THE INSTITUTE FOR FRONTIER MATERIALS







IFM
INSTITUTE FOR
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THE INSTITUTE FOR FRONTIER MATERIALS

The Institute for Frontier Materials (IFM) at Deakin University was established to address some of the major challenges facing society through innovations in materials design and performance.

Our vision is to lead and inspire innovations in materials science and engineering that have a transformational benefit to society.

Recognised as one of Australia's leading materials research organisations, IFM's mission is to foster innovation and excellence in materials science and engineering research with the aim of developing:

- Innovative manufacturing technologies
- Energy efficiency, resource and infrastructure sustainability.

CORE RESEARCH AREAS

> Corrosion and protection
> Materials and process modelling
> Nanotechnology and plasma technology
> Fibres, polymers, composites and textiles
> Alloy design and processing
> Biomaterials and biomimicry
> Electromaterials and membranes

IFM INSTITUTE FOR FRONTIER MATERIALS

DEAKIN UNIVERSITY

Professor Matthew Barnett
Alfred Deakin Professor

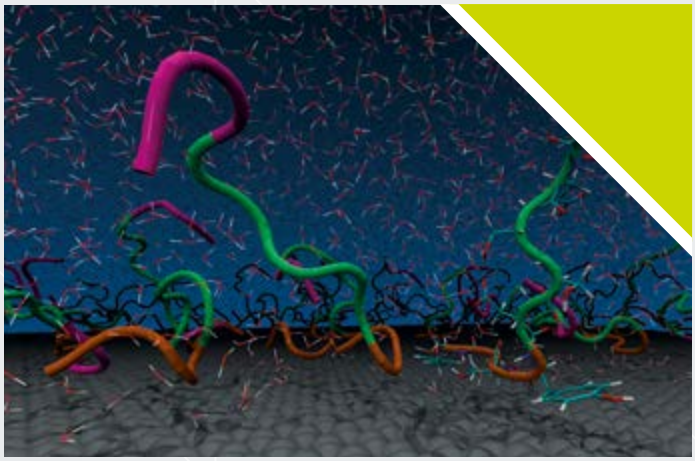
Interim Director, Institute for Frontier Materials

CORROSION AND PROTECTION

Corrosion research at IFM targets desalination and water infrastructure, oil and gas refining and production, defence and aerospace, mining and power industries. Our work covers research in a wide range of areas, including infrastructure durability, materials and alloy development, corrosion monitoring and prevention, bio-corrosion and coatings and inhibitors for surfaces and interfaces.

RESEARCH ACTIVITIES INCLUDE:

- Leading Energy Pipelines CRC on pipeline corrosion, coating, cathodic protection and life prediction research
- Performance and behaviour of stainless steels in seawater conditions (part of National Centre of Excellence in Desalination Research)
- Corrosion inhibition – CO_2 corrosion in oil and gas environments, pitting corrosion in oil pipelines and welding zone corrosion of stainless steels.



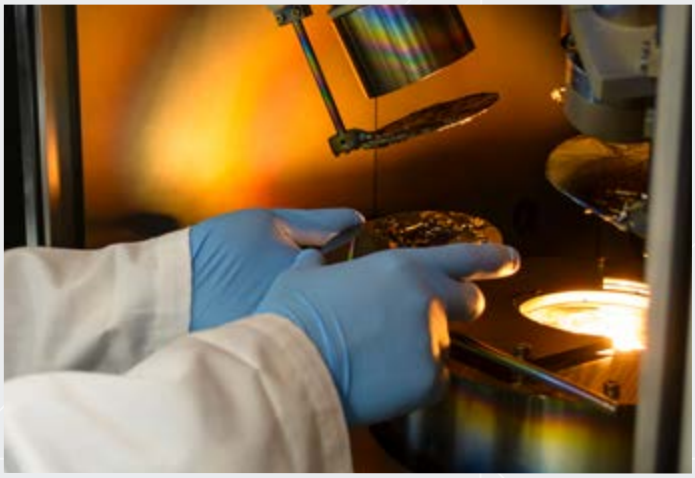
MATERIALS AND PROCESS MODELLING

IFM researchers use computer modelling to predict properties and behaviours of different materials and also to design materials and structures for automotive applications.

MOLECULAR MODELLING AND SIMULATION

KEY RESEARCH AREAS ARE:

- Structure-property relationships of interfaces between biological matter for applications in a wide range of areas, e.g. medical diagnostics and fundamental research on bio-mineralisation
- Prediction of formulation – property and structure – property relationships associated with high-performance carbon-fibre composite materials
- Development of strategies to predict structures, properties and behaviours of protein systems of interest to personal care and pharmaceutical industries
- Developing new, more accurate models of material behaviour for use in 'virtual' engineering and alloy design.



NANOTECHNOLOGY AND PLASMA TECHNOLOGY

NANOTECHNOLOGY

IFM's nanotechnology research is focused on developing novel nanomaterials and using nanotechnology to solve some of today's challenges in energy storage (batteries and supercapacitors), environmental protection and health and medical issues.

Nanotechnology and nanomaterials are key tools to improve the performance of energy storage technologies. The group's experience in nanomaterials synthesis and applications is leading to new electrode materials for batteries and supercapacitors. The IFM group was the first in the world to commercialise boron nitride nanotubes and has produced boron nitride nanotube-metal composites with excellent high-temperature mechanical performance and thermal composite materials with high thermal conductivity.

The group's pioneering research into boron nitride (BN) nanosheets has important environmental applications, such as water resource protection by removing solvents, dyes and other contaminants; and as a method for cleaning up oil spills on land and water, as well as corrosion protection, and improved sensitivity of Raman spectroscopy.

PLASMA TECHNOLOGY

Plasma is an exciting new way of shaping materials for scientific and industrial applications. The group's research ranges from projects to improve the efficiency of solar cells and batteries, biomaterials, food sterilisation, agriculture, sensors and nano-fabrication to wastewater treatment and electronic textiles.

IFM researchers are working with a number of industry collaborators on projects as diverse as smart plasma coating to delaminate glass – an issue for recycling and disposal of laminated glass; development of liquid plasma techniques for milk and food sterilisation; to application of atmospheric pressure plasma technology to textile materials to solve problems such as pilling of knitwear.

FIBRES, POLYMERS, COMPOSITES AND TEXTILES

Research into fibres, polymers, composites and textiles is carried out as part of the Australian Future Fibres Research and Innovation Centre (AFFRIC), which is a collaboration between the Institute for Frontier Materials and CSIRO, supported by the Victorian and Australian governments.

IFM is also leading a new ARC Future Fibres Industrial Transformation Research Hub, in partnership with several highly innovative companies and international research leaders. The hub will accelerate the transformation of Australia's traditional manufacturing industry to a vibrant future-fibre oriented advanced manufacturing sector.

CARBON FIBRES AND COMPOSITES

Carbon fibre materials are becoming increasingly prevalent in a wide range of industries, such as aerospace, automotive and infrastructure, where they are replacing traditional materials like steel and aluminium.

The challenges for industry are to reduce the cost of carbon fibre, increase its performance and to reduce manufacturing time. Our research is focused on these areas as well as the fundamental understanding of carbon fibre. An advanced carbon fibre manufacturing facility 'Carbon Nexus' combines a pilot-scale research plant capable of producing aerospace grade carbon fibre with a comprehensive fibre and composite characterisation facility.

FUNCTIONAL FIBROUS MATERIALS

New functional materials are being developed with enhanced properties, such as non-wetting, self-cleaning, or needle stick resistance. Our work in this area includes medical textiles, super hydrophobic (water repellant) textiles, protective garments and gloves, directional moisture management in fabrics and fibre reinforced materials.

GREEN NATURAL FIBRES

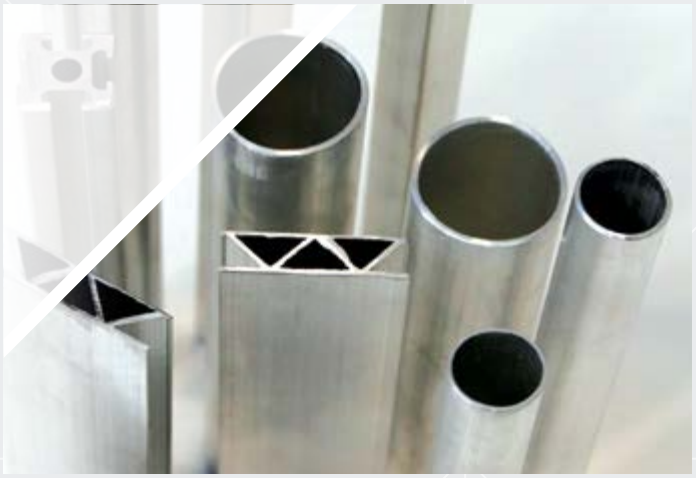
Australia is well known for its high-quality wool and cotton industries. IFM's natural fibre research focuses on environmentally friendly ways of processing these fibres, as well as investigating the properties of other natural fibres, such as silk, bamboo and hemp. Research in this area also develops novel, value-added products and processes for cotton and animal fibres.

NANOFIBRES

Nanofibres have a wide range of applications, including filtration (e.g. advanced air filters and face masks), biomedical (e.g. wound dressings and tissue engineering), sound absorbing and noise shielding products, energy generation and storage, reinforcement and sensors. IFM researchers are exploring novel, unique functions and applications of nanofibres and developing new methods of nanofibre production and assembly, including large-scale production of electrospun nanofibres and short nanofibres.

POLYMERS

Polymers research at IFM focuses on development of new polymer materials that will meet a diverse range of applications. Projects include: synthesis and characterisation of materials; advanced thermosets for high performance coatings, adhesives and composites; biodegradable polymers for biomedical applications; and green processing of natural polymers.

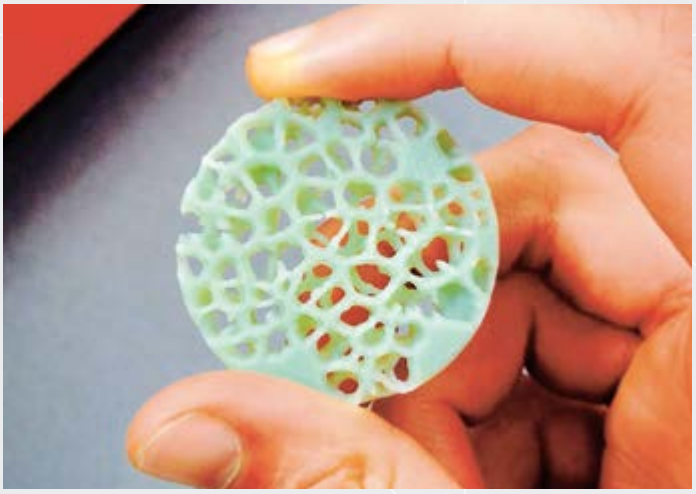


ALLOY DESIGN AND PROCESSING

IFM metals research spans the spectrum from fundamental to commercial. This means performing short term feasibility studies for industry as well as developing the blue sky ideas that will underpin Australia's future manufacturing sector. Our research aims to increase profitability and competitiveness, extend product life and reduce energy consumption.

RESEARCH PROGRAMS INCLUDE:

- Alloys for mining applications
- High entropy alloys for surfaces
- New aluminium extrusion alloys
- Severe plastic deformation
- Flexible roll forming
- Steel microstructures
- Magnesium fundamentals
- 3D alloy printing.

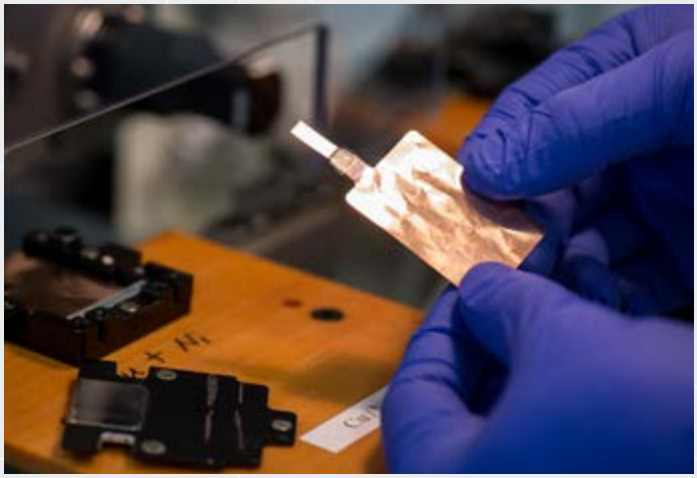


BIOMATERIALS AND BIOMIMICRY

Biomaterials are derived from nature or synthesised in the laboratory using chemical approaches which involve polymers, ceramics, composite materials or metallic components. Biomimicry is an approach which can be used across all research areas and involves the imitation of nature for designing and developing new materials and structures.

PROJECTS INCLUDE:

- Scaffolds for cell research
- Biocompatible and bioactive surfaces
- Biodegradable magnesium alloys
- Short polymer fibres.



ELECTROMATERIALS AND MEMBRANES

MEMBRANES

Development of nanoporous membrane materials is helping to address future biomedical and environmental challenges. The group's research focuses on fabrication and characterisation of membranes with unique nanostructures for use in areas such as water treatment and desalinisation.

ELECTROMATERIALS

The development of safe, efficient rechargeable batteries is key to achieving sustainable future energy supplies. The IFM electromaterials team has excellent facilities and includes experts in the fundamental analysis of electrolyte materials, and the development of rechargeable batteries and new thermal energy harvesting devices.

IFM researchers are investigating new device chemistries, such as metal-air or sodium-based batteries and also trying to improve the performance of existing technologies such as lithium-ion batteries.

Their approach is to optimise ionic liquids and organic ionic plastic crystals to replace currently used flammable electrolytes for these devices and thus address safety issues.

A Masters degree in Electromaterials, offered through the ARC Centre of Excellence for Electromaterials Science (ACES) as a joint degree between Deakin and the University of Wollongong provides students with skills to address some of the world's most challenging problems in clean energy, human health and advanced manufacturing.

For more information about the MPhil (Electromaterials): electromaterials-enquiries@deakin.edu.au

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