IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

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| **Project Title:** | Deformation behaviour of 3D printed Al-Ni-Ti multilayer metal composite | |
| **Project Number** | **IMURA0736** | |
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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)*

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| 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)*

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| ***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

Residual stresses are critical factors for deciding life of an engineering component. In 3D printed metals via additive manufacturing route, these become even more important due to differential cooling process. Also, process generated porosities have complex effects on mechanical behaviour of layered metal composites. The focus of this research is threefold viz. (1) role of directional evolution of grain morphology, (2) effects of voids / porosities on mechanical properties, (3) effect of residual strains. This will be achieved via integrated experimental and simulation studies. We will use crystal plasticity, phase field and molecular dynamics models for simulations. Experimental data will be procured using EBSD, TEM and Atom Probe tomography. A lightweight and high strength alloy is sought for many engineering applications. Thus, we intend to create a 3D multilayer metal composite of Al-Ni-Ti for this study.

### Project aims

1. Mechanical characterization of 3D printed layered metal composites at various temperatures and stresses
2. Understanding microstructure with help of EBSD, TEM and atom probe tomography
3. Modeling of mechanical behaviour multiscale plasticity model

### Expected outcomes

1. Multiscale model of mechanical behaviour of 3D layered metal composites
2. Correlation between 3D printing process and microstructure
3. Effect of process generated defects on mechanical behavior

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

The objective of this project is to understand residual stresses in 3D printed layered metal composites and to investigate effect of 3D printing generated defects on mechanical behavior. 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 in service. 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

*General Electric, ISRO, BARC,CSIRO. We have not contacted any yet.*

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.

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