roll No. 06MT9703, Scheme, 2014), Structure-Property Relations in Zirconium and Hafnium Diboride Based Ultra High Temperature Ceramic Composites (Supervisor: R. Mitra and Joint Supervisor: K.K. Ray)
 18. **Suresh Telu** (Roll No. 09MT9703, Scheme+Institute, 2014), High Temperature Oxidation Behavior of Tungsten Based Materials Processed by Powder Metallurgical Route (Supervisor: R. Mitra and Joint Supervisor: S.K. Pabi).
 19. **Sourav Sarkar** (Roll No. 05MT9503, Sponsored, 2011), Mechanical Properties and Tribological Behaviour of Carbon Fibre Reinforced Composites with Carbon, Phenolic or Epoxy Matrices (Supervisor: R. Mitra and Joint Supervisor: V.G. Shekaran, ASL, Hyderabad)
 20. **Siddhalingeswar, I.G.** (Roll No. 07MT9702, QIP, 2011), Microstructure-Property Relationships In Mushy State Rolled In-situ Al-4.5Cu-5TiB₂ Composite (Supervisor: R. Mitra and Joint Supervisor: M. Chakraborty)
 21. **Sharma Paswan** (Roll No. 04MT9703, Scheme, 2010), Non-Isothermal, Isothermal and Cyclic Oxidation Behaviour of Mo-Si-B and Mo-Si-B-Al alloys (Supervisor: R. Mitra and Joint Supervisor: S.K. Roy)
 22. **Sharmilee Pal** (Roll No. 04MT9402, Institute, 2010), Creep Behavior of Hot Rolled Powder Metallurgy Processed Al-SiCp Composites (Supervisor: R. Mitra and Joint Supervisor: K. K. Ray)
 23. **Sarika Mishra** (Roll No. 04MS9502, Sponsored, 2009), Processing, Structure and Properties of Porous Silica and Silica Fiber Reinforced Composite Foams (Supervisor: R. Mitra and Joint Supervisor: M. Vijayakumar, DMRL, Hyderabad) Was awarded the G.C. Jain Memorial Prize for the “Best PhD Thesis in Materials Science” by the Materials Research Society of India for the year 2009.

24. **Debdas Roy** (Roll No. 05MT9601, Self-financed, 2009), Nano-Intermetallic/Ceramic Dispersed Al-Based Amorphous/Nanocrystalline Matrix Composites Synthesized By Mechanical Alloying (Supervisors: I. Manna and R. Mitra)
25. **Kausik Chattopadhyay** (Roll No. 03MT9407, Institute, 2008), Structure-Property Relationships in Nb-Si-Mo alloys (Supervisors: R. Mitra and K. K. Ray)
26. **Mervin A. Herbert** (Roll No. 04MT9702, QIP, 2008), Some studies on the mushy state rolling of Al-4.5Cu alloy based in-situ composites reinforced with TiB₂ or TiC particles (Supervisors: R. Mitra and M. Chakraborty).

Ph.D. Guidance (On-going)

As Supervisor:

1. **Adarsha Ranjan Mishra**, Roll No. 22MT91J02-Institute (Supervisor: Prof. R. Mitra, Joint Supervisor: Dr. Manish Patel, DMRL Hyderabad) Area of research: Processing and characterization of ultra-high temperature ceramic matrix composite
2. **Thinesh Kumar S**, Roll No. 22MT91W02 – Working Professional (Supervisor: Prof. R. Mitra, Joint Supervisor: Dr. Loganathan S, Titan Company Limited, Hosur) Development of decorative coatings through advanced physical vapour deposition
3. **Soma Hansda**, Roll No. 22MT91W01-Working Professional (Supervisor: Prof. R. Mitra, Joint Supervisor: Dr. Soupitak Pal, CSIR-CGCRI, Kolkata) Area of research: Development of high entropy ultra-high temperature ceramic coatings
4. **Sadananda Behera**, Roll No. 21MT92S01-Sponsored (Supervisor: Prof. R. Mitra, Joint Supervisor: Dr. T.K. Nandy, DMRL Hyderabad) Area of research: Structure property correlations of Ni based superalloy
5. **Virushni S.N.**, Roll No. 20MT92R10-Institute (Supervisor: Prof. R. Mitra, Joint Supervisor: Prof. Santanu Dhara) Area of research: Development of near-net shaped ZrB₂-SiC based ultra-high temperature ceramic composites
6. **Jyotiprakash Beura**, Roll No. 20MT91R10-Institute (Supervisor: Prof. R. Mitra, Joint Supervisor: Dr. Sarabjit Singh, DMRL Hyderabad) Area of research: Processing and characterization of C_f/SiC composites
7. **Raashid Firoz**, Roll No. 19MT92R07-Institute (Supervisor: Prof. R. Mitra, Joint Supervisor: Prof. Amlan Dutta) Area of research: Mechanical behavior of high temperature alloy
8. **Ghewade Hrishikesh Dinkar**, Roll No. 18MT91P01-Institute (Supervisor: Prof. R. Mitra, Joint Supervisor: Prof. Tapas Laha) Area of research: Structure-property relation of Molybdenum Silicide Based Intermetallic Composites
9. **Ramya Krishna**, Roll No. 18MT91P01-Scheme (Supervisor: Prof. R. Mitra, Joint Supervisor: Dr. A. Udayakumar, NAL Bangalore) Area of research: Structure-property relations of C_f/SiC Composites processed by chemical vapour infiltration.
10. **Sudipta Roy**, Roll No. 16MT92R05-Institute (Supervisor: Prof. R. Mitra, Joint Supervisor: Prof. S. Mandal, IIT Kharagpur). Area of Research: Structure-Property Relations in Nanocrystalline Thin Films.

As Joint Supervisor

11. **Rejeesh R**, Roll No. 18MT91R12-Institute (Supervisor- Prof. D. Chakrabarti, IIT Kharagpur, Joint Supervisor – Prof. R. Mitra)
Area of Research: Study on the impact toughness and fracture toughness of high-strength steels
12. **Marupalli Bharatcharan Goud**, Roll No. 17MT91R05-Institute (Supervisor-Prof. S. Aich, IIT Kharagpur, Joint Supervisor – Prof. R. Mitra)

Area of research: Shape memory of alloys

13. **Koushik Bera**, Roll No. 17MT92R01-Institute (Supervisor: Prof. Anushree Ror, IIT Kharagpur, Joint Supervisor – Prof. R. Mitra)
Area of Research: Nano-materials
14. **Ankita Bhattacharya**, Roll No.16MT91R05-Institute(Supervisor- Prof. D. Chakrabarti, IIT Kharagpur, Joint Supervisor – Prof. R. Mitra)
Area of Research: Development of high strength - high toughness steels for strategic applications
15. **Swarnalata Behera**, Roll No.15MT91Q01-QIP (Supervisor- Prof. D. Chakrabarti, IIT Kharagpur, Joint Supervisor – Prof. R. Mitra)
Area of Research: Microstructure, texture, mechanical property relationship in high-carbon steel

M.Tech Theses (Completed)

1. Adarsha Ranjan Mishra, “Processing of near-net shaped ZrB₂-based UHTC composites and their structure-property correlation,” May 2022.
2. Onkar Nath Pandey, “Creep crack growth behaviour of IN617 alloy,” May 2022.
3. Md. Ahsan Ali, “Evaluation of Creep Crack Growth (CCG) rate of SS304HCu welds required for integrity assessment of components,” May 2020
4. Swapnil Morankar, “Study of Structure-Property Relationships of Nb-Silicide Based Refractory Intermetallic Composites with Mo and Fe Additions”, May 2019.
5. Sambhagni Varna, “Microstructural evolution and mechanical behaviour of Cu-Ti thin films containing nanocrystalline and/or amorphous phases”, May 2019.
6. Aditya Kumar, “Effect of Boron and Zirconium on structure property correlation of Nb-Mo-Si alloys,” May 2018.
7. Bhavya Kumari, “Effect of Fe addition on the initial stage oxidation behaviour of multiphase Mo-Si-B alloy at 1150 oC,” May 2017.
8. Soumyajit Jana, “Effect of Cerium addition on properties of ZrB₂-based ultra-high temperature ceramics,” May 2017.
9. Deepak Kumar, “Effect of Boron and Zirconium on Structure-Property Correlation of Nb-Si-Mo Alloys,” May 2017.
10. Devesh Mukherjee, “Some studies on the mushy state rolling of Al-4.5Cu alloy based in-situ composites reinforced with TiB₂ particles, May 2017
11. Vamsi Sai Krishna, “Oxidation Behavior of Mo-Si-B Alloys,” May 2016.
12. Soma Hansda, “Structure and properties of nanocrystalline nickel films,” May 2016
13. Ashish Kumar, “Mechanism of creep failure in 9Cr-1Mo Steel,” May 2016.
14. Sunil Kashyap, “Processing-microstructure-property relations in LaB₆-ZrB₂-SiC composites prepared by pressureless sintering and spark plasma sintering of composites,” May 2015
15. Kumar Bhaskar, “Mechanical behavior of Ni-TiN nanocomposite thin films,” May 2015
16. Bibhu Prasad Sahu, “Structure and properties of Ni-TiN coatings on weathering steel,” May 2014
17. Dipanjan Kumar, “Oxidation and creep behavior of pressureless sintered ZrB₂-SiC-Si₃N₄ composites,” May 2014
18. Venkat Appala Narasaya, “Mode - I and Mixed-mode fracture behavior of 2024Al alloy in different aging conditions,” May 2014
19. Kumar Karthik Imaneni, “Non-isothermal oxidation behavior of molybdenum silicide matrix composites,” May 2014
20. Rahul Raghav, “Recovery and Efficacy of Cored Wire Injection in Steel Melt,” May 2013.
21. Santu Chakraborty, “Creep behaviour of pressure-less sintered ZrB₂-SiC composites,” May 2013
22. Barna Roy, “Transient stage Oxidation behaviour of Mo-Si-B alloy,” May 2012.
23. Jishnu Jyoti Bhattacharya, “Creep behaviour of Al-SiC composites,” May 2011.
24. K. Pavitra, “Wear behaviour of mushy state rolled Al-4.5Cu-5TiB₂ composite,” May 2011.

25. Kumud Kant Mehta, "Effect of varying cooling rate after solutionising on low cycle fatigue and cyclic stress strain behaviours of nickel base superalloy "Supercast 247", May 2009.
26. Arindom Bardhan, "Processing and structure-property relations of titanium and titanium-nickel thin films," May 2009.
27. R. Padhasaradhi, "Effect of rare earth additions on oxidation behaviour of molybdenum-silicide based alloys," May 2009.
28. Adiraj Behra, "Structure-property relations in In-Situ Al-Matrix composites subjected to mushy state forming," May 2009.
29. Kadali Neelima, "Structure-property relation in niobium silicide based ternary alloys," May 2008.
30. Vangala Sreedhar, "Effect of superficially applied CeO₂ coatings on the isothermal and cyclic oxidation behaviour of Ti-6Al-4V at high temperatures," May 2008.
31. Dibyendu Chatterjee: "Characterization of third generation nickel base superalloy single crystals with respect to as cast orientation and creep property" May 2008.
32. Atish Kumar Hatui, "Creep behaviour of P/M processed and hot rolled Al-SiC_p composites," May 2008.
33. Upender Sankari: "Structure-property relations in zirconium diboride based ultra high temperature ceramic (UHTC) composites," May 2007.
34. N.A.P. Kiran Kumar, "Structure-Property Relations of Nanocrystalline Cu-Ni Alloy Produced by Pulse Electrodeposition Technique," May 2006.
35. Subrata Chakraborty, "Damage Analysis of Thermally Cycled Zirconium Diboride Based Ultra High Temperature Ceramic Composites," May 2006.
36. Shubhakant Nayak, "Correlation Between Elastic Constants and Thermal Shock Behaviour of Intermetallics and Their Composites," May 2006.
37. Chandan Sarkar, "Forming Behaviour of Al-4.5Cu Alloy and Al-4.5Cu – TiB₂ Composite in Mushy State," May 2005 (**Awarded the Best Thesis in Foundry**).
38. Jogendra Majhi, " Isothermal Oxidation Behaviour of MoSi₂ and Mo-Si-W Ternary Alloys in the Temperature Range of 400°-900°C," May 2005.
39. Arvind Kumar Srivastava, "Microstructure and Mechanical Behaviour of Mo-Si-B Alloys with and without Al Alloying," May 2004.
40. Sharma Paswan, "Intermediate Temperature Oxidation Behaviour of Mo-Si-B and Mo-Si-B-Al Alloys," May 2004.
41. Sharmilee Pal, "Study of Interfaces in P/M 2124 Al Alloy-SiC and In-Situ Al-TiC Metal Matrix Composites," May 2004.
42. V. Siva Challapathi Rao, "Interface Characterization of SiC_p Reinforced Al Metal Matrix Composites," December 2002.

SPONSORED PROJECTS (>Rs. 16 Crores as PI)

1. Study of crack growth mechanism of nickel base superalloy GTM Su718 under constant load at elevated temperatures; PI: Prof. R. Mitra, Co-PI: Prof. Debalay Chakrabarti; Sponsor: GTRE (CARS) Bengaluru; Amount: Rs. 82.9285 Lakhs; 05-01-2023 onwards (On-going)
2. Development of high performance materials for various defence related applications; PI: Prof. R. Mitra, Co-PI: Prof. S. Kar, Prof. I. Sen, Prof. D. Chakrabarti, Prof. S. Mandal, Co-I: Prof. K. Biswas, Prof. S. Dhara; Sponsor: DRDO; Amount: Rs. 442.45 Lakhs; 30-01-2019 to 29-07-2023.
3. Research services for studying and analyzing the phenomenon of segregation in T-72/T-90 PYT barrels; PI: Prof. R. Mitra, Co-PI: Prof. D. Chakrabarti; Sponsor: Metal and Steel Factory, Ishapore, Nawabgunj, North 24 Parganas; Amount: Rs. 18 Lakhs. Duration: 31-07-2018 to 31-10-2020 (Consultancy)
4. Evaluation of Creep Crack Growth (CCG) Behaviour for IN625 Cast Material; PI: Prof. R. Mitra, Co-PI: Prof. D. Chakrabarti; Sponsor: National Mission Project on Advanced Ultra Supercritical Technology, IGCAR; Amount: Rs. 422.99 Lakhs; Duration: 01-12-2017 to 31-01-2021.

5. Evaluation of Creep Crack Growth (CCG) Behaviour of SS 304HCu Weld Material; PI: Prof. R. Mitra, Co-PI: Prof. D. Chakrabarti; Sponsor: National Mission Project on Advanced Ultra Supercritical Technology, IGCAR; Amount: Rs. 419.05 Lakhs; Duration: 01-12-2017 to 31-01-2021.
6. Structure - Property Relations of C_f-SiC Composites Prepared by Chemical Vapor Infiltration (GTMAP). PI: Prof. R. Mitra, Co-PI: Prof. K. Biswas; Sponsor: ARDB (GTMAP), DRDO; Amount: Rs. 35.36 Lakhs; Duration: 07-04-2017 to 05-09-2021.
7. Evaluation of Fracture and Fatigue Crack Growth (FCG) for IN625 Cast Material; Sponsor: National Mission Project on Advanced Ultra Supercritical Technology, IGCAR; Amount: Rs. 478.77 Lakhs; Duration: 01-12-2017 to 31-12-2020.
8. Evaluation of Fracture and Fatigue Crack Growth (FCG) Behaviour of SS304HCu Weld Material; PI: Prof. D. Chakrabarti, Co-PI: Prof. R. Mitra; Sponsor: National Mission Project on Advanced Ultra Supercritical Technology, IGCAR; Amount: Rs. 470.63 Lakhs; Duration: 01-12-2017 to 31-12-2020.
9. Modelling of Oxidation and Exfoliation of Oxide in Grade T91 Steel; PI: Prof. S. Mandal, Co-PI: Prof. R. Mitra; Sponsor: NTPC, New Delhi; Amount: Rs. 20.39 Lakhs; Duration: 01-05-2018 - 31-04-2020.
10. Microstructure Engineering to Enhance Resistance Against Creep & High Temperature Hot Corrosion in a Ni-Based Superalloy. PI: Prof. S. Mandal; Co-PI: Prof. R. Mitra; Science and Engineering Research Board (SERB); Amount: Rs. 47.2805 Lakhs, Duration: 20-09-2016-19-09-2019.
11. Comparative study of the isothermal/cyclic oxidation behavior of molybdenum silicide based alloys and composites in wet and dry air, and effect of prior oxidation on their creep strengths. PI: Prof. R. Mitra, Co-PI: Prof. J. Das; Sponsor: DRDO ER&IPR; Amount: 36.02505 Lakhs, Duration: 26.09.2013 to 31.03.2017.
12. Microstructural evaluation and structure property correlations for nickel, titanium and iron based alloy systems. PI: Prof. R. Mitra; Sponsor: GE India Technology Center Pvt. Ltd., Plot No. 122, EPIP Phase II, Hoodi Village, Whitefield Road, Bangalore-560 066; Amount: Rs. 9 Lakhs (Completed).
13. Development of Niobium Silicide Based Alloys and Composites for Elevated Temperature (Defence Research and Development Organization, Rs. 32.37 Lakhs); with Prof. K.K. Ray (as PI), Prof. S.K. Roy (Co-PI) (Completed)
14. Development of high temperature oxidation resistant tungsten based bulk refractory alloys (Defence Research and Development Organization, Rs. 27.30 Lakhs); with Prof. S.K. Pabi (as PI) (Completed)
15. Life Estimation and Microstructural Damage of Irradiated and Un-irradiated Cu-Cr-Zr Alloy (BRFST, Gujarat, Rs. 30.38 Lakhs) (Completed), with Prof. K.K. Ray as PI.
16. Effect of Rare Earth Additions on Oxidation Behavior of Molybdenum and Niobium Silicide (Defence Research and Development Organization, Rs. 14.31 Lakhs); Principal Investigator: Dr. Rahul Mitra ; CO-PI: Prof. S. K. Roy (Completed).
17. Structure-Property Relations In Ceramic Composites For High Temperature Applications In Nose Cone Tiles Of Hypersonic Vehicles (Defence Research and Development Laboratory, Rs. 72.96 Lakhs) Principal Investigator: Dr. Rahul Mitra ; Co-PI: Prof. K. K. Ray (Completed).
18. Effect of Cyclic Oxidation and Residual Stresses on Oxidation Kinetics and Mechanisms of Molybdenum Silicide Based Alloys and Composites (Defence Research and Development Organization, Rs. 22.95 Lakhs) Principal Investigator: Dr. Rahul Mitra ; CO-PI: Prof. S. K. Roy (Completed).
19. Development of High Strength In-Situ Al-TiC Composites (Defence Research and Development Organization, Rs. 31.56 Lakhs) Principal Investigator: Prof. M. Chakraborty ; CO-PI: Dr. Rahul Mitra (Completed).

20. Synthesis and Characterization of Nanostructured Materials for Functional and Structural Applications (Department of Science and Technology, Rs. 279.51 Lakhs) Principal Investigator: Prof. I. Manna ; Co-PIs: Prof. Samit Ray, Dr. Rahul Mitra (Completed).
21. Modernization of Mechanical Testing Laboratory (Ministry of Human Resource Development, Rs. 14 Lakhs), PI: Prof. Rahul Mitra.

CONFERENCE PRESENTATIONS (AS THE PRESENTING AUTHOR)

1. “Structural evolution, mechanical and corrosion behavior of $\text{Ni}_x\text{Zr}_{1-x}$ alloy thin films processed by dc magnetron co-sputtering,” Third International Conference on Nanomaterials: Synthesis, Characterization and Applications (ICN 2018), Mahatma Gandhi University, Kottayam, Kerala, 11-13 May 2018 (INVITED).
2. “Structure and Chemistry of Interfaces in Sintered SiC and ZrB_2 - SiC Based Composites,” International Conference and XXXVIII Annual Meeting, Electron Microscope Society of India, Mahabalipuram, 17-19 July, 2017 (INVITED).
3. “Molybdenum and niobium silicide based multiphase alloys: structure-property relations and high temperature oxidation behavior,” International Conference in Materials Engineering, IIT Kanpur, June 2-4, 2017 (INVITED).
4. “Mechanical properties of ceramic matrix composites” DST-SERB School on Mechanical Testing 2017, Department of Materials Engineering, IISc Bangalore, May 29, 2017 (INVITED).
5. “Mechanical properties of ceramic materials” DST-SERB School on Mechanical Testing 2017, Department of Materials Engineering, IISc Bangalore, May 29, 2017 (INVITED).
6. “Transmission Electron Microscopy,” Short term course on "Processing, Characterization and Applications of Advanced Materials" (PCAAM-2017), Department of Metallurgical and Materials Engineering, National Institute of Technology, Durgapur-713209, February 27-March 03, 2017 (INVITED).
7. “Nano-tribological and corrosion behavior of Ni-TiN and $\text{Ni-(Ni}_x\text{Zr}_{1-x})$ nanocomposite thin films,” Advances in Materials Engineering, 3rd Indo-Austrian Symposium on Materials Engineering, Indian Institute of Technology Bombay, Powai, Mumbai, December 18-19, 2016. (INVITED)
8. “Development of composite materials for light-weight and high temperature structural applications,” INAE Annual Convention, SAC-ISRO, Ahmedabad, December 8-9, 2016.(INVITED-NEW INAE FELLOW LECTURE)
9. “Evolution of Materials Education and approach for training research professionals,” 70th Annual Technical Meeting 2016, Indian Institute of Metals, Indian Institute of Technology, Kanpur, November 11-14, 2016 (INVITED).
10. “Effect of Reinforcements on Creep, Thermal Shock, Oxidation and Ablation Behavior of ZrB_2 and HfB_2 Based Ultra-high Temperature Ceramic Composites,” 70th Annual Technical Meeting 2016, Indian Institute of Metals, Indian Institute of Technology, Kanpur, November 11-14, 2016 (INVITED).

11. "Effect of reinforcement additions and W-contamination on mechanical and thermal properties as well as oxidation and ablation properties of ZrB₂ based ultra-high temperature ceramic composites," International Conference on Advances in Materials and Materials Processing, IIT Kharagpur, November 5-7, 2016. (INVITED)
12. "Effect of Mushy-State Rolling on Microstructure and Tensile Creep Behaviour of Al_{4.5}Cu Alloy and In-situ Al_{4.5}Cu-5TiB₂ Composite," Materials Science and Technology 2016, Salt Lake City, Utah, October 21-27 (2016).
13. "Effect of SiC Content on Thermal and Ablation Properties of Pressureless Sintered ZrB₂-based UHTCs," Materials Science and Technology 2016, Salt Lake City, Utah, October 21-27 (2016).
14. "Effect of Zr addition on oxidation behavior of Mo-Si-B alloys in dry and moist environments," Materials Science and Technology 2016, Salt Lake City, Utah, October 21-27 (2016).
15. "Creep and Stress Rupture," Workshop on Materials Characterization: Principles and Practices Indian Institute of Engineering Science and Technology, Shibpur, July 25 – August 5, 2016. (INVITED)
16. "Microstructural Evolution and Structure-Property Relationships of Mushy State Rolled In-Situ Al-4.5Cu-5TiB₂ Composite," International Conference on Metals and Materials Research, Indian Institute of Science, Bangalore – 560 012, June 20-22, 2016 (INVITED)
17. "Imaging, micro-texture analysis and nano-scale patterning using FIB-FEG scanning microscopy," International Conference on Electron Microscopy, EMSI – 2016, Varanasi, June 2-4, 2016 (INVITED)
18. "Transmission Electron Microscopy," National Workshop on X-ray Powder Diffraction, Dynamic Light Scattering, Scanning and Transmission Electron Microscopy (NXDST-2016), Punjab University, Chandigarh, March 15-21, 2016.
19. "Advanced imaging and in-situ techniques for study of interfacial phenomena and deformation behavior of materials," Workshop on Advanced Probing techniques in TEM, Indian Institute of Technology Guwahati, February 15-16, 2016 (INVITED)
20. "Effect of Ceramic Reinforcements on Densification, Structure and Properties of ZrB₂ Based UHTCs," Workshop on Ultra High Temperature Ceramics for Thermo-structural Applications, Materials Research Centre, IISc, Bangalore, December 15, 2015 (INVITED)
21. "High Temperature Structural Intermetallics for Gas Turbine Applications," ASME 2015 Gas Turbine India Conference, Hyderabad, India, December 2-3, 2015 (INVITED)
22. "The Role of Interfaces in High Temperature Mechanical Behavior of Molybdenum Silicide and Zirconium Diboride Based composites," Electron Microscopy Society of India – 2015, Mumbai July 7-9, 2015 (INVITED)
23. "Structure-property relations in reactively co-sputtered Ni-TiN nanocomposite thin films," 78th Annual Session of the Indian Ceramic Society, Jamshedpur, February 2 -3, 2015 (INVITED)
24. "Structure-property relations in reactively co-sputtered Ni-TiN nanocomposite thin films," 3rd International Conference on Laser and Plasma Application in Materials Science (LAPAMS 2015) January 15-17, 2015 (INVITED)

25. "Study of Internal Interfaces and Deformation Mechanisms Using Transmission Electron Microscopy," Workshop on Current Trends of Research on Electron Microscopy in Materials Science, Central Glass and Ceramic Research Institute, Kolkata, December 22, 2014 (INVITED)
26. "Effect of mushy state rolling on the tensile creep behavior of Al-4.5Cu alloy and in-situ Al-4.5Cu-5TiB₂ composite," Conference on Advances in Light Metals and Composites (CALM 2014) in honour of Prof. M. Chakraborty, December 6-7, 2014, SRM University, Kattankulathur, Chennai (INVITED)
27. "Mechanical Behavior of Composite Materials: Some interesting results and surprises," 68th Annual Technical Meeting, College of Engineering, Pune, November 11-14 (2014) (NMD AWARD-METALLURGIST OF THE YEAR AWARD-METAL SCIENCE CATEGORY)
28. "Mechanical Behavior and Oxidation Resistance of Ultra-High Temperature Structural Materials," 67th Annual Technical Meeting, IIT-BHU Varanasi, November 11-14 (2013) – (PLENARY TALK INVITED)
29. "Interfaces in ZrB₂-SiC Composites" EMSI Conference, Kolkata, July 5-7, 2013 (INVITED)
30. "Structure-Property Relations of Interfaces in Metal and Ceramic Matrix Composites," Conference-cum Workshop on Electron Microscopy, IIT-BHU, December 6-8, 2012 (INVITED)
31. "Processing and Elevated Temperature Creep, Oxidation and Ablation Behavior of ZrB₂ and HfB₂ Based Ultrahigh Temperature Ceramic Composites," Design and Development of Materials for Advanced Technologies, Department of Metallurgical Engineering, IT-BHU, Varanasi, January 23-24, 2012 (INVITED)
32. "Research on High Temperature Materials," Workshop on High Temperature Materials & Processing, Aeronautical Research and Development Board, Indian Institute of Science, Bangalore, April 27, 2012 (INVITED)
33. "Mechanical, Thermophysical and Oxidation Behavior of Zirconium Diboride and Hafnium Diboride Based Ultrahigh Temperature Ceramic Composites" Indo-French Seminar on "High Performance Composites for Aeronautics and Space Applications and Extreme Environments," Bangalore, India, November 30 – December 2, 2011 (INVITED)
34. "Processing- Microstructure-Property Relations of Pressure-less Sintered ZrB₂-SiC Composites," TMS Fall Meeting, Columbus, Ohio, October 16-20, 2011
35. "Effect of Age-Hardening on Dry Sliding Wear Behaviour of Mushy State Rolled In-Situ Al-4.5Cu-5TiB₂ Composite," K.K. Chawla Symposium, TMS Fall Meeting, Columbus, Ohio, October 16-20, 2011
36. "Effect of hot rolling temperature and thermal cycling on creep and damage behavior of powder metallurgy processed Al-SiC_p composites," K.K. Chawla Symposium, TMS Fall Meeting, Columbus, Ohio, October 16-20, 2011
37. "Age-hardening and Tensile Deformation Behavior of Mushy State Rolled Al-4.5Cu Alloy and In-Situ Al-4.5Cu-5TiB₂ Composite," Indo-Austrian Symposium 2010: Advanced Materials Engineering, Non-Ferrous Materials Technology Development Corporation, Hyderabad, December

8-9, 2010 **(INVITED)**.

38. "Oxidation Behavior of Mo-Si-B-(Al,Ce) Ultrafine Composites," 2010 MRS Fall Meeting, Materials Research Society, Boston, Massachusetts, USA, November 29 – December 03, 2010.
39. "Compressive Deformation Behavior of Hypoeutectic and Hypereutectic Nb-Si-Mo Alloys," 2010 MRS Fall Meeting, Materials Research Society, Boston, Massachusetts, USA, November 29 – December 03, 2010.
40. "Sliding Wear Behavior of In-Situ Al-4.5Cu-5TiB₂ Composite Processed by Single and Multiple Roll Passes in Mushy State," *Deformation, Wear and Fracture – 2010*, at the Metallurgical and Material Engineering Department, Jadavpur University, March 24- 25, 2010 **(INVITED)**.
41. "Effect of Thermal Cycling on Microstructure and Creep Behavior of Powder Metallurgy Processed and Hot Rolled Al and Al-SiC Particulate Composites," Materials Science and Technology Conference 2009, Pittsburgh, Pennsylvania, USA, October 25-29, 2009.
42. "Effect of Particulate Volume Fraction on Mechanical Properties of Pressure-Less Sintered ZrB₂-SiC Ultra High Temperature Ceramic Composites," Materials Science and Technology Conference 2009, Pittsburgh, Pennsylvania, USA, October 25-29, 2009.
43. "Effect of Alloying with Al on Non-Isothermal and Cyclic Oxidation Behavior of Mo-Si-B Alloys, Materials Science and Technology Conference 2009, Pittsburgh, Pennsylvania, USA, October 25-29, 2009.
44. "Role of Interfaces in Deformation Behavior of Metal and Intermetallic Matrix Composites," Workshop on Interface Related Mechanical Behavior of Materials, UGC Networking Resource Centre for Materials (NRC-M), Department of Materials Engineering, Indian Institute of Science, Bangalore 560 012, October 12-13, 2009 **(INVITED)**.
45. "Tough Molybdenum and Niobium Silicide Based Intermetallic Alloys with High Temperature Strength and Oxidation Resistance," *61st Annual Technical Meeting, Indian Institute of Metals*, Jamshedpur, November 15 – 16, 2007 **(INVITED)**.
46. "Mushy State Rolling of Al-4.5Cu Alloy and Al_{4.5}Cu-5TiB₂ Composite: Alligatoring and Structure-Property Relations," *Deformation and Damage – 2007*, at the Metallurgical and Material Engineering Department, Jadavpur University, 24- 25 January, 2007 **(INVITED)**.
47. "Structure-Property Relations in Nanocrystalline Copper and Copper-Nickel Alloy Produced by Electrodeposition Technique," *60th Annual Technical Meeting, Indian Institute of Metals*, Jamshedpur, November 14 – 16, 2006.
48. "Effect of Electrodeposition Parameters on Composition, Grain Size and Hardness of Nanocrystalline Ni-W and Cu-Ni Alloys," *8th International Conference on Nanostructured Materials*, Indian Institute of Science, Bangalore, August 20-25, 2006.
49. "Structure-property relations in molybdenum and niobium silicide based composites," *International Conference on Advanced Materials Design and Development (ICAMDD)*, Goa Marriott Resort, Goa, December 14-16, 2005 **(INVITED)**.
50. "A Comparison of Grain Size Measurements by X-Ray Diffraction and Transmission Electron Microscopy Methods," *International Symposium on Advanced Materials and Processing*, IIT,

Kharagpur, December 6-8, 2004.

51. "Microstructure and Mechanical Behaviour of Multiphase Mo-Si-B Alloys," *58th Annual Technical Meeting, Indian Institute of Metals*, Thiruvananthapuram, November 17 – 19, 2004.
52. "Chemical Reaction Control and Deformation Response at the Interfaces in Cast Al-SiC_p Composites," *57th Annual Technical Meeting of The Indian Institute of Metals*, Kolkata, India, November 14-16, 2003.
53. "Effect of Microstructural Parameters and Al-alloying on Creep Behaviour, Threshold Stress and Activation Volumes of Molybdenum Disilicides," *57th Annual Technical Meeting of The Indian Institute of Metals*, Kolkata, India, November 14-16, 2003.
54. "High Temperature Deformation and Oxidation Behaviour of Molybdenum Disilicides," *14th Annual General Meeting, Materials Research Society of India*, Mumbai, February 11-13, 2003. **(MRSI MEDAL LECTURE, INVITED).**
55. "Molybdenum-Silicides Based Materials: Structure Property Relationships," *56th Annual Technical Meeting of The Indian Institute of Metals*, Vadodara, India, November 14-17, 2002.
56. "Elevated Temperature Deformation Behaviour of Molybdenum Disilicide with different Grain Size and SiO₂ Content," *56th Annual Technical Meeting of The Indian Institute of Metals*, Vadodara, India, November 14-17, 2002.
57. "Molybdenum Silicides: Processing-Structure-Property Relationships and Future Trends," *Nonferrous Meet - 2002*, Nonferrous Materials Technology Development Corporation, Hyderabad, June 28-29, 2002**(INVITED).**
58. "High temperature mechanical properties of MoSi₂-based materials," *International Conference on Advances in Materials and Materials Processing*, Indian Institute of Technology, Kharagpur, February 1 – 3, 2002.
59. "Structure and Properties of Sputtered Multilayered Al-Ti Films and Al-Al₃Ti Nanocomposites formed on Annealing," *55th Annual Technical Meeting of The Indian Institute of Metals*, Bhubaneswar, India, November 18-21, 2001.
60. "Effect of Grain Size and Al Alloying on Deformation Behaviour of MoSi₂ at Elevated Temperatures," *55th Annual Technical Meeting of The Indian Institute of Metals*, Bhubaneswar, India, November 18-21, 2001.
61. "Nanocrystalline Nickel Films: Processing, Structure and In-situ Deformation," *Conference on Perspectives in Physical Metallurgy and Materials Science*, Indian Institute of Science, Bangalore, July 12-14, 2001**(INVITED).**
62. "Processing and Characterization of Nanocrystalline Nickel Films," *International Workshop on Nano-materials*, Saha Institute of Nuclear Physics, Kolkata, February 5 – 8, 2001.
63. "Effect of Processing Methods on Purity and Structure of Internal Interfaces and High Temperature Strength of MoSi₂ and MoSi₂-SiC Composites," *64th Annual Session of The Indian Ceramic Society*, Hyderabad, January 28 – 31, 2001.
64. "In-situ TEM Straining of Sputtered Free Standing Nanocrystalline Nickel Films," *54th Annual Technical Meeting of The Indian Institute of Metals*, Bhubaneswar, India, November 14-17, 2000.
65. "Effect of Annealing on Microstructure and Properties of Al-Ti Multilayered Films," *Symposium V:*

Thin Films-Stresses and Mechanical Properties VIII, MRS Fall Meeting, Boston, U.S.A., November 29 - December 3, 1999.

66. "Assessment of Grain Size Distributions in Nanocrystalline Copper and their effect on Mechanical Behavior," *The Julia R. Weertman Symposium, TMS Fall Meeting, Cincinnati, Ohio, U.S.A., October 31 - November 4, 1999.*
67. "Microstructural evolution in Al-Ti Multilayered Film with Annealing," *Microscopy and Microanalysis Conference, 1999, Microscopy Society of America Portland, Oregon, U.S.A., August 1-5, 1999.*
68. "TEM Study of Nanocrystalline Ni Films grown by DC Magnetron Sputtering," *Microscopy and Microanalysis Conference, 1999, Microscopy Society of America, Portland, Oregon, U.S.A., August 1-5, 1999.*
69. "Molybdenum and Titanium Silicide Based Composites and Alloys," *Second International Symposium on Structural Intermetallics, SevenSpringsMountain Resort, Champion, Pennsylvania, USA, September 21-25, 1997.*
70. "Processing-microstructure-property relationship in MoSi₂ and MoSi₂ matrix composites," *Second International Conference on Advances in Composites, Indian Institute of Science, Bangalore, India, Dec. 18-20, 1996.*
71. "Reaction hot pressed silicides and silicide matrix composites," *59th Annual Session, Indian Ceramic Society, Madras, India, January 10-11, 1996.*
72. "Microstructure and properties of reaction hot pressed MoSi₂ and MoSi₂/SiC composites," *49th Annual Technical Meeting, Indian Institute of Metals, Calcutta, India, November 14-17, 1995.*
73. "Liquid phase displacement reaction assisted sintering of Al/TiC composites," *49th Annual Technical Meeting, Indian Institute of Metals, Calcutta, India, November 14-17, 1995.*
74. "Interfacial phenomena in discontinuously reinforced metal matrix composites," *Indo-US Workshop on Nucleation and Growth in Solids, Indian Institute of Science, Bangalore, March 14 – 16, 1994.*
75. "Structure and energies of interfaces in Al/TiC metal matrix composites prepared by in-situ process," *47th Annual Technical Meeting, Indian Institute of Metals, Hyderabad, India, November 17-19, 1993.*
76. "Interfaces in Al/TiC_p metal matrix composites," *John E. Hilliard Symposium, Northwestern University, Evanston, Illinois 60208, U.S.A., May 14, 1992.*
77. "Modification of microstructure and mechanical properties in XDTM Al/TiC metal matrix composites by 913 K exposure," *Symposium on Development of Ceramic and Metal Matrix Composites, TMS Annual Meeting, San Diego, CA, U.S.A., March 1-5, 1992.*
78. "Study of interfaces in XDTM Al/TiC_p metal matrix composites," *Symposium on Structure and Properties of Interfaces in Materials, MRS Fall Meeting, Boston, Massachusetts, U.S.A, December 2-5, 1991.*

DMRL TECHNICAL REPORTS

1. **R. Mitra**, N. Eswara Prasad, A. Venugopal Rao, V. V. Rama Rao, M. Sreenivasa Rao, R. Mohan Rao and J. Subrahmanyam, "Effect of processing and microstructure on mechanical behaviour of MoSi₂, MoSi₂-SiC and in-situ MoSi₂-Al₂O₃ composites," *DMRL TR 2001295* (2001).

2. M. K. Jain, **R. Mitra**, S. V. Kamat and J. Subrahmanyam, "Niobium foil reinforced molybdenum di-silicide matrix laminated composites: processing, microstructure and properties," *DMRL TR 2000291* (2000).
3. A. Chakraborty, S. V. Kamat, **R. Mitra**, K. S. Prasad, M. K. Jain, R. Mohan Rao, V. V. Rama Rao and J. Subrahmanyam, "Feasibility studies for processing of Al_2O_3 -SiC composites by incorporating different morphologies of discontinuous SiC reinforcement," *DMRL TR 2000275* (2000).
4. A. Chakraborty, **R. Mitra**, S. V. Kamat, V.V. Rama Rao, V.A. Joshi, M.K. Jain and J. Subrahmanyam, "Feasibility studies for fabricating MoSi_2 and Nb reinforced Al_2O_3 matrix composites," *DMRL TR 2000271* (2000).
5. M. K. Jain, **R. Mitra**, S. V. Kamat, V.V. Rama Rao and B.V.R. Bhat, "Nb, Mo and W particulate reinforced molybdenum di-silicide matrix composites," *DMRL TR 98246* (1998).
6. A. Chakraborty, S. Deb, **R. Mitra**, S.V. Joshi and B.V.R. Bhat, "Development of a hot nitrogen gas filtration assembly for the gas dynamic laser system," *DMRL TR 98226* (1998).
7. **R. Mitra**, M. Srinivasa Rao, V. V. Rama Rao, A. Venugopal Rao and N. Eswara Prasad, "Effect of small aluminium additions on microstructure, mechanical properties and oxidation behaviour of molybdenum di-silicide," *DMRL TR 98228* (1998).
8. **R. Mitra**, M. Srinivasa Rao, V. V. Rama Rao, N. Eswara Prasad and Y. R. Mahajan, "Titanium silicides and composites", *DMRL TR 97211* (1997).
9. **R. Mitra**, N. Eswara Prasad, V.V. Rama Rao and Y.R. Mahajan, "Processing, microstructure and properties of $\text{MoSi}_2/\text{SiC}_p$ composites", *DMRL TR 95194* (1995).