Shahadat Hussain, PhD

Postdoctoral Fellow · Mechanical Engineering · ADAM Lab

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Summary

In a position as a postdoctoral fellow at Khalifa University, an esteemed institution ranked 181st by QS, I am fervently engaged in a multitude of projects centered around the additive manufacturing of NiTi triply periodic minimal surface (TPMS) structures. My active collaboration with the Advanced Digital and Additive Manufacturing Center (ADAM) at KU bolsters my endeavors. Furthermore, I am fortunate to collaborate with renowned universities such as the University of Thessaly in Greece and CSIR-AMPRI in India. My contributions to the scientific community have been substantial, with numerous high-impact research papers published in esteemed journals. Equipped with adept skills, I proficiently supervise students and successfully navigate the publication process independently. Moreover, I possess valuable experience in teaching mechanical engineering to undergraduate students. My research work has been showcased on multiple occasions at both national and international conferences, amplifying its reach and impact.

Research Interests

Laser Powder Bed Fusion (LPBF), Additive Manufacturing (AM), Shape Memory alloys (SMAs), Fatigue testing, Microstructural Characterization, Thermal Analysis, High Temperature Casting, Hot Rolling, Heat Treatment

Teaching Interests

Basic Mechanical Engineering, Engineering Thermodynamics, Mechanics of Materials, Engineering Materials, Heat Transfer

Work Experience

Postdoctoral Researcher

Abu Dhabi, UAE

Mechanical Engineering, Khalifa University

Feb 2020 - Present

- Examining and characterizing the properties of additively manufactured NiTi triply periodic minimal surface (TPMS) structures, specifically Schwartz primitive and Schoen gyroid lattices, which belong to the category of porous, cellular, and architected materials.
- Performing tensile and fatigue tests on thin NiTi wires with different diameters, chemical compositions, and surface treatments (including etched, mechanically polished, etched polished, and light oxide coating) using an Instron 8872 fatigue testing machine.
- Applying various analytical techniques such as optical microscopy, SEM (Scanning Electron Microscopy), XRD (X-ray Diffraction), EDS (Energy-Dispersive X-ray Spectroscopy), metallography, heat treatment, EBSD (Electron Backscatter Diffraction), AFM (Atomic Force Microscopy), and EBSD for the investigation and analysis of the materials.
- **Technical Skills:** EBSD, AFM, Python.
- **Soft Skills:** Teamwork, Time Management, Communication, Presentation Skills.

Project Fellow

Bhopal, India

CSIR-Advanced Materials and Processes Research Institute

May 2013 - Aug 2014

- Extensive scientific research experience with experimentation, data analysis, teamwork, problem-solving, and effective communication. Proficient in relationship building, negotiation skills.
- Engaged in diverse experimental tasks: alloy synthesis, metallography, heat treatment, and material characterization using spectroscopy, microscopy, diffractometry, calorimetry, hardness, tensile, and hot rolling.
- Published 5 research articles, presented research via posters and oral presentations, collaborated with Indian Institute of Technology, Madras.
- **Technical Skills:** Induction Casting, Optical Microscopy, Tensile Testing, Hot Rolling, Heat Treatment
- **Soft Skills:** Communication Skills, Presentation, Scientific Writing, Project Management

Lecturer *Bhopal, India*

Mechanical Engineering, Oriental Group of Institutions *Sep 2012 - May 2013*

- Taught mechanical engineering subjects, covered materials science, machine component design, mechanics of materials, and basic concepts. Conducted laboratory activities for practical learning.
- Participated in ISTE workshop on Engineering Thermodynamics, gained skills in classification, problem-solving, and technical presentation.
- Positive student feedback, completed syllabus on time, promoted academic excellence, supported student improvement, established strong student relationships.
- **Technical Skills:** Teaching, Mechanical Engineering, Materials Science
- **Soft Skills:** Communication, Presentation, Time Management

Education

Academy of Scientific and Innovative Research *Bhopal, India*

PhD (Engineering Sciences) in Materials Science and Technology *Aug 2014 - Jun 2019*

- Doctoral research on Cu-Al-Ni shape memory alloys, studied impact of grain refiners, alloying additions, and processing parameters on shape memory properties for high-temperature applications.
- Published 2 research articles, and delivered 5 conference presentations.
- **Skills:** High Temperature Casting, Hot Rolling, Heat Treatment, Shape Memory Testing, Mechanical Testing, Spectroscopy

University Institute of Technology-RGPV *Bhopal, India*

Bachelor of Engineering in Mechanical Engineering *Aug 2008 - May 2012*

- Graduated with first division aggregate
- Underwent 2-week industrial training at Steel Authority of India Limited (SAIL)-Bokaro, gained practical knowledge in hot rolling, continuous casting, and machining.

Research Projects

Additive manufacturing of NiTi shape memory alloys, constitutive modeling and fatigue failure criteria *Abu Dhabi, UAE*

Khalifa University *Feb 2020 - Present*

- Involved in 3D printing of NiTi samples and TPMS structures
- Extensive characterizations performed using SEM, TEM, XRD, AFM, DSC, and fatigue testing
- Made novel findings and published research articles based on the conducted research
- **Technical Skills:** Additive Manufacturing, Overleaf, LaTeX, Python
- **Soft Skills:** Time Management, Teamwork, Presentation Skills, Report Writing.

Design and Development of Thermo-Responsive and Magnetic Shape Memory Materials and Devices for Engineering Applications *Bhopal, India*

CSIR-Advanced Materials and Processes Research Institute *Jun 2013 - Aug 2014*

- Develop copper-based shape memory materials with superior mechanical properties, high transition temperatures, and cost-effective production of shape memory wires and strips.
- Project outcomes: Published 5 research articles in scientific journals, presented at national events, collaborated with Indian Institute of Technology, Madras. Well-received oral and poster presentations.
- **Technical Skills:** Hot Rolling, High Temperature Casting, Heat Treatment, Spectroscopy, Microscopy, Mechanical Testing, Shape Memory Testing, Origin, ImageJ
- **Soft Skills:** Presentation Skills, Teamwork

Publications

- **Shahadat Hussain**, Ali N Alagha, Wael Zaki, (2024) Phase Transformation Behavior of NiTi Triply Periodic Minimal Surface Lattices Fabricated by Laser Powder Bed Fusion. Journal of Materials Engineering and Performance, `https://doi.org/10.1007/s11665-024-09162-7`.
- **Shahadat Hussain**, Ali N Alagha,Gregory N. Haidemenopoulos, Wael Zaki, (2023) Microstructural and surface analysis of NiTi TPMS lattice sections fabricated by laser powder bed fusion. Journal of Manufacturing Processes, 102:375-386, `https://doi.org/10.1016/j.jmapro.2023.07.055`.
- **Shahadat Hussain**, Ali N Alagha, Wael Zaki, (2022) Imperfections Formation in Thin Layers of NiTi Triply Periodic

Minimal Surface Lattices Fabricated Using Laser Powder Bed Fusion. Materials, 15(22) 7950, https://doi.org/10.3390/ma15227950.

- Ali N Alagha, **Shahadat Hussain**, Wael Zaki, (2021) Additive Manufacturing of Shape Memory Alloys: A Review with Emphasis on Powder Bed Systems, Materials & Design , 204:109654, https://doi.org/10.1016/j.matdes.2021.109654.
- Abhishek Pandey, **Shahadat Hussain**, Prasanth Nair, Rupa Dasgupta, (2020) Influence of niobium and silver on mechanical properties and shape memory behavior of Cu-12Al-4Mn alloys. Journal of Alloys and Compounds, https://doi.org/10.1016/j.jallcom.2020.155266.
- **Shahadat Hussain**, Abhishek Pandey, Rupa Dasgupta, (2019) Nano-CeO2 Doped Cu-Al-Ni SMAs with Enhanced Mechanical as well as Shape Recovery Characteristics. Metals and Materials International, (2021) 27:1478–1482, https://doi.org/10.1007/s12540-019-00570-2.
- Rupa Dasgupta, Abhishek Pandey, **Shahadat Hussain**, Ashish Kumar Jain, Ayub Ansari, V Sampath (2019) Effect of Microstructure on Roll-Ability and Shape Memory Effect in Cu-Based Shape Memory Alloys. Applied Innovative Research 1:29-37, http://nopr.niscpr.res.in/handle/123456789/45840.
- **Shahadat Hussain**, Abhishek Pandey, Rupa Dasgupta (2019) Designed polycrystalline ultra-high ductile boron doped Cu-Al-Ni based shape memory alloy. Materials Letters 240:157-160, https://doi.org/10.1016/j.matlet.2018.12.
- Abhishek Pandey, Ashish Kumar Jain, **Shahadat Hussain**, V Sampath, Rupa Dasgupta (2016) Effect of Nano CeO2 Addition on the Microstructure and Properties of a Cu-Al-Ni Shape Memory Alloy. Metallurgical and Materials Transactions B 47:2205-2210, https://doi.org/10.1007/s11663-016-0691-0.
- Ashish Kumar Jain, **Shahadat Hussain**, Pravir Kumar, Abhishek Pandey, Rupa Dasgupta (2015) Effect of Varying Al/Mn Ratio on Phase Transformation in Cu–Al–Mn Shape Memory Alloys. Transactions of Indian Institute of Metals 69:1289-1295, https://doi.org/10.1007/s12666-015-0689-3.
- **Shahadat Hussain**, Pravir Kumar, Ashish Kumar Jain, Abhishek Pandey, Rupa Dasgupta (2015) Effects of Different Quaternary Additions in the Properties of a Cu-Al-Mn Shape Memory Alloy. Materials Performance and Characterization 4:225-235, https://doi.org/10.1520/MPC20150017.
- Pravir Kumar, Ashish Kumar Jain, **Shahadat Hussain**, Abhishek Pandey, Rupa Dasgupta (2015) Changes in the properties of Cu-Al-Mn shape memory alloy due to quaternary addition of different elements. Revista Materia 20:284-292, https://doi.org/10.1590/S1517-707620150001.0028.
- Rupa Dasgupta, Ashish Kumar Jain, Pravir Kumar, **Shahadat Hussain**, Abhishek Pandey (2015) Role of alloying additions on the properties of Cu–Al–Mn shape memory alloys. Journal of Alloys and Compounds 620:60-66, https://doi.org/10.1016/j.jallcom.2014.09.047.
- Rupa Dasgupta, Ashish Kumar Jain, Pravir Kumar, **Shahadat Hussain**, Abhishek Pandey (2014) Effect of alloying constituents on the martensitic phase formation in some Cu-based SMAs. Journal of Materials Research and Technology 3:264–273, https://doi.org/10.1016/j.jmrt.2014.06.004.

Conference Presentations

Oral Presentation

- Participated in **The Best Practices in Teaching and Learning Conference** held in May 2023 at Khalifa University, Abu Dhabi, UAE. Organizers: Khalifa University, American University of Sharjah and Amity University Dubai.
- "Inhomogeneous Microstructure due to Non-Uniform Solidification Rate in NiTi Triply Periodic Minimal Surface (TPMS) Structures Fabricated via Laser Powder Bed Fusion" presented at **ASME-International Mechanical Engineering Congress and Exposition (IMECE-2022)**, Columbus, Ohio, USA in November 2022.
- "Improvement in shape memory properties of CuAlNiZn shape memory alloys due to addition of grain refiners" presented at **National Seminar on Advances in Smart & Functional Materials** held at CSIR-AMPRI, Bhopal between 13-14th January 2017. Organizers: CSIR-AMPRI Bhopal, IIM (Bhopal Chapter), MRSI (Bhopal Chapter) and TSI (Bhopal Chapter).
- "Study of effect of Fe, Cr and Ti on the martensite phase formation in Cu-12.5wt%Al-5wt%Mn SMA" presented at **International Conference on Materials Science and Technology** held at University of Delhi, Delhi India between 1-4th March 2016. Organizers: International Association of Advanced Materials (IAAM), VBRI Press and University of Delhi.

Poster Presentation

- "Microstructural changes and its effect on mechanical as well as shape memory properties in a CuAlNi alloy on addition of dispersoid" presented at **Recent Innovations in Advanced Materials (RIAM-2018): Physics of Advanced Materials** held at CSIR-AMPRI, Bhopal between 18-19th September, 2018. Organizers: CSIR-AMPRI Bhopal, MRSI (Bhopal chapter), IIM (Bhopal chapter) and MPCOST Bhopal.
- "Changes in properties due to alloying addition of Mn and Cr to Cu-Al-Ni-Zn shape memory alloys" presented at **India International Science Festival (IISF-2016)** held at CSIR-NPL, New Delhi India between 7-11th December, 2016. Organizers: CSIR-NPL, CSIR-NISCAIR, Ministry of Science & Technology GOI, Ministry of Earth Sciences GOI, Vigyan Bharti and Vigyan Prasar.
- "Effect of Addition of Alloying Element Chromium to Cu-Al-Ni-Zn Shape Memory Alloys" presented at **70th IIM NMD-ATM Conference** held at IIT Kanpur India between 11-13th November 2016. Organizers: IIM, MSE-IIT Kanpur and DMSRDE Kanpur.
- "Role of grain refiners for improved shape memory properties of Cu-12.5wt%Al-5wt%Mn Shape Memory Alloy" presented at **National Seminar on 'Recent Innovations in Advanced Materials'** held at CSIR-AMPRI, Bhopal India on 29th December, 2015. Organizers: CSIR-AMPRI Bhopal, MRSI (Bhopal Chapter) and MPCOST Bhopal.

Conference Publications

- **Shahadat Hussain**, Ali N Alagha, Wael Zaki (2022) Inhomogeneous Microstructure due to Non-Uniform Solidification Rate in NiTi Triply Periodic Minimal Surface (TPMS) Structures Fabricated via Laser Powder Bed Fusion.ASME International Mechanical Engineering Congress and Exposition (IMECE-2022), Ohio, USA. `https://doi.org/10.1115/IMECE2022-95320`
- **Shahadat Hussain**, Ashish Kumar Jain, Ansari MA, Abhishek Pandey, Rupa Dasgupta (2017) Study of effect of Fe, Cr and Ti on the martensite phase formation in Cu-12.5wt%Al-5wt%Mn SMA. Advanced Materials Proceedings 2(1):22-25. `https://doi.org/10.5185/amp.2017/106`

Book Chapter

- Rupa Dasgupta., Jain A.K., **Shahadat Hussain**, Abhishek Pandey., V Sampath. (2018) Effect of Alloying Additions on the Properties Affecting Shape Memory Properties of Cu–12.5Al–5Mn Alloy. In: Muruganant M., Chirazi A., Raj B. (eds) Frontiers in Materials Processing, Applications, Research and Technology. Springer, Singapore. `https://doi.org/10.1007/978-981-10-4819-7_33`

Awards, Fellowships, Grants & Honors

2016	Highest CGPA, PhD Course Work	*India*
2016	Senior Research Fellowship, CSIR-GATE	*India*
2014	Junior Research Fellowship, CSIR-GATE	*India*
2013	Qualified Graduate's Aptitude Test in Engineering thrice (2013, 2014 and 2015), GATE	*India*

Courses, Training & Collaborations

- **Our collaboration** involved working alongside Prof. Greg Haidemenopoulos, Director of the Laboratory of Materials in the Department of Mechanical Engineering at the University of Thessaly in Volos, Greece. Together, we focused on **additive manufacturing using laser bed fusion techniques to create NiTi architected alloys**. Additionally, we conducted microstructural characterizations of these alloys as part of our research efforts.
- Successfully completed **10-week teaching certificate course**, conducted by Center for Teaching and Learning (CTL) department at Khalifa University in 2023, covering the modules of effective teaching strategies, assessment techniques, ethics, professionalism and boundaries, educational technology tools, active learning and course alignment, classroom dynamics, intercultural communication, and gender communication styles, with several micro-teaching sessions.
- Completed **hydrofluoric acid handling course** in 2021, preparing risk assessment and standard operating procedure forms for chemical etching of 3D printed NiTi samples.
- Completed **laboratory training courses** under EHS (Environment, Health and Safety) department at Khalifa University in 2021, covering subjects of introduction to lab safety, compressed gas safety, radiation safety, lab ventilation and fume hood, emergency eye wash station and safety shower, chemical safety and industrial hygiene, handling of cryogenic substance, handling of flammables and combustibles chemicals, lab waste

management, administration structure to lab safety and risk assessment, electrical safety, personal protective equipment, emergency preparedness and response, and basic fire safety.

- Fulfilled the requirements of **Responsible Conduct of Research (RCR) courses**, conducted by Collaborative Institutional Training Initiative (CITI) Program, Florida, US, in 2020, under Course Learner Group of Engineering and Computing RCR, covering subjects of research involving human subjects, plagiarism, authorship, collaborative research, conflicts of interest, data management, research misconduct, and introduction to RCR, achieving 100% grade.
- During my PhD, I **trained lab operators** in the casting shop on **vacuum induction melting and die casting techniques**. Additionally, I created standard operating procedure **manual** for operating the furnace. I was solely responsible for operating these machines and successfully synthesized Cu-based shape memory alloys from elemental raw materials.
- Conducted CSIR-800 study on entrepreneurship in a village, involving **surveying, questionnaire design**, consulting with village head and Patwari, **data collection, data analysis, data visualization and report creation.**
- Completed **14 subjects during PhD coursework** from 2014 to 2016, including materials science and engineering, scientific ethics, technical communications and safety, characterization and analytical techniques, heat treatment, tribology-science and practice, phase transformation, lightweight materials, powder metallurgy, composite science and engineering, nano science and engineering, materials synthesis and processing, computer simulation and design, functional and smart materials, and cellular materials, achieving distinction.
- I **partnered** with Prof. Sampath V, a professor in the Department of Metallurgical and Materials Engineering at IIT-Madras, India, to utilize his laboratory for **synthesizing Cu-based shape memory alloys**. We employed the induction melting technique thereafter, which marked the beginning of the facility in our laboratory at CSIR-AMPRI, Bhopal, India. Furthermore, **we collaborated on research work and jointly authored research articles** based on our findings.

Expertise

Proficient in operating advanced characterization and analysis equipment:

- **Scanning Electron Microscopes (SEM)**: JEOL 7610F, FEI Nova NanovSEM, and FEI Quanta 3D FIB, for imaging and EDS analysis.
- **X-ray Diffraction**: Utilized Bruker D2 phasor and Rigaku MiniFlex II for crystal structure analysis.
- **Optical Microscopy**: Skilled in using Leica microscopes for detailed observation and analysis.
- **Thermal Analysis**: Experienced in performing differential scanning calorimetry using Mettler Toledo DSC 1 and Setaram instruments.
- **Optical Emission Spectroscopy**: Proficient in utilizing Bruker Q4 Tasman for elemental analysis of copper and nickel-based alloys.
- **Mechanical Testing**: Conducted tensile and compression tests with Instron 5969 static loading and fatigue testing using Instron 8872 machine.
- **Metallography**: Skilled in metallographic techniques including grinding, polishing, hot and cold mounting, and ultrasonic and plasma cleaning using Struer and Buehler equipment.
- **Chemical Etching**: Competent in performing etching of metal alloys using various etchants, including hydrofluoric acid.
- **Casting/Fabrication**: Experience in alloy casting/fabrication using vacuum induction melting furnace.
- **Heat Treatment**: Proficient in applying heat treatment processes using muffle furnaces with different temperature profiles and quenching cycles.
- **Rolling**: Skilled in both cold and hot rolling techniques of metallic samples using asymmetric two-roll mill machines.
- **Additive Manufacturing**: Experienced in the additive manufacturing of NiTi shape memory alloys.
- **Software**: Proficient in various software applications including Xpert HighScore Plus, ImageJ, Origin, microscope image analysis software like Gatan Suite, computer-aided design(CAD), 3D modeling, programming languages such as Python and its libraries like pandas, numpy, scipy, matplotlib and seaborn for data analysis and visualization, and word processing tools like LaTeX.

Certifications

- **Introduction to Project Management**, June 2024, IBM
- **Additive Manufacturing Specialization**, June 2024, Arizona State University
- **Data Science Professional Certificate**, April 2024, IBM
- **Python for Everybody Specialization**, February 2024, University of Michigan
- **Teaching Certificate Course for Postgraduate Students**, May 2023, Khalifa University

Reviewer

Intermetallics, Additive Manufacturing, Journal of Manufacturing Processes, Materials Characterization, Advances in Industrial and Manufacturing Engineering, Materials Today Communications, Journal of Materials Research and Technology, Additive Manufacturing Letters

Research Metrics

(May 2024)

- Experience (Research and Teaching) = 6 years
- Google Scholar Citations = 312
- Google Scholar H Index = 8
- Google Scholar I10 Index = 7

Referees

- Prof. Wael Zaki, Professor, Mechanical Engineering Department, Khalifa University, Abu Dhabi, UAE. Email: wael.zaki@ku.ac.ae
- Dr. Abhishek Pandey, Senior Scientist, CSIR-Advanced Materials and Processes Research Institute, Bhopal, India. Email: abhishekpandey@ampri.res.in