IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Experimental and Numerical Analysis of Fatigue Characteristics of Dissimilar Joints**	
Project Number	**IMURA0*831***	
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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

Joints of dissimilar materials provide venues for light weighting in many applications. Dissimilar materials can be joined with solid state joining techniques like friction stir welding, as well as fusion welding techniques, which allow improved control over melt pool and heat affected zone like laser welding. Either way, intermetallic compounds are inevitable in dissimilar material joints. These intermetallic compounds significantly affect the mechanical properties of the dissimilar joints. The fatigue and fracture characteristics of dissimilar joints are of particular interest for the applications where joints are subjected to cyclic loading. Therefore, it is desirable to understand the influence of the joining process parameters on the fatigue behaviour of the dissimilar joints. The joining process parameters directly affect the type, size and location of the intermetallic compounds formed during the joining process. The nature (type) of intermetallic compound and its distribution determines the fatigue performance of the joint. The objective of this work is twofold. First, to map the intermetallic compound formation to the joining process parameters. Secondly, to correlate the intermetallic compound formation to the fatigue behaviour of the dissimilar joints. This will enable the prediction of the fatigue behaviour of the dissimilar joints with respect to the joining process parameters.

Project aims

The aims of this project are:

1. Develop a model for predicting the size and location of intermetallic compounds formed during dissimilar joining, with respect to the process parameters.
2. Validate the intermetallic compound formation model against the experimental results from joint characterization.
3. Perform a parametric study of the effect of intermetallic compounds on the fatigue crack growth and fracture behaviour.
4. Develop a correlation between the fatigue characteristics and intermetallic compounds.
5. Integrate the correlation with the intermetallic compound prediction model, to predict the fatigue characteristics of the joint with respect to joining process parameters.

Expected outcomes

The outcomes of this project are:

1. A simulation method for intermetallic compound formation during dissimilar joining.
2. A simulation method for predicting the fatigue characteristics of dissimilar joints.
3. Process parameter selection strategy for optimised amount of intermetallic compounds and desired fatigue properties of dissimilar joints.

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

Joints play a significant role in modern manufacturing, since virtually all products are fabricated from multiple components/parts. However, limitations with mechanical properties of dissimilar joints significantly reduce the choice of the materials which can be used for such applications. This project addresses this challenge by investigating a very important mechanical characteristic (fatigue) of dissimilar joints. This justifies the manufacturing theme. In order to predict the intermetallic compound formation and fatigue behaviour of the dissimilar joints, computational simulations will be performed. This justifies the advanced computational engineering and simulation themes.

Capabilities and Degrees Required

List the ideal set of capabilities that a student should have for this project. Feel free to be as specific or as general as you like. These capabilities will be input into the online application form and students who opt for this project will be required to show that they can demonstrate these capabilities.

Computational skills, MATLAB, Microstructural characterization

Potential Collaborators

Please visit the IITB website www.iitb.ac.in OR Monash Website www.monash.edu to highlight some potential collaborators that would be best suited for the area of research you are intending to float.

Professor Wenyi Yan from Monash University

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.

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