

Catalysis by metal complexes

Overview

Catalysis by metal complexes has far reaching significance and relevance in diverse areas, ranging from new drug discovery and novel pharmaceuticals to the petrochemical industry. It is essential to understand the fundamentals of how catalytic reactions using metal complexes occur and then be able to design metal complexes with specific and high catalytic activity. Traditionally, metal complexes of selected d-block metals have been used for several industrially important catalytic purposes, and these have served to understand the basic mechanistic phenomena. In recent times considerable interest has been placed on the designed synthesis of molecular catalysts containing a divers range of metal atoms, including metal clusters. Chemical tailoring of the molecular catalysts enables the fine tuning of activation of organic species leading to controlled transformations to give desired products selectively and in high yields. The course is particularly important to today's concept due its relevance to green chemistry, an aspect which will also be covered.

Course participants will learn these topics through lectures and hands-on experiments. Also case studies and assignments will be shared to stimulate research motivation of participants.

Modules	
	Module I. 3 hours Metal complexes in catalysis The principles : catalysis and green chemistry The fundamental reactions The main applications in catalysis and examples of catalytic cycles Cross coupling reactions and their catalysts
	Module II. 2 hours Ruthenium in selective catalysis 1. Ruthenium in catalysis and Activation of alkynes -vinylidenes -oxidative couplings of alkynes: synthesis of dienes - addition of carbenes to alkynes -stereoselective reduction of alkynes - hydrogenation - hydroboration 2. Borrowing hydrogen processes - principles - applications in reduction reactions
	Module III. 2 hours Alkene metathesis - principle and applicatioons - access to main catalysts -transformation of terpenes

-biomass into polyamides
-recent preparation of Z-alkenes

Module IV. 2 hours

Activation and catalytic functionalisation of C-H bonds with palladium catalysts

1. cross coupling reactions with organometallics
2. first examples of C-H bond cross couplings
3. use of Pd(OAc)₂ catalyst for arylation of heterocycles
4. discussion of the mechanisms with Pd catalysts
5. some arylations of azoles
6. arylations in green solvents
7. recent results at Rennes
8. arylations with tolerance to silyl groups
9. ester as blocking group
10. deprotonation of C-H bonds
11. C-H bond activation for molecular materials

Module V. 2 hours

Activation and catalytic functionalisation of C-H bonds with Ru(0) and Ru(II) catalysts

1. introduction- first examples
2. the Murai reaction with Ru(0) catalyst
3. direct arylation with Ru(II) catalyst
 - first examples
 - influence of carbonate and carboxylate partner
 - mechanism discussion
 - arylation in green solvent: dialkylcarbonate
 - arylation in water
 - monoarylations in pharmacy; in water
4. alkenylations with Ru(II) catalyst
 - first examples since 2011
 - alkenylation versus alkylation
5. annulation with alkyne via C-H bond activation
6. formation of C-N bonds

Module VI. 2 hours

Activation of C-H by catalysts of Ru(III) and Ir(I & III)

1. Alkenylation of sp² C-H bonds with Rh(III) catalysts
2. Rh(III) catalysed arylation: cross coupling of 2 C-H bonds
3. iridium catalysed functionalisation of C-H bonds
 - silylation
 - borylation
 - borylation and arylation

	<p>Module VII. 2 hours</p> <p>Activation of sp^3 C-H by catalysts of palladium and ruthenium</p> <ol style="list-style-type: none"> sp^3 C-H bond activation/functionalisation with Pd catalysts <ul style="list-style-type: none"> - preparation of boron derivatives - formation of C-C bond and cycles form C-Br ad C-H bonds -dehydrogenation of alkyl sulfonamides sp^3 C-H bond activation/functionalisation with Ru(0) catalysts <ul style="list-style-type: none"> - insertion of alkenes -insertion of carbon monoxide -arylation with arylboronates sp^3 C-H bond activation/fucntionalisation with Ru(II) catalysts <ul style="list-style-type: none"> - direct arylation -functionalisation of alkylamines at alpha carbon atom - 3-alkylation of cyclic alkylamines <p>Module VIII. 0.5 hour</p> <p>Pincer complexes</p> <ul style="list-style-type: none"> - synthesis and catalysis <p>Module IX. 0.5 hour</p> <p>Photoredox catalysts</p> <ul style="list-style-type: none"> -principle and applications to synthesis <p>Module X. 1 hour</p> <p>Brief review of recent applications in catalysis</p> <p>Number of participants for the course will be limited to fifty.</p>
<p>You Should Attend If...</p>	<ul style="list-style-type: none"> * Masters and PhD students from Chemistry, Physics, Material Science and Engineering from different institutes across the country. * Researchers in R&D laboratories. * Faculty and academics interested in interdisciplinary research in design and synthesis of molecular magnets. * Researchers in education from reputed institutes as catalysis by metal complexes is a much sought after, but little taught in India, subject.
<p>Fees</p>	<p>The participation fees for taking the course is as follows: Academic Institutions: Rs 5,000/- per participant for each host institute Participants from industry: Rs 40,000/- per participant for each institute Free for participants from host institute</p> <p>The above fee includes all instructional material, computer use for tutorials and assignments, laboratory equipment usage charges, 24 hour free internet facility. The participants will be provided with accommodation on payment basis.</p>

The Faculty



Professor Pierre H. Dixneuf, Professor of Chemistry, University of Rennes, institut sciences chimiques de Rennes, UMR 6226 CNRS-Université de Rennes, France, pierre.dixneuf@univ-rennes1.fr; <http://scienceschimiques.univ-rennes1.fr/catalyse/personal%20web%20pages/dixneuf/index.htm> Key past events and positions Since 2000 Member of the « Institut universitaire de France » 1986-1999 Director of a Research Unit UMR CNRS-University Rennes “Organometallics & Catalysis 1996-1999 Deputy Director of CNRS-Chemistry Headquarters in Paris 2000 Initiator and first Director de l'Institut de Chimie de Rennes 1.1.2000/31-3-02 2001 vice president for research of the University of Rennes Jan 2001-Dec 2004, >440 papers in international journals : 57 since 2011 20 review articles; 19 book chapters; 8 patents, 6 books Awards and Distinctions 1990 A. von Humboldt prize for Research 1994 Académie des Sciences award 1996 Doctor Honoris Causa, Waterloo, Canada 2000 Prix Le Bel (French Chemical Society) 2000 Member of the « Institut universitaire de France » 2001 Grignard-Wittig Prize (Germany) 2006 Grand prix IFP académie des sciences 2006 Sacconi medal (Italy) 2014 Prix Catalan of the Spanish Chem Society 2014 Prize of the Chinese Chemical Society 2014 Member of the European Academy of Sciences and Arts National responsibilities 1995 Elected Member of the National Committee of the CNRS (95-96), nominated 2000-04 1996 Deputy director for CNRS-Department of Chemical Sciences in Paris (nov 96-Dec 99) Invited professor positions/ International seminars/ Consulting for research Invited prof :Chapel hill, waterloo, Florence, Moscow, Auckland, Beyrouth (11-09), Heidelberg (11), Lanzhou univ (4-09), SIOC Shanghai (9-09), Wuhan (11-13), Guangzhou SCUST (14), Chinese Chemical Society lectureship 2015 : CAS Beijing-Nankai U-Shanghai SIOC-Fudan jan 2015 University of Gabes for master course april 2011 Advisory board Max-Planck institute Muelheim,

Course duration:

November 21 – 26, 2016

Course Co-ordinator

Professor Pradeep Mathur
Director, IIT Indore
Professor of Chemistry
Indian Institute of Technology Indore
Simrol
Indore 453 552
Phone: +91 (0)731 2438 711/712
E-mail: director@iiti.ac.in

Germany (2005-11) Coorganisor of International workshops organometallics & Catalysis (China-France,2005,2006,2008), Coorganisor of Indo-French CEFIPRA seminars “organometallics and materials” Bhubaneswar feb 2014, IICT Hyderabad “Catalysis & Green chemistry” nov 2015, India Coorganisor of Brazil France seminar on Catalysis Oct 2015 International Advisory boards ICOMC, OMCOS, ICCOS, ISGC, ISHHC, C-H activation symposium Journal Advisory, Editorial boards Previously Organometallics, Chemical communications, Advances in Synthesis and catalysis 00-10 1997 - Editor board of “ Topics in Organometallic Chemistry ”series, Springer 2010- Green Chemistry Research topics - Homogeneous catalysis especially with ruthenium catalysts - Current topics : catalytic biomass transformations , C-H bond activation/function



Professor Pradeep Mathur is the Director of the Indian Institute of Technology Indore. He is also a Professor of Chemistry at the same institute as well as at Indian Institute of Technology Bombay. Prior to joining IIT Bombay in 1984, Dr. Mathur was at Yale University as a postdoctoral research associate and has been a Visiting Professor at Cambridge University, Freiburg University and Karlsruhe University.

He obtained his Ph. D. and DSc-hc from Keele University and a BSc (Hons) in Chemistry from the University of North London. Dr. Mathur is a recipient of the prestigious Shanti Swarup Bhatnagar Prize in Chemical Sciences. He is a J. C. Bose Fellow and a Fellow of the Indian Academy of Sciences, Bangalore. He is a member of various committees of the Government of India’s largest funding agency, the Council of Scientific and Industrial Research and has authored over 200 research papers and has supervised 27 PhD theses. He has been or is on Editorial Boards of several journals, including Organometallics, Journal of Organometallic Chemistry and Journal of Cluster Science.

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E-mail: director@iiti.ac.in

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<http://www.gian.iitkgp.ac.in/GREGN>