IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	Nanoindentation studies of 3D printed High Entropy Alloys	
Project Number	**IMURA0735**	
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IITB Department:	Mechanical Engineering	

Research Clusters:

Highlight which of the Academy's CLUSTERS this project will address?
*(Please nominate JUST **one.** For more information, see www.iitbmonash.org)*

1	*Material Science/Engineering (including Nano, Metallurgy)*
2	*Energy, Green Chem, Chemistry, Catalysis, Reaction Eng*
3	*Math, CFD, Modelling, Manufacturing*
4	*CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control*
5	*Earth Sciences and Civil Engineering (Geo, Water, Climate)*
6	*Bio, Stem Cells, Bio Chem, Pharma, Food*
7	*Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Eng*
8	*HSS, Design, Management*

Research Themes:

Highlight which of the Academy's Theme(s) this project will address?
(Feel free to nominate more than one. For more information, see www.iitbmonash.org)

1	*Advanced computational engineering, simulation and manufacture*
2	*Infrastructure Engineering*
3	*Clean Energy*
4	*Water*
5	*Nanotechnology*
6	*Biotechnology and Stem Cell Research*
7	*Humanities and social sciences*
8	Design

The research problem

High-entropy alloys (HEA) demonstrate properties e.g. lightweight, high strength and high ductility. Increasing availability of 3D additive manufacturing processes for metals present with greater possibilities for applications of HEAs. We intend to study the fundamental and microstructure mechanisms that give rise to exceptionally high strength and ductility to HEAs. Single phase and dual phase HEAs will be selected and deformation behaviour will be studied. These microstructure mechanisms will then we implemented in currently existing multiscale models for developing predictive tools of mechanical behaviour of HEAs. Exact constitutents of HEA for this project will be chosen in the beginning of project.

Project aims

1. Mechanical characterization of a pre-existing HEA at various temperatures and stresses
2. Understanding deformation behaviour with help of EBSD and TEM
3. Understanding local mechanical behaviour with help of nanoindentation, EBSD and atom probe tomography
4. Incorporation of new deformation mechanisms in crystal plasticity via multiscale modelling approach
5. Multiscale modeling of mechanical response of HEA

Expected outcomes

1. Multiscale model of mechanical response of HEA
2. Dataset suggesting various mechanisms of deformation of HEA at various deformation conditions
3. Direction for further modifying microstructure of HEAs

How will the project address the Goals of the above Themes?

The objective of this project is to understand fundamental mechanisms deformation of high entropy alloy. After investigating such mechanisms via experiments these will be incorporated in multiscale models. Such models are predictive in nature and will be helpful in understanding the failure modes in complex environment conditions. This project involves concepts of metallurgical engineering, computational mechanics and materials engineering.

Capabilities and Degrees Required

List the ideal set of capabilities:

1. Analytical skills
2. Willingness to learn and work hard
3. Molecular Dynamics
4. Phase Field Modeling
5. Crystal Plasticity
6. Advanced Numerical Methods

Potential Collaborators

ISRO, BARC

Select up to **(4)** keywords from the Academy's approved keyword list **(available at http://www.iitbmonash.org/becoming-a-research-supervisor/)** relating to this project to make it easier for the students to apply.

Modelling and Simulation, Metallurgy, Materials Chemistry/Science, Computational Fluid Dynamics and Mechanics