IITB-Monash Research Academy

An Indian-Australian research partnership

Indian Institute of Technology Bombay | MONASH University

Project Title:	**Mechanics of Thin Film Coatings at High Temperatures**
Project Number	**IMURA0442**
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Monash Co-supervisor(s) (Name, Email Id, Phone)	
Monash Department:	Mechanical Engineering
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IITB Department:	Mechanical Engineering

Research Academy 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

The research problem

Coatings are regularly used in many industrial applications where it is important to protect the structural components from corrosion, high/low temperatures, impact, abrasion, etc. The coating materials could be ceramics, metals or polymers depending on the application. It is important to study the mechanical response of coatings when subjected to various loading conditions including mechanical and thermal cycling.

Also, many of the coatings used in industry currently are very thin layers with thickness varying from a few nanometers (e.g., DLC coatings on hard disc drives for memory storage applications) to a millimeter (e.g., thermal barrier coatings used in jet engines, steam turbines, etc.). This low value of thickness requires careful mechanical experiments to understand their response and failure independently. This project aims at developing novel in-situ mechanical experiments on thin film coatings, over a wide range of temperatures to understand their response to thermo-mechanical loads. Various aspects of failure, fracture, thermal cycling, and fatigue will studied in detail to establish a robust method of experimentation. Also, the experimental results will be used to develop constitutive models that can be used to predict mechanical response in actual operating conditions.

Project aims

1. Develop novel in-situ experimental methods for conducting mechanical experiments at high temperatures on thin film coatings.

2. Investigate the effect of oxidation (corrosion) on the mechanical behavior at high temperatures

3. Experimental and Numerical studies on failure, fracture and fatigue under thermo-mechanical loading

Expected outcomes

1. A robust in-situ method to characterize thin film coatings under varying temperatures.
2. Material constitutive models including the selection of RVEs for heterogeneous and composite thin film materials.
3. Publications in good journals and patents.

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

1. Computational mechanics will include modelling creep and fracture at varying temperatures and correlate it with experimentally obtained mechanical results.
2. It is proposed that nanoscale deformation measurements will be conducted at varying temperatures, which is a big challenge in experimental mechanics. These measurements will aid in the identification of RVE for continuum scale modelling.

Capabilities and Degrees Required

1. B.E./B.Tech/M.E./M.Tech in Mechanical/Metallurgical Engineering.
2. Strong interest in experimental work. For students with Master's degree, experience in conducting mechanical experiments is preferred.
3. Some knowledge or interest in programming is a must as the instrumentation for the experiments and the computational work will require it.
4. Prior work in the filed of fracture mechanics or fatigue or creep or high temperature experiments will be given preference.

Potential Collaborators

Prof. Rafaat Ibrahim and Prof. Raman Singh