Dr. Mirtunjay Kumar

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Employment History

Oct 2023 – · · · · **Postdoctoral Research Associate,** University of Sheffield, UK

Development of Novel Solders for Sustainable Battery Technologies
Working within the research group of Prof. Russell Goodall as part of the EPSRC-funded SURFACTANT project, I focus on the design, synthesis, and characterisation of novel solder alloys aimed at improving the repairability and recyclability of electric vehicle battery assemblies. My work involves developing flux-free, multi-material joining processes and investigating wetting behaviour on laser-textured surfaces. I employ techniques such as alloy design, vacuum melting, SEM/EBSD, and XRD to establish composition–microstructure–property relationships, supporting the creation of sustainable joining methods for next-generation energy systems.

Mechanical Properties of battery materials (2 years)
I was responsible for mechanically characterising battery materials as part of the FutureCAT consortium. My work involved in-situ nano-indentation using an Alemnis indenter to assess the particle mechanics of pristine and cycled cathode materials, along with micro-computed tomography to examine their 3D electrode microstructure, defect content, and mechanical resilience. I analysed the resulting datasets to elucidate how variations in composition, cation-ordering, and electrochemical history influence mechanical behaviour, contributing to the understanding and optimisation of next-generation battery technologies.

Nov 2022 – Oct 2023 **Postdoctoral Research Associate,** University of Manchester, UK

Modelling the formability of light alloys during warm forming processes.
During my tenure, I was responsible for extending the crystal plasticity models in DAMASK, specifically to enhance our understanding of light alloys during warm forming processes. This work was a key element of the LightForm programme, enabling a more comprehensive description of the deformed state by coupling the enriched crystal plasticity models with phase transformation and dynamic precipitation simulations. By refining these computational tools, I contributed to unlocking new insights into the formability of advanced materials under industrially relevant conditions, supporting the programme's aim of realising innovative alloy processing routes.

Education

2022 **M.Tech–Ph.D. (Joint degree), Indian Institute of Technology Kanpur**
Ph.D. Thesis: *Experimental and Crystal Plasticity Simulation Study on the Deformation Behavior of Liquid Phase Sintered Tungsten Heavy Alloys.*

Developed an in-depth understanding of deformation mechanisms in two-phase tungsten heavy alloys by investigating the influence of the Ni-Fe-W solid solution matrix. Utilised advanced techniques such as neutron and X-ray diffraction, EBSD, and crystal plasticity simulations (VPSC and DAMASK) to analyse texture evolution and stress partitioning. Identified the critical role of slip localisation and shear band formation in strain localisation and failure, elucidating the anisotropic plastic behaviour of tungsten phases and the matrix. These insights advance the optimisation of WHA for enhanced performance in defence applications.

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

Optimised conventional sintering processes for tungsten heavy alloys, achieving full density while maintaining dimensional stability and strength through precise control of matrix composition and sintering parameters. Analysed microstructural evolution using EBSD, quantifying grain growth, contiguity, and connectivity over varying sintering times. Evaluated mechanical properties, revealing strain rate-dependent tensile and compressive strengths and validating the voce hardening law for hardness variation. Investigated fracture mechanisms by examining failure modes on tensile sample surfaces, enhancing understanding of material behaviour under stress.

CGPA: 8.7 / 10.

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: 8.18/10 (First Class with Distinction)

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%

Professional Development

WMG-Faraday Battery School

Topics: *Battery chemistries* (Li-ion, Na-ion, post-Li), *advanced characterization* (X-ray diffraction, tomography), *module/pack design*, BMS, *safety/testing*, recycling. **Hands-on labs**: Electrode fabrication, cell manufacturing, smart cells, forensic analysis. **Key principles**: Electrochemistry, systems engineering, predictive modeling, end-of-life management. **Outcome**: Enhanced expertise in battery R&D, directly applicable to mechanical characterization of battery materials and next-gen optimization.

Powder Diffraction Refinement Course

Topics: *Rietveld refinement* using GSAS-II software, *crystallographic data analysis*, and *XRD pattern quantification*. **Preparation**: Completed 3-hour pre-course module on XRD theory, installed/tested GSAS-II workflows. **Practical**: Hands-on refinement of multi-phase systems, error analysis, and quantitative phase characterization. **Outcome**: Enhanced capability to analyze crystallographic structures of battery materials through advanced diffraction data processing.

Publications

Journal Articles

1. **M. Kumar**, H. Ranot, T. Kamal, N. P. Gurao, and A. Upadhyaya, "Automated quantification of dihedral angles in sintered tungsten heavy alloys using image processing," *International Journal of Refractory Metals and Hard Materials*, p. 107 467, 2025, ISSN: 0263-4368. DOI: 10.1016/j.ijrmhm.2025.107467.

2. A. Jangde, **M. Kumar**, İ. T. Gülenç, L. Wheatcroft, and B. J. Inkson, "Mechanical properties of cycled single crystal $LiNi_{0.8}Mn_{0.1}Co_{0.1}O_2$ (NMC811) particles," *Batteries & Supercaps*, e202400691, 2025. DOI: 10.1002/batt.202400691.

3. P. Setia, S. S. Singh, P. Rawat, N. Tripathi, S. Mukherjee, **M. Kumar**, T. Venkateswaran, and S. Shekhar, "Mapping dynamic restoration mechanisms and flow instability in 12cr–10ni maraging steel: Microstructural insights from ebsd, tem, and xrd-line profile analysis," *Metallurgical and Materials Transactions A*, vol. 56, no. 5, pp. 1585–1604, May 2025, ISSN: 1543-1940. DOI: 10.1007/s11661-025-07714-7.

4. **M. Kumar** and S. Mishra, "Implications of the micromechanical taylor factor on work hardening parameters: New perspectives from fft simulations in damask," *Computational Materials Science*, vol. 237, p. 112 892, 2024, ISSN: 0927-0256. DOI: https://doi.org/10.1016/j.commatsci.2024.112892.

5. **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: 10.1016/j.ijrmhm.2022.105849.

6. **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: 10.1016/j.matchar.2022.112010.

7. **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.

8. **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.

9. **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.

10. 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.

11. 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.

12. 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.

13. 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.

14 V. S. Khairnar, A. N. Kulkarni, V. V. Lonikar, N. D. Jadhav, D. P. Patil, A. B. Gite, and **M. Kumar**, "Effect of concentration of electrolyte on thermoelectric properties of electrodeposited bi2te3 thin films," *Journal of Materials Science: Materials in Electronics*, vol. 35, no. 19, pp. 1–15, 2024. DOI: 10.1007/s10854-024-13138-7.

Skills

Experimental Skills

- Micro computed X-ray Tomography – Worked and trained on Zeiss Xradia Versa 620 XRM at University of Sheffield
- Neutron Diffraction – Conducted neutron diffraction for Pole figure measurement and Residual stress measurement at Garching, Germany
- 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.
- Insitu Nano-Indentation and Tensile Test – Alemnis for Indentation, MICROTEST Stages by Deben for tensile Test
- 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

Analytical Skill

- Worked on **Avizo** and **Dragonfly** for processing stack of images from **XCT**
- **Batch Image processing** of microstructure using MATLAB and **ImageJ**
- 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

Skills (continued)

Expertise of equipment

- TA on Transmission Electron Microscopy (FEI Tecnai T20) for two years (2016 – 2018) at MSE department

  Field Emission SEM (Nova nanosem 450, 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, Data structure, Seaborn and Image analysis

  Programming with MATLAB

  Basics of Fortran and C++
  Version control system using **GIT and GITHUB**

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, Misbah Mumtaz, Narayan Simrit Kaur, Anthony R West, Serena A. Cussen, Beverley J Inkson, "Intergranular Fracture of Mo-Doped Lithium Nickel Oxide (Mo-$LiNiO_2$) particles via In Situ SEM Nanoindentation." In The Faraday Institution Conference 2025 at University of Warwick.

- 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.

Presentations (continued)

- 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.

- 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

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

Available on Request

Declaration

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

November 9, 2025

Signature,

(Dr. Mirtunjay Kumar)