Mirza Faizaan, PhD

Materials Engineering & Additive Manufacturing

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Bangalore, Karnataka, India | Open to International Relocation

Google Scholar: 25 citations, h-index: 2 | ResearchGate RIS: 45.4 | 28 citations, h-index: 2

Research Background & Interests

Materials scientist and manufacturing engineer bridging qualification-grade polymer characterization with production-scale additive manufacturing. My doctoral research (Cotutelle: MIT-MAHE + IFM, Deakin University) established process-structure-property relationships in polymer extrusion AM through 500+ specimens tested under Taguchi DOE arrays, high-resolution μ-CT void mapping (2.9 μm), and a 2,000-hour UV/humidity degradation dataset tracked via time-resolved FTIR, XRD, and DSC. Key contributions include geometric descriptors linking part architecture to parameter-insensitive performance.

Beyond the laboratory, I designed and built custom single-screw extrusion hardware, qualified high-performance polymers and composites (PEEK, Silk/PCL, CF/ABS, CF/PLA) on filament and pellet-extrusion platforms. I led technical operations at Fracktal Works Pvt. Ltd driving a 92.5% first-pass-yield improvement across a 15-printer fleet. I have deployed an agentic AI pipeline that synthesizes raw experimental data into manuscript-level output and applied vision-language models to interpret 230+ SEM fractography images, methods that position me at the intersection of materials characterization and applied AI.

I work at the interface of scientific machine learning and advanced manufacturing, pursuing data-driven process-microstructure-property models, in-situ monitoring, and high-performance material systems for aerospace and biomedical applications.

Education

Doctor of Philosophy (PhD), Cotutelle Program January 2020, October 2025
Manipal Institute of Technology, MAHE, Manipal, India & Institute for Frontier Materials, Deakin University, Australia

Cotutelle program jointly administered between India and Australia; included extended research residency at Deakin University (Waurn Ponds, VIC) and facility access at Carbon Nexus, Deakin University.

Dissertation: *Structure-Property and Weathering Studies of Additively Manufactured Lightweight Cellular Structures*

Master of Technology, Automobile Engineering 2017, 2019
Manipal Institute of Technology, MAHE, Manipal, India

Bachelor of Engineering, Automobile Engineering 2013, 2017
Dayananda Sagar College of Engineering, Bangalore, India

Research Experience

Chief of Staff (Technical Lead and Manufacturing Ops) August 2025, February 2026
Fracktal Works Pvt. Ltd., Bangalore, India

Applied research and development in polymer additive manufacturing with focus on high-performance materials qualification and process validation.

- Qualified patent-pending PCL composite blend for biomedical applications (*Osteoforge Medtech Pvt.*

Ltd.) through systematic tensile testing program (120 specimens), establishing process parameters for technology transfer to industrial partner under NDA.

- Achieved repeatable high-performance polymer (PEEK) printing on custom-built platform, demonstrating 94 MPa tensile strength across 12 consecutive prints; delivered validation samples to ISRO, National Aerospace Laboratories, and academic research institutions.
- Established systematic calibration protocols and process control methodologies, improving manufacturing repeatability from baseline 0% first-time success to 92.5% (failure rate <8%) through implementation of resonance compensation and flow control systems.
- Developed dFMEA for in-house pellet extrusion toolhead, identifying feeding mechanism failure modes and proposing design improvements for next-generation system.
- Conducted technical feasibility analysis and authored strategic research proposals for space-based additive manufacturing systems (lunar regolith processing and zero-gravity fabrication) for Indian Space Research Organisation collaboration (total value: INR 2.85 crore; proposals under review).
- Managed multi-technology additive manufacturing facility (15+ systems spanning FDM, pellet extrusion, and high-temperature platforms); used production environment as applied research testbed for parameter robustness, material qualification, and process control methodology development under real-world manufacturing conditions.

Doctoral Researcher, Cotutelle PhD Program January 2020, March 2025
Manipal Institute of Technology, MAHE & Institute for Frontier Materials, Deakin University

Independent research program investigating process-structure-property relationships in material extrusion additive manufacturing with emphasis on qualification-level testing, manufacturing variability quantification, and long-horizon durability.

- **Qualification-Scale Mechanical Testing:** Designed and executed large-N experimental programs comprising 500+ manufactured parts including 190 tensile specimens (ASTM D638), 20 flexural specimens, and 30 compression specimens tested across controlled Design of Experiments (Taguchi L9 arrays, 5 replicates per condition) with rigorous ANOVA statistical treatment to establish defensible process windows and quantify manufacturing variability.
- **Multi-Scale Defect Characterization:** Conducted high-resolution μ-CT imaging (2.9 μm voxel resolution) establishing quantitative correlations between void architecture (0.117% to 4.99% void fraction) and mechanical performance; demonstrated that toolpath-aligned porosity and inter-raster bonding dominate failure behavior over nominal material properties.
- **Long-Horizon Environmental Durability:** Designed and executed 2000-hour accelerated weathering program (UV-B + relative humidity exposure) establishing time-series mechanical degradation data; characterized degradation mechanisms through multi-modal analysis (FTIR for chemical evolution, XRD for crystallinity, DSC for thermal properties) linking chain scission reactions to progressive strength loss while demonstrating modulus stability.
- **Manufacturing Penalty Quantification in Lattice Structures:** Evaluated process-induced performance penalties in cubic-octet (Isomax) lattice structures through combined experimental testing and FEA benchmarking; demonstrated that geometric isotropy does not guarantee manufactured isotropy when process-induced anisotropy (layer interfaces, toolpath discontinuities) dominates load transfer mechanisms. Identified that compression behavior remains geometry-dominated (14% simulation-experiment mismatch) while tensile/flexural failures exhibit >50% property reduction versus idealized predictions due to inter-cell junction weaknesses.
- **Polymer Composite Development:** Investigated chopped basalt fiber (3 mm) compounding in PLA matrix using twin-screw extrusion and internal mixing; documented systematic failure modes (fiber agglomeration, brittle fracture, dimensional instability) establishing that printability constraints and

filament robustness dominate formulation success over theoretical property predictions, contributing negative-result insights to field knowledge.

- **Research Infrastructure & Management:** Established multi-technology additive manufacturing laboratory incorporating FDM, SLA, and LPBF systems at Manipal Institute of Technology. Managed annual research budget (INR 3-4 lakh) covering consumables, characterization services, and equipment maintenance; coordinated equipment procurement decisions and laboratory operations.

Research Assistant, Precursor Fiber Scale-Up October 2023, April 2024
Carbon Nexus, Deakin University, Waurn Ponds, VIC, Australia

- Supported pilot-to-production transition for carbon fiber precursor (PAN) manufacturing in collaboration with SABIC; managed end-to-end pilot line operations (6-hour runs, 3-person team) including dope preparation, inventory planning, and real-time process monitoring.
- Performed root cause analysis on filter pressure anomalies, identifying metal debris contamination in feedstock material; enabled mid-run corrective intervention preventing production halt and informing upstream quality control protocols.
- Conducted sample preparation and characterization supporting process optimization activities; produced 4 fiber spools per run meeting quality specifications for downstream carbonization trials.

Manufacturing Engineering Intern, Quality & Process Improvement May 2018, October 2018
TVS Motor Company Ltd., Mysore, Karnataka, India

- Investigated crankshaft bearing noise defects in Apache engine assembly line using 8D methodology and fishbone analysis; systematically eliminated potential failure modes to identify root cause as operator mishandling during bearing installation at two critical stations.
- Developed and implemented corrective actions including standard operating procedures, visual training materials, and process audits; achieved sustained zero-defect rate over two-week monitoring period with 66% reduction in bearing scrap costs.
- Applied coordinate measuring machine (CMM) inspection and geometric dimensioning & tolerancing (GD&T) principles during dimensional analysis to eliminate housing tolerance stack-up as potential failure source.

Publications

Journal Articles

1. **Mirza, F.**, Baloor Shenoy, S., Nunna, S., Kini, C. R., & Creighton, C. (2025). Temporal evolution of structure-property relationship for UV+RH artificially weathered material extrusion additive manufactured PLA. *Scientific Reports*. https://doi.org/10.1038/s41598-026-41192-0

2. **Mirza, F.**, Baloor Shenoy, S., Nunna, S., Kini, C. R., & Creighton, C. (2025). A study on the overall variance and void architecture on MEX-PLA tensile properties through printing parameter optimisation. *Scientific Reports*. https://doi.org/10.1038/s41598-025-87348-2

3. **Mirza, F.**, Baloor Shenoy, S., Nunna, S., Kini, C. R., & Creighton, C. (2024). Effect of material extrusion process parameters on tensile performance of pristine and discontinuous fibre reinforced PLA composites: A review. *Progress in Additive Manufacturing*. https://doi.org/10.1007/s40964-024-00825-4

4. **Faizaan, M.**, Shenoy, S., Kini, C. R., Nunna, S., & Creighton, C. (2024). Tensile and flexural performance of hybrid FDM and compression moulded PLA/Basalt biocomposite. *Materials Science Forum*, 1120, 77-84. https://doi.org/10.4028/p-duyo7m

5. **Mirza, F.**, Baloor Shenoy, S., Nunna, S., Kini, C. R., & Creighton, C. Process-structure interactions in stretching-dominated lattices: How nodal toolpath fragmentation limits geometric isotropy in MEX-AM. *Progress in Additive Manufacturing*. **Preprint**: https://doi.org/10.21203/rs.3.rs-9196136/v1

6. **Mirza, F.**, Baloor Shenoy, S., Nunna, S., Kada, S. R., & Creighton, C. Build orientation enables parameter robustness in MEX-PLA tensile properties via Shell Dominance. **[Under Review]**

Conference Proceedings

- **Faizaan, M.**, Shenoy, S., & Kini, C. R. (2024). Impact of lattice geometry on compressive strength: A finite element analysis. Accepted in conference proceedings at International Conference on Computational Methods in Engineering & Health Sciences (ICCMEH2024). [Manuscript subsequently expanded and submitted as journal article, see "Under Review" above]

Conference Presentations & Awards

Best Paper Award, International Conference on Computational Methods in Engineering & Health Sciences (ICCMEH2024), Manipal Institute of Technology, Manipal, India, December 2024.

Poster Presentation: "To what extent do FDM printing parameters really affect PLA tensile performance?" IFM Research Conference, Institute for Frontier Materials, Deakin University, Geelong, VIC, Australia, November 2023.

Paper Presentation: 3rd International Conference on Advances in Material Sciences (ICAMS2023), May 2023.

Patents & Intellectual Property

Design Patent (Granted): Mirza, F. (2024). Tensile sample mount for accelerated weathering chamber. Indian Design Patent No. 383798-001.

Note: Patent covers novel fixture design enabling exposure of gauge length region only during UV + relative humidity weathering, accommodating up to 40 ASTM D638 Type I tensile specimens with controlled environmental conditioning.

Research Skills & Techniques

Additive Manufacturing Technologies

Material Extrusion (FDM/MEX-AM), expert-level process optimization, parameter development, toolpath analysis; Pellet Extrusion Systems, process validation, material qualification; Stereolithography (SLA), equipment setup, process validation; High-Performance Polymers (PEEK, PCL), thermal management, repeatability control.

Mechanical Testing & Characterization

ASTM Standards (D638 Tensile, Flexural, Compression), 500+ specimens tested; Universal Testing Machine operation and data analysis; Fractography (SEM, Optical Microscopy), failure surface analysis; Coordinate Measuring Machine (CMM), dimensional inspection and GD&T application; Single-fiber tensile testing (FAVIMAT+).

Multi-Modal Material Characterization

Imaging: High-resolution Micro-Computed Tomography (μ-CT) at 2.9 μm voxel resolution for volumetric defect analysis; Scanning Electron Microscopy (SEM); Optical Microscopy.

Thermal & Chemical Analysis: Fourier Transform Infrared Spectroscopy (FTIR), degradation mechanism identification; X-Ray Diffraction (XRD), crystallinity quantification; Differential Scanning Calorimetry (DSC), thermal transition characterization.

Image Analysis: ImageJ, GIMP for quantitative defect morphology extraction.

Experimental Design & Statistical Analysis

Design of Experiments (DOE), Taguchi orthogonal arrays, full factorial, response surface methodology; ANOVA and regression analysis; Process capability studies; Statistical software: Minitab, OriginLab, MATLAB.

Computational Tools

Data Analysis & Visualization: MATLAB (expert), Python (data processing, statistical analysis).

Finite Element Analysis: ANSYS Workbench (structural mechanics, validation against experimental data).

CAD/CAM: SolidWorks, CATIA (mechanical design, fixturing, tooling).

Materials Processing

Polymer compounding (twin-screw extrusion, internal mixing); Filament extrusion (single-screw, lab-scale); Accelerated weathering protocols (UV-B + RH exposure up to 2000 hours); Density measurements (Archimedes principle).

AI-Assisted Research Automation & Workflow

- Designed and deployed a 5-agent autonomous research pipeline capable of producing manuscript section from raw experimental data, including ANOVA tables, S/N plots, regression figures. AI assistance disclosed per journal guidelines (manuscript under review).
- Applied a local vision-language model (Qwen3-Vision, Llava Vision via Ollama) to systematically interpret 230+ SEM fractography images across three layer thickness conditions; integrated outputs directly into down-selection and categorization for manuscript analysis.
- Pipeline capabilities: automated literature discovery; statistical analysis and figure generation; end-to-end LaTeX manuscript compilation.

Teaching & Mentorship Experience

Invited Workshop, Resource Person February 2026
"From Digital to Tactile Anatomy: A Hands-On 3D Printing Workshop"
Department of Anatomy, Kasturba Medical College, MAHE, Manipal
Delivered full-day workshop covering DICOM data processing, segmentation workflows, and FDM/SLA slicing optimisation for anatomical model fabrication; audience of medical faculty and postgraduate students.

Technical Training, Additive Manufacturing Operations 2025-2026
Fracktal Works Pvt. Ltd., Bangalore
Developed and delivered two-part structured training programme for production staff:

- *Printer Troubleshooting & Print Failure Diagnosis*, systematic fault identification, resonance compensation, flow calibration, and corrective protocols
- *Slicing Software Fundamentals*, parameter reasoning, profile development, and print strategy selection

Trained post-processing technician (non-specialist background) to full operational independence on PLA

and ABS print-farm management, including material handling safety, post-processing techniques, and quality assessment protocols.

Graduate Student Supervision 2020-2025

Manipal Institute of Technology, MAHE

Supervised and trained undergraduate and master's students in experimental methods, mechanical testing protocols (ASTM D638, flexural, compression), data management, and technical reporting. Developed training materials emphasising reproducibility, data provenance, and statistical rigour.

Research Funding & Proposals

Lead Author & Coordinator (Proposals Under Review):

- "Lunar Regolith-Based Additive Manufacturing for In-Situ Resource Utilization," proposed to Indian Space Research Organisation (ISRO) as an academia-industry collaboration. Total project cost: INR 1.85 crore (CAPEX + OPEX). **Role:** Market analysis, Feasibility Analysis Lead author for proposal (Drafted single-handedly during tenure as Chief of Staff at Fracktal Works).
- "Zero-Gravity Additive Manufacturing System for Bharat Space Station," proposed to Indian Space Research Organisation (ISRO) as an academia-industry collaboration. Total project cost: INR 1.00 crore (CAPEX + OPEX). **Role:** Market analysis, Feasibility Analysis Lead author for proposal (Drafted single-handedly during tenure as Chief of Staff at Fracktal Works).

Equipment Procurement: Secured major research infrastructure including INR 11 lakh 3Devo Composer 350 filament extruder for polymer composite development at Manipal Institute of Technology (2023).

Professional Development & Certifications

Scientific Writing and Publishing, Nature Masterclass, 2021

MATLAB Fundamentals & Introduction to Statistical Methods with MATLAB, MathWorks, 2021

Safety Induction and Training, Deakin University, 2023

Technical Competencies Summary

Additive Manufacturing: FDM/MEX-AM process optimization, pellet extrusion, SLA, high-performance polymers (PEEK, PCL), print farm operations (15+ systems), slicing optimization.

Materials Science: Polymer composites (fiber-reinforced, particulate), thermoplastics (PLA, ABS, PEEK, PCL), environmental degradation mechanisms, structure-property relationships, failure analysis.

Experimental Methods: Large-N statistical testing programs, DOE (Taguchi, RSM), ANOVA, accelerated aging protocols, multi-scale characterization (μ-CT, SEM, FTIR, XRD, DSC), mechanical testing (ASTM).

Engineering Analysis: Root cause analysis (8D, Fishbone), DFMEA, GD&T, CMM inspection, FEA (ANSYS), process capability studies, calibration protocols.

Software & Tools: MATLAB, Python, Minitab, OriginLab, ANSYS, SolidWorks, CATIA, ImageJ.

AI & Research Automation: Multi-agent pipeline design, prompt engineering, LaTeX automation, PDF/document processing pipelines, scientific figure generation.

References

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Additional references available upon request.