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Employment History

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

Mechanical Properties of battery materials

I am responsible for fabricating and mechanically characterising battery materials as part of the FutureCAT consortium, employing sophisticated particle consolidation methods to produce complex metal oxides. My work involves in-situ nano-indentation using an Alemnis indenter to assess the particle mechanics of pristine and cycled cathode materials, as well as EBSD and micro-computed tomography to investigate their 3D electrode microstructure, defect content, and resilience. I also analyse the resulting data to understand how distinct compositions, cation-ordering patterns, and electrochemical histories influence mechanical properties, thereby contributing to the 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**

Title of 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.

Education (continued)

- **Title of 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-TiB₂ 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 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}O₂ (NMC811) particles," *Batteries & Supercaps*, e202400691, 2025.  DOI: <https://doi.org/10.1002/batt.202400691>.
- 2 **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>.
- 3 **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>.
- 4 **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>.
- 5 **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](https://doi.org/10.1007/s11661-021-06586-x).
- 6 **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](https://doi.org/10.1080/02670836.2021.2007455). eprint: <https://doi.org/10.1080/02670836.2021.2007455>.

- 7 **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](#).
- 8 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](#).
- 9 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](#).
- 10 V. S. Khairnar, A. N. Kulkarni, V. V. Lonikar, A. B. Gite, **M. Kumar**, D. P. Patil, and D. P. Kadam, "Electrodeposition of BiTe_3 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](#).
- 11 R. Jain, **M. Kumar**, K. Biswas, and N. Gurao, "Deformation behaviour of the silicon doped metastable $\text{Fe}_{50}\text{Xmn}_{30}\text{Co}_{10}\text{Cr}_{10}\text{Si}_x$ 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](#).
- 12 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 BiTe_3 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

Skills (continued)

- 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**
- 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, 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.
- 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.

Presentations (continued)

- 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