Dr. Mirtunjay Kumar

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Employment History

Oct 2023 – · · · ·

Postdoctoral Research Associate, University of Sheffield, UK

Mechanical Properties of battery materials

The project focuses on the mechanical properties of battery materials, employing advanced microscopy techniques to analyze a variety of complex metal oxides. These materials are fabricated within the FutureCAT consortium using an array of sophisticated particle consolidation methods. Specifically, the project utilizes a suite of advanced characterization methodologies, such as micromechanical testing, electron microscopy, and X-ray tomography. These techniques are employed to conduct a comprehensive evaluation of the 3D electrode microstructure, defect content, and mechanical properties or resilience. The study targets a range of cathode materials, each with unique compositions, cation-ordering patterns, and electrochemical histories.

Nov 2022 – Oct 2023

Postdoctoral Research Associate, University of Manchester, UK

Modelling the formability of light alloys during warm forming processes.

This project was focussed on the modelling the formability of light alloys during warm forming processes, so that these may be exploited to fulfil the vision of the LightForm programme. It will also involve extending current crystal plasticity models to enrich the current description of the deformed state and couple them with phase transformation and dynamic precipitation models.

Education

2013 – 2022

M.Tech−Ph.D. (Joint degree), Indian Institute of Technology Kanpur

Title of Ph.D. Thesis: *Experimental and Crystal Plasticity Simulation Study on the Deformation Behavior of Liquid Phase Sintered Tungsten Heavy Alloys.*

The thesis delves into the deformation mechanisms of Tungsten heavy alloys (WHA) used in defense and civil sectors. Utilizing neutron and x-ray diffraction, electron backscatter diffraction, and crystal plasticity simulations, the study focuses on the role of the Ni-Fe-W matrix phase in WHA's deformation behavior. It reveals that tungsten content and interactions between phases critically affect deformation. Through a detailed analysis of crystallographic texture evolution, the research highlights the importance of slip localization and shear band formation in understanding the alloy's performance and failure mechanisms. This work fills a knowledge gap in WHA deformation behavior.

Education (continued)

Title of M.Tech. Thesis: *Development of Processing-Microstructure-Mechanical Behaviour Paradigms for Tungsten Heavy Alloys.*

The thesis delves into optimizing the conventional sintering process for manufacturing Tungsten Heavy Alloys (WHA) with an emphasis on retaining dimensional stability and achieving full density. By meticulously adjusting matrix composition and sintering parameters, the study investigates microstructural evolution such as grain growth and connectivity. Electron Backscatter Diffraction (EBSD) is employed to quantify microstructural properties, and the thesis evaluates the hardness, tensile, and compressive strengths of the alloys. The research reveals that the strengths are strain rate-sensitive and further quantifies this sensitivity. Additionally, the study analyses hardness variation and examines fracture surfaces for different failure modes.

CGPA: 8.7 / 10.

2009 – 2013 **B.Tech., Metallurgical and Materials Engineering, National Institute of Technology Warangal**

B.Tech Project: *Pressureless sintering behaviour of Cu-TiB_2 composite produced by powder metallurgical technique.*

CGPA: 8.18 out of 10.

2008 **Class XII:CBSE**

School: *Jamshedpur Public School A.I.W.C, Jamshedpur.*

Score: 73.8%

2006 **Class X:CBSE**

School: *P.T.J.M. Saraswati Vidya Mandir, Bokaro.*

Score: 82.7%

Publications

Journal Articles

1. **M. Kumar**, N. Gurao, and A. Upadhyaya, "Evolution of microstructure and crystallographic texture during cold rolling of liquid phase sintered tungsten heavy alloy," *International Journal of Refractory Metals and Hard Materials*, vol. 105, p. 105 849, 2022, ISSN: 0263-4368. DOI: https://doi.org/10.1016/j.ijrmhm.2022.105849.

2. **M. Kumar**, N. Gurao, and A. Upadhyaya, "Implications of slip transition on the work hardening and texture evolution of nickel-tungsten-iron ternary alloy," *Materials Characterization*, vol. 189, p. 112 010, 2022, ISSN: 1044-5803. DOI: https://doi.org/10.1016/j.matchar.2022.112010.

3. **M. Kumar**, N. P. Gurao, and A. Upadhyaya, "Effect of tungsten content and compression on microstructure and texture evolution in liquid phase sintered heavy alloy," *Metallurgical and Materials Transactions A*, vol. 53, no. 4, pp. 1253–1266, Apr. 2022, ISSN: 1543-1940. DOI: 10.1007/s11661-021-06586-x.

4. **M. Kumar**, A. Singh, and S. Mishra, "Enriching mean-field self-consistent texture simulations using the full-field fft model," *Materials Science and Technology*, vol. 37, no. 17, pp. 1343–1352, 2021. DOI: 10.1080/02670836.2021.2007455. eprint: https://doi.org/10.1080/02670836.2021.2007455.

5. **M. Kumar**, A. Singh, V. K. Beura, and S. Mishra, "Incorporating latent hardening in visco-plastic self-consistent framework for performing texture simulations," *Materials Science and Technology*, vol. 37, no. 8, pp. 752–764, May 2021, ISSN: 0267-0836. DOI: 10.1080/02670836.2021.1946949.

6. **M. Kumar** and S. Mishra, "Revisiting taylor factor using fast fourier transform based model and its implications on work hardening," *Materials Science and Engineering A*, 2022. DOI: 10.2139/ssrn.4125910.

7 S. Mishra, **M. Kumar**, and A. Singh, "Evolution of rotated brass texture by cross rolling: Implications on formability," *Materials Science and Technology*, vol. 36, no. 12, pp. 1272–1281, Aug. 2020, ISSN: 0267-0836. DOI: 10.1080/02670836.2020.1773036.

8 B. P. Singh, **M. Kumar**, R. Jain, A. Singh, and S. Mishra, "Finite element assisted self-consistent simulations to capture texture heterogeneity during hot compression," *International Journal of Materials Research*, vol. 114, no. 3, pp. 219–230, Feb. 2023. DOI: 10.1515/ijmr-2022-0138.

9 V. S. Khairnar, A. N. Kulkarni, V. V. Lonikar, A. B. Gite, **M. Kumar**, D. P. Patil, and D. P. Kadam, "Electrodeposition of bi2te3 thin films for thermoelectric applications: Effect of electrolyte ph," *Journal of Materials Science: Materials in Electronics*, vol. 34, no. 10, p. 875, Apr. 2023, ISSN: 1573-482X. DOI: 10.1007/s10854-023-10295-z.

10 R. Jain, **M. Kumar**, K. Biswas, and N. Gurao, "Deformation behaviour of the silicon doped metastable fe50-xmn30co10cr10six complex concentrated alloy using experiments and crystal plasticity simulations," *Materials Science and Engineering: A*, p. 145 620, 2023, ISSN: 0921-5093. DOI: 10.1016/j.msea.2023.145620.

Skills

Experimental Skills

- **Scanning electron microscopy** – Scanning electron imaging, Backscattered electron imaging, Energy-dispersive X-ray spectroscopy (EDS), Electron Backscatter Diffraction (EBSD), Fractography.
- **Transmission Electron Microscopy** – Bright Field Imaging, Dark Field Imaging, EDS.
- **Optical Microscopy** – Bright field, Dark field and Differential Imaging Contrast (DIC).
- **X-ray Diffraction** – Standard measurement, Pole figure measurement, Residual stress measurement.
- **Universal Testing Machine (UTM)** – Compression testing, Tensile test, Strain Rate Jump test and Strain Relaxation test

Expertise of equipment

- TA on Transmission Electron Microscopy (FEI Tecnai T20) for two years (2016 – 2018) at MSE department
- Field Emission SEM (JEOL JSM-7100F) including Orientation Imaging Microscopy (OIM) and in-situ tensile testing for five years (Jan 2015 – Dec 2020) at Advanced Centre for Materials Science (ACMS), IIT Kanpur
- TA on Nova NanoSEM 450 (FEG-SEM) for one year equipped with Hikari EBSD camera and Octan Plus for EDS
- TA on CARL ZEISS EVO 50 W-SEM for 6 month
- TA on JEOL JSM-6010LA W-SEM for two years

Programming Skill

- MATLAB – Basics and problem-solving approaches
- Python - Basic programming and Data structure
- Programming with MATLAB
- Basics of Fortran and C++
  Version control system using GIT and GITHUB

Skills (continued)

Analytical Skill

- Full-Field Crystal Plasticity (DAMASK) and viscoplastic Fast Fourier Transform (VPFFT)
- Mean-Field Crystal Plasticity simulation (VPSC)
- Synthetic microstructure generation using Dream.3D, Neper and Voronoi Tessellation
- EBSD analysis using TSL-OIM and MTEX
- X-ray data analysis using X'Pert HighScore Plus
- Image processing of microstructure using MATLAB and ImageJ

Academic Responsibility

- Teaching Assistance (TA) for two semester in Nature and property of materials
- Teaching Assistance (TA) for two semester in Introduction to Manufacturing Processes
- Teaching Assistance (TA) for one semester in Manufacturing Process Lab
- Teaching Assistance (TA) for one semester in Process metallurgy Lab
- **Tutor** for three semester in Introduction to Manufacturing Processes Lab
- Independent user for four semester in **Transmission Electron Microscopy facility** equipped with tungsten filament
- Independent user for six semesters in **Scanning Electron Microscopy facility** equipped with FEG and tungsten filament.

Presentations

Poster Presentation

- Mirtunjay Kumar, Nilesh P. Gurao, Anish Upadhyaya, "In-situ electron back scatter diffraction study of deformation behaviour of concentrated Ni-24W-22Fe alloy." In 26th International Symposium on Metastable, Amorphous and Nanostructured Materials at IIT Madras. DOI: dx.doi.org/10.5281/zenodo.4630117

- Mirtunjay Kumar, Nilesh P. Gurao, Anish Upadhyaya, "Microstructure and texture analysis of deformation of Ni-W-Fe matrix alloy." In Microstructural Engineering 2018-19 at IIT Kanpur.

- Mirtunjay Kumar, Nilesh P. Gurao, Anish Upadhyaya, "Towards a comprehensive understanding of the role of shear bands on recrystallization texture in Ni-24W-22Fe alloy." In 7th International Conference on Recrystallization and Grain Growth at University of Ghent, Belgium. DOI: dx.doi.org/10.5281/zenodo.4630023.

Oral Presentation

- Mirtunjay Kumar, Nilesh P. Gurao, Anish Upadhyaya, "Microstructure and mechanical properties of W-Ni-Fe tungsten heavy alloy." In 46th Annual Technical Meeting of PMAI (PM2020) at Mumbai, India.

Presentations (continued)

- Mirtunjay Kumar, N. P. Gurao, A. Upadhyaya, "An automated methodology for assessing the microstructural attributes of liquid phase sintered microstructure." In Research Scholar Day 2020 at IIT Kanpur.

- Mirtunjay Kumar, N. P. Gurao, A. Upadhyaya, "Development of Processing-Microstructure-Mechanical behaviour Paradigms for Tungsten Heavy Alloys." In 5th International Conference on Powder Metallurgy in Asia (APMA 2019) at Pune, India.

- Mirtunjay Kumar, N. P. Gurao, A. Upadhyaya, "Understanding the role of shear bands on recrystallization texture of 54Ni-24W-22Fe alloy." In Research Scholar Day 2019 at IIT Kanpur.

- Mirtunjay Kumar, N. P. Gurao, A. Upadhyaya, "Deformation behaviour of dual phase tungsten heavy alloy." In NMD-ATM 2019 at Koavalam, Kerala.

- Mirtunjay Kumar, N. P. Gurao*, A. Upadhyaya, "Effect of matrix volume fraction on deformation texture evolution in two phase tungsten heavy alloy." In 18th International Conference on Textures of Materials (ICOTOM-18) at St George, Utah, USA.

- Mirtunjay Kumar, N. P. Gurao, A. Upadhyaya, "Rolling of liquid phase sintered 90W-7Ni-3Fe tungsten heavy alloy." In NMD-ATM 2016 at IIT Kanpur.

- Mirtunjay Kumar, Anish Upadhyaya "Rolling of liquid phase sintered 90W-7Ni-3Fe tungsten heavy alloy." NMD-ATM 2014 – COEP, Pune, India.

Invited Speaker

- Invited speaker in SPARC Workshop 2023 on " Advanced Tools for Hierarchical Microstructure Characterization" jointly organized by IIT Roorkee and IIT Kanpur in March, 2023.

- Invited lecture at NIT Warangal Organised by MME association jointly with IIM-Students Chapter, NITW on 15 December 2022.

- Guest Speaker in Material Advantage outreach Programme on topic "Correct and Incorrect Phase Diagrams Features" at UIET - CSJM University Kanpur in September 2019.

Certification

Specializations from Coursera

July 2023 — **Digital Technologies and the Future of Manufacturing Specialization**.

Courses
- Industrial Internet of Things (IIoT).
- Digital Twins
- Additive Manufacturing

Standalone Courses from Coursera

June 2020 — Getting Started with Python and Python Data Structures

July 2020 — Programming with MATLAB

Certification (continued)

	Introduction to advanced tomography *(with Honors)*
September 2020	Ferrous Technology I and Ferrous Technology II
June 2021	Material Behavior
July 2023	Introduction to Git and GitHub

References

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Prof. Nilesh Prakash Gurao
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Declaration

I hereby declare that the information furnished above is true to the best of my knowledge and belief.

October 4, 2023

Signature,

(Dr. Mirtunjay Kumar)