IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Organometallic Chemistry and Catalytic Applications of Lanthanoid-Phosphine (Phosphine oxide) complexes**	
Project Number	**IMURA0859**	
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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.iitbmonash.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, Design, Management*

Research 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*
7	*Humanities and social sciences*
8	Design

The research problem

Define the problem

The most challenging issue in metal mediated organic sythesis is the design and synthesis of highly active and selective metal-catalysts containing suitable ligands. Although these ligands do not participate directly in the catalytic process, they control the course of the reactions that occur at the metal center either electronically or sterically or by both. These ligands partly occupy the coordination sphere and make way for incoming reagents by activating other labile M-L bonds thereby allowing incoming reagents to bind to metal centrs. A typical bisphosphine can be tuned to do these fucntions efficiently so that catalytic conversion or organic transformations can be carried out smoothly at the metal center. In case of lanthanides, unless phosphines are highly basic, they do not readily coordinate with phosphines. However, bis-, tris- or polyphosphines can be oxidized to form the corresponding phosphine oxides which can readily get incorporated into lanthanide coordination sphere. Since our group has specialized in making novel phosphorus based ligands, phosphine-oxides can be generated and employed in making lanthanide derivatives with suitable other ligands to promote a variety of organic transformations. The objective of this project is to make lanthanide based organometallic complexes to explore their catalytic and if possible photophysical aspects.

Project aims

Define the aims of the project

1. Identify suitable bisphosphine ligands and make their oxide and other chalcogenide derivatives.
2. Exploring coordination properties, assessing spectroscopic and structural features,
3. Studying the reactivity of lanthanoid complexes, further derivatization and exploring their utility in homogeneous catalysis.
4. Developing synthetic methods utilising lanthanoid metals

Expected outcomes

Highlight the expected outcomes of the project including likelihood of patents

It is expected that the project will lead to new molecules of high reactivity with wide applications. If the research work in catalysis or in activation of small molecules such as CO_2 is unique, exceptional and

highly successful, it is possible that patents will come. Nevertheless, we are expecting very good research outcome from this project in the general area of high reactivity rare earth chemistry.

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.

Activation of small molecules such as CO_2, SO_2, S_8 or N_2 or even oxidation of water will arise with molecules of nanoscale dimensions. Calalytic applications will involve nanoscale molecules. Rare earths/lanthanoids are the materials of the 21st century and are used in nanoscale applications. They are of particular importance to Australia, which has vast under-developed reserves, which act as a buffer to Chinese supply domination.

Capabilities and Degrees Required

List the ideal set of capabilities that a student should have for this project. 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.

Basic understanding of Inorganic, organometallic and physical chemistry. Knowledge of standard spectroscopic techniques and their application. Experience in X-ray crystallography would be an advantage but not essential. 1st class Honours or a 1st class master's degree in general or inorganic chemistry

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.

Prof. M.S. Balakrishna
Dr Victoria Blair
Prof Glen Deacon

Select up to **(4)** keywords from the Academy's approved keyword list **(available at http://www.iitbmonash.org/becoming-a-research-supervisor/)** relating to this project to make it easier for the students to apply.

Catalysis, Green chemistry and renewable energy, Material chemistry,