

An Indian-Australian research partnership

Project Title: Data Science coupled Multiscale Mechanics for Understanding Fatigue Behaviour of 3D Printed Ti6Al4V Alloy

Project Number IMURA0917

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Research Clusters:

Research Themes:

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8	HSS, Design, Management	8	Design

The research problem

Due to an attractive set of properties in addition to high strength to weight ratio, Ti6Al4V has found extensive applications in biomedical domain. 3D printed Ti6Al4V is being used for developing patient specific implants by many commercial entities. 3D printed metals have inherent residual stresses due to primarily directional microstructure evolution. Such residual stresses play a key role in failure due to fracture and fatigue in Ti6Al4V. Fatigue in Ti6Al4V is a complicated phenomena mediated by multiphase multiscale nature. For understanding the fatigue behaviour of 3D printed Ti6Al4V we study the interaction of residual stresses with co-deformation of dual phase microstructure of Ti6Al4V. This project will apply a combination of multiscale computational mechanics approach and data science. The test cases of Ti64 will be drawn from the conditions relevant to design of biomedical implants.

Project aims

1. Mechanical characterization of 3D printed Ti6Al4V and corresponding X-ray tomography
2. Modeling of fatigue using data science, empirical model and crystal plasticity.
3. Experimental investigation of effect of residual stress on fatigue behaviour in simulated body fluid.

Expected outcomes

1. A multiscale thermomechanical model for fatigue in Ti64
2. Understanding various models of fatigue failures in Ti64 relevant to biomedical implants.

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

The objective of this project is to understand impact of residual stress on fatigue of 3D printed Ti6Al4V for conditions most relevant to biomedical implants. We intend to understand and model the effect of residual stress via combining the modelling and experimental efforts. This effort makes extensive use of concepts of mechanics of materials (especially plasticity) and numerical methods.

Capabilities and Degrees Required

An ideal candidate should have a BTech or BE or Master in Mechanical Engineering, Aerospace Engineering, Civil Engineering or Materials Engineering with a strong inclination towards advanced mathematics, numerical methods, continuum mechanics, non-linear elasticity. Experience in at least two of the following three criteria is desired: 1. Background in mechanics of materials; 2. Expertise in numerical methods for PDEs (finite element methods); 3. Expertise in programming (Python, C, C++, Fortran). The candidate should also have an interest in fracture of biomaterials.

Potential Collaborators

3D printing companies, hospitals, doctors. We have not contacted 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.

Biomedical Implants, Fatigue, Data Science, Computational Mechanics