IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Nanofiller Incorporated Co-continuous Binary Polymer Blends: Rheological and Morphological Investigation**	
Project Number	**IMURA0674 (1)**	
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Research Clusters:

Highlight which of the Academy's CLUSTERS this project will address?
*(Please nominate JUST **one.** For more information, see www.iXXXXX.org)*

1	***Material Science/Engineering (including Nano, Metallurgy)***
2	***Energy, Green Chem, Chemistry, Catalysis, Reaction Eng***
3	***Math, CFD, Modelling, Manufacturing***
4	***CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control***
5	***Earth Sciences and Civil Engineering (Geo, Water, Climate)***
6	***Bio, Stem Cells, Bio Chem, Pharma, Food***
7	***Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Eng***
8	***HSS***

The research problem

Define the problem

Nano-filler based polymer nanocomposites have garnered considerable research interest in the academic, as well as in industrial, communities in recent years. This is primarily due to the intrinsic mechanical, thermal and electrical properties associated with the nano-filler, and the fact that their small size means that good property enhancement can be achieved with very low concentrations. In addition to these benefits we and others have started to find that these materials can actually act as interfacial agents in immiscible polymer blends, acting like a compatibilizer. That is, the nanoparticles can be made to sit at the interface of the two polymer components and influence the final morphology of the blend. The are a number of quite different nanoparticles that can be used in this work, which very in type (organic, ceramic), surface chemistry and dimensionality (particulate, rod or platelet-lie). The materials include organically modified clay, carbon nanotubes, graphene oxide and nanosilica. However, the mechanism behind the compatibilization that they produce is still not clear in these blend systems.

The current project will involve a systematic investigation of the role of 1D as well as 2D nanomaterials, (viz.; carbon nanotubes graphene oxide, graphene nanoplatelets etc.) on various immiscible blends through morphological and rheological studies of the blends. The effect of the nanoparticle as a compatibilizer will be evaluated through dynamic mechanical analysis and modern imaging techniques. The surface chemistry of these materials can also be manipulated to influence their location and properties. This project thus seeks to increase the functionality and usefulness of the nanoparticles in the blends, in addition to their intrinsic functionality, other blend properties can be manipulated.

Project aims

Define the aims of the project

1. To investigate the morphology of the blends in the presence of nanofillers via 4D-X-ray (Tomography), TEM and SEM techniques

2. To investigate the rheological characterization of these blends in the presence of nanofiller, in order to elucidate their dispersion and ability to act as solid surfactants

3. To evaluate mechanical properties through dynamic mechanical thermal analysis and nanoindentation.

Expected outcomes

Highlight the expected outcomes of the project

1. *To investigate whether nano-filler (with surface modification/functionalization) can potentially be an alternative for polymeric compatibilizer*
2. *To investigate whether mechanical and thermal properties can be tuned with these nanofillers with respect to their localization (in any of the phases or at the interface)*

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.

The research area in the field of carbon nanotubes and graphene (graphene oxide) based polymer nano-composites can be considered as sub-research area of 'Nanotechnology', wherein carbon nanotubes (or graphene oxide) are aimed to disperse in their molecular dimension in a bulk polymer matrix, which should alter the mechanical and thermal properties of the polymer nanocomposites and may exhibit various functional properties.

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.

1. *We are looking for 1 Ph.D. student in this project; candidates who have worked in the area of polymer composites involving carbon nanotubes/graphene would be desirable.*
2. *M.Tech in Polymer/Fiber Science/Materials Science & Engineering*
3. *M.Sc in Physics, Chemistry with 2 years of research experience*

Potential Collaborators

Please visit the IITB website www.iitb.ac.in OR Monash Website www.monash.edu to highlight some potential collaborators that would be best suited for the area of research you are intending to float.

Select up to **(4)** keywords from the Academy's approved keyword list **(available at www.iitbmonash.org)** relating to this project to make it easier for the students to apply.

Polymer blends, rheology, morphology, Nanomaterials