

An Indian-Australian research partnership

**Project Title:** DEVELOPMENT OF MICROBIAL FUEL CELLS WITH IMPROVED PERFORMANCE

**Project Number** IMURA0257

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## 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](http://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

*Define the problem*

Worldwide, novel approaches for the sustainable bio-production of fuels and chemicals are under development. Apart from this, there is an increased interest in the industrial and research fraternity either to reduce the treatment costs incurred for the Waste Water treatment or to get value added products from the waste. Biological fuel cells potentially offer solutions to all these problems through harvesting energy from organic wastes and renewable biomass. Biofuel cells convert energy obtained from biochemical reactions into electrical energy in presence of different types of biological catalysts (living microorganisms, organelles or enzymes). One of the major differences between each type of fuel cell is the type of biocatalyst used at the anode of the fuel cell. Microbial fuel cells (MFCs) utilize whole living microorganisms that act as microreactors and allow multiple substrates to be oxidized deeply or completely. Microbial fuel cells (MFC) show excellent thermodynamic performance in laboratory scale. However, the poor electrode kinetics results in high activation overpotential. Moreover, the poor ion and electron transport also lead to poor performance. MFC also fails to sustain the laboratory scale performance in scaled up design.

## Project aims

*Define the aims of the project*

The proposed work aims at designing Microbial Fuel Cells suitable for waste water. Efforts will be made to reduce the activation losses by improved electrode designing to enhance the power density. Novel design will be adopted to minimize the charge transports losses by introducing turbulent in the flow which can be easily scaled up.

Specific objectives:

- CFD analysis will be carried out to design the MFC for better charge transport
- Improvement of electrode kinetics by exploiting different microorganisms from different natural habitats
- Microbial enrichments at anodic biofilms in MFC using pure substrates inoculated with different mixed microbial samples
- Analysis of the influence of different environmental parameters on bio-anode performances of the MFC
- Modelling of bio-anode kinetics
- Scale up of laboratory scale MFC

## Expected outcomes

*Highlight the expected outcomes of the project*

Through the completion of this project, novel design and mathematical model of Microbial Fuel Cells will be developed. It is expected to come up with scaled up MFC system which could be further scaled up to pilot plant scale. Publications of two or three high quality papers in internationally renowned journals are desirable and patent.

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

*Describe how the project will address the goals of one or more of the 6 Themes listed above.*

Electricity is being generated directly from biowastes and organic matter. This energy can be used for operation of the waste treatment plant, or sold to the energy market.

## Additional costs and equipment

*Describe below additional costs that would be needed to complete this project.*

*This would typically include project-related costs (such as consumables).*

*Note that computers, desks, student travel, etc need not be included*

- BOD incubator, AUD \$800 x 2 units (for simultaneously study of one parameter)
- pH meter, AUD \$150
- COD meter AUD \$ 200
- DO meter, AUD \$150
- Chemicals, AUD \$1000
- Designing and fabrication of reactors, AUD \$500 pa
- Electrode, Membrane, etc AUD \$1000
- Total: AUD \$4600

## Capabilities and Degrees Required

*List the ideal set (up to 8) of background and capabilities required in a student for this project noting that the more specific you make it, the less likely that you will get a candidate that matches the requirements exactly.*

The potential candidate is expected to have the following background and/or research capabilities:

- Master Degree in Microbiology/Energy.
- Background knowledge regarding Fuel Cells.
- Experience on working with Microbial Fuel Cells
- Interested in clean energy research.