

An Indian-Australian research partnership

Project title: Nanotech for Corrosion Resistance

Project number: **IMURA0061**

Monash University supervisors: Associate Professor Raman Singh

Monash University contact: Full name and title; Raman Singh Email: raman.singh @eng.monash.edu.au

IITB supervisors: Full names and titles: Professor V.S. Raja

IITB contact: Full name and title; Professor V.S. Raja, Email: vsraja@iitb.ac.in

Research Academy theme/s

List only the research academy theme/s that is relevant to the project

1. Nanotechnology

The research problem

For their unique physico-mechanical properties and exciting industrial applications, nanostructured materials are the most widely investigated materials research topic. However, corrosion of nano materials has received very limited research attention, even though the materials will be required to demonstrate acceptable corrosion resistance in most potential applications. This project will investigate: (a) corrosion mechanism of nanostructured Fe-Cr alloys, and (b) application of nanocrystalline structure in an innovative approach to corrosion mitigation (based on hypotheses: it may be much easier to develop a protective film on nanocrystalline alloys). Validation of the hypothesis will have highly attractive economic/industrial implications.

Because of their poor thermal stability, synthesis and processing of nanocrystalline Fe-Cr alloys is a non-trivial task. However, A/Prof R. Singh's group has been successful in synthesis of such alloys by powder metallurgical route, through an international collaboration with leaders in the area (viz, Prof Carl Koch, North Carolina State University). Besides this invaluable collaboration this project: (a) has also received funding support from Australian Research Council and (b) involves collaborations with other reputable scientists, Prof Roger Newman (University of Toronto) and Prof V.S. Murty (IIT-Madras).

Project aims

The **Principal Aims** of the proposed work are:

1. Comparison of the localized and general corrosion of a high purity material in its nanocrystalline and microcrystalline forms. For this purpose pure copper is chosen.
2. Preparation of model nanocrystalline and microcrystalline research alloys with varying concentrations of the elements responsible for corrosion resistance (such as iron-chromium alloys with varying chromium contents),
3. Comparison of the localized and general corrosion of the nanocrystalline and microcrystalline Fe-Cr alloys of similar chemical composition,
4. Thorough post-corrosion characterisation in order to develop mechanistic understanding of the comparative corrosion resistance of micro- *vis-à-vis* nanocrystalline alloys,

Expected outcomes

This project will investigate an innovative approach to corrosion mitigation, i.e., examining corrosion resistant alloys in their nanocrystalline state. The basis of this examination lies in the hypotheses that it may be possible to develop a protective film of Cr_2O_3 :

- (a) on nanocrystalline alloys with much lower chromium contents, and thus replacing quite a lot of high-chromium alloys (such as stainless steels) with alloys of relatively much lower chromium contents. This hypothesis, if validated will have economically and industrially highly attractive implications,
- (b) on nanocrystalline alloys in the low temperature regime (where electrochemical corrosion is a common concern in Fe-Cr alloys), and thus develop a more durable mitigation of localized electrochemical corrosion.

Which of the above Theme does this project address?

Nanotechnology

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

The project clearly aims at understanding the corrosion mechanism of nanocrystalline Fe-Cr alloys, it also addressing has the objective of achieving corrosion resistance at much lower (than usual) Cr content through application of nanotechnology.