

An Indian-Australian research partnership

Project Title: **Organic Semiconductor Based Photovoltaic Devices**

Project Number **IMURA0354**

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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)

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

This research proposal focuses on the global energy challenge by the concept of the production of energy using excitonic organic photovoltaic (OPVs) devices. OPVs are made up of hydrocarbon based organic molecules, which exhibits semiconducting properties. To generate photo-induced charge carriers OPVs has two kind of molecules, in which one of the material absorb the light to form excitons and this exciton diffuses to interface and with right electronic coupling between the two materials, exciton gets ionized and either of the charge carrier gets transferred to second material. Former material called donor and latter one called acceptor in such case. After charge transfer process these photo-induced charge needs to reach the respective charge extracting electrodes without encountering bi-molecular recombination, which can be achieved by a self-driven interpenetrating network of these materials in a blend film. Hence, an efficient

PV action can be achieved by a basic understanding of structural information in terms of packing of these macromolecules, morphology of donor-acceptor systems and interaction between light and molecular semiconductor on nanometer level domains. It involves transient and steady state studies of molecular semiconductors and nano-composites (hybrid semiconductors) based on various optoelectronic devices. Optical modeling of these functional devices will also be carried out to further improve our understanding of optical coupling and charge generation region vs transport issues in these OPVs.

Project aims

Study of nano-structured organic semiconductor thin films in terms of their morphology, packing of macromolecules & interaction between chains of donor-acceptor type system, which will enable us to demonstrate high performance OPVs devices.

Expected outcomes

Highlight the expected outcomes of the project

Monash group is expert in characterizing soft thin film to understand morphology and packing of macromolecules, which is very important in fabricating high performance devices.

Indian partner is expert in characterizing various optoelectronic devices and photophysics of these materials.

In combination, we expect to have technologically important cheap solar cells and lighting source.

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.

Nanostructured thin films are required to generate efficient photoinduced charge generation with an optimum transport network for positive and negative polarons to make efficient photovoltaics from these excitonic semiconductors. However, to achieve this nanostructured film, there is a need of good control over morphology and packing of polymer chains at nanometers level domain.

Clean energy: Outcome is going to give low cost photovoltaic technology and energy efficient lighting from molecular semiconductor films.

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.

Ideal candidate should have

1. Sound knowledge of Physics
2. Photonics as major
3. Good in handling Labview and Matlab towards computer program
4. Either electrical engineer/ engineering physics at undergrad level or masters in Physics