

## UQIDAR: The University of Queensland - IIT Delhi Academy of Research Joint PhD Project Proposal Template

<b>1. Project Title:</b>	<b>Polymer Nanocomposites for Advanced Gas Barrier Applications</b>
<b>Project ID</b>	<b>UQIDAR-00104</b>

### 2. Supervision Team

Please visit the IITD website [www.iitd.ac.in](http://www.iitd.ac.in) and UQ Website <http://researchers.uq.edu.au/> to highlight potential collaborators that would be best suited for the proposed project. Complete where possible – advise if you'd like assistance establishing contacts.

	University of Queensland	IIT Delhi	External/Industry (if applicable)
<b>Supervisor Name</b>	Prof Darren Martin	Prof Mangala Joshi	Graphene Manufacturing Australia (GMA) ( <a href="https://www.graphenemanufacturing.com.au/">https://www.graphenemanufacturing.com.au/</a> ) TenasiTech Pty Ltd ( <a href="http://www.tenasitech.com/">http://www.tenasitech.com/</a> )
<b>School or Department (or company, if applicable)</b>	Australian Institute for Bioengineering and Nanotechnology (AIBN)	Department of Textile Technology	Sponsored project from Govt. of India
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### 3. Other Supervisor Details

Please include other associate supervisors below:

Full Name and Title(s): School/Department/Company details: Phone/Email/URL:
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### 2. Field of Research CODES:

(Specify up to four four-digit FOR codes for your project – see [here](#) for more detail on FoR codes)

100708 Nanomaterials	091202 Composite and hybrid materials
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091209 Polymers and plastics

100707 Nano manufacturing

### 3. Keywords: *(this will assist in classifying project and presenting projects to students on the applications portal)*

Choose up to 4 keywords for your project.

Eg: nanotechnology, data science, novel batteries, etc

Nanotechnology

Gas barrier

Nanocomposite

Advanced manufacturing

### 4. Discipline Background of Candidate: *(this will assist in presenting projects to applicants on the apps portal)*

Ideally this project requires students with a background in...

Eg: organic chemistry, physiology, topology, CFD, etc

Materials science

Chemical Engineering

Chemistry

Composites

### 5. Project description

Polymer Nanocomposites are a new class of materials with much superior properties such as mechanical, thermal, flame retardancy, gas barrier etc. They are mixtures of a polymer matrix and reinforcing filler that have at least one dimension in nanometer range. The uniform dispersion of 2D- layered nanofillers such as layered organosilicates, graphene etc results in a very large surface area and a network of platelets able to produce a tortuous path which works as a barrier structure to retard the permeation of gases, water vapour etc. A high tortuosity leads to higher barrier properties and lowered permeability in polymer nanocomposites. The barrier properties of polymers are generally poor when compared to metals and glass because of low density and open structure through which small molecules such as gases can easily pass through, thus presenting a limitation in many applications. The enhancement of barrier properties of polymers is therefore very important in areas such as packaging, protective coatings, inflatable products and in construction materials. Various polymeric films, like TPU, PP, PE, PET etc including many others are being used for packaging and protective coating applications where the enhancement of gas barrier properties remains one of the most important parameters.

In this research project the aim is to develop advanced polymer nanocomposite based films and coatings with improved gas barrier property to gases such as helium, nitrogen, oxygen, water vapour etc; apart from having desired mechanical strength, flexibility at a range of service temperatures, weather resistance, thermal stability etc. for advanced applications such as inflatable products and packaging. The nanofillers such as clays, graphene, graphene oxide, nanocellulose (CNC and CNF) and other layered metal salts will be explored. Thermoplastic polyurethane would be the matrix for inflatable product applications and biodegradable polymers like PLA would be the choice for packaging materials. The emphasis would be on advancing fundamental insight in order to achieve competitive improvements in nanocomposite barrier, weather resistance and mechanical performance. The challenges like nanomaterial pre-treatment and scalable processing to get immaculate nanofiller distribution and dispersion resulting in a fully-exfoliated morphology of layered nanofillers will be extensively investigated. The outcome of this project will significantly impact the new high performance material development having applications in the areas like inflatable on one hand and eco-friendly packaging on the other.

## 6. Project deliverables/outcomes

*Highlight the expected outcomes of the project*

The project aims to develop polymer nanocomposites based films, coatings and laminates for advanced gas barrier applications.

The focus would be on following two areas –

1. Thermoplastic Polyurethane (TPU) based nanocomposite films and coatings for inflatable products.
2. Biodegradable Food packaging films with improved gas barrier and antimicrobial properties.

## 7. Research Impact Themes:

**Highlight which Research Impact Theme(s) this project will address?**

*(Feel free to nominate more than one. For more information, see <http://www.uq.edu.au/research/impact/>)*

1. Healthy Ageing
2. Feeding the World
3. Resilient Environment
4. **Technology for Tomorrow**
5. Transforming Societies

## 8. Type of Student



THE UNIVERSITY  
OF QUEENSLAND  
AUSTRALIA



Indian Institute of  
Technology Delhi

This project is best suited for an:

<b>i-student</b>	<input type="checkbox"/>
<b>a-student</b>	<input type="checkbox"/>
<b>i- or a-student</b>	<input checked="" type="checkbox"/>

Note that an i-student will be expected to spend year-1 at IIT-D, year-2 at UQ and the remaining time at IIT-D.

An a-student will spend year-1 at UQ, year-2 at IIT-D and the remaining time at UQ.

All students will be required to complete some amount of coursework in their first year.

## 9. Student capabilities and qualifications

List the ideal set of capabilities (at least 2 essential and 2 desirable) 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. Add specific skill sets here...

### Essential Capabilities:

B Tech and M Tech Degree in Materials Science/ Polymer Technology/ Coating and Surface Engineering/ Chemical Engineering/ Textile Technology ( Fiber Science or Textile Chemistry)

### Desirable Capabilities:

First Class in all previous degrees ( CGPA of 6.75 or 60% marks)

### Expected qualifications (Courses/Degrees etc):

Major Research Project in Polymer Nanocomposite or related topics at UG or PG level