Centre for Organometallic Chemistry

Dr. R. Ramesh

Professor and Coordinator

Genesis

Organometallic chemistry lies at the interface between classical organic and inorganic chemistry which provides a common platform for both organic and inorganic chemists to work under a single roof. This field has provided a series of important conceptual insights and surprising structures. The sustained interest in the area is due to the application of organometallic compounds in selective organic synthesis, particularly in the development of industrially important, high-performance, homogeneous catalysts and the enormous potential of organometallics as precursors in the production of new advanced materials such as sensors, switches and other types of solids with important, nonlinear optical properties. Further, bio-organometallic chemistry is an emerging field of research and, in particular, the use of organotransition metal complexes as potential anticancer agents appears to be promising.

About the centre

In appreciation of the contributions made by the research group under the leadership of Prof. R. Ramesh, Bharathidasan University has approved the proposal for the creation of a Centre and thereby the 'Centre for Organometallic Chemistry'(COMC)was established in the year 2016.The Centre has been supported by various national funding agencies like UGC, CSIR, DST-SERB. Further, Indo-French Center for Promotion of Advanced Research (IFCPAR), New Delhi has sanctioned an amount of Rs.1.90 crores under the scheme of collaborative research project, with Dr. David Semeril and Dr. Domnique Matt, Laboratory of Molecular Inorganic Chemistry and Catalysis, University of Strasbourg, France. This project offers exchange visits for both Principal Investigators and research scholars for three years. At present the centre has instruments facilities such as GC-MS, GC, Electrochemical analyser, Schlenk line set- up, Rotavapours and some more will be acquired.

Mission

COMC encourages the development of novel and innovative ideas and solutions in the field of organometallic chemistry and to generate new materials for various applications.

Vision

Our Centre (COMC) is dedicated to

- Promote the development of innovative research programs
- Perform high-quality research in the field of organometallic chemistry

- Sensitize a diverse population of students towards this area of research
- Develop the strategic partnerships with chemical industry, pharmaceuticals, research laboratories spread over the country
- Extending the Centre's facilities for campus and external users
- Produce knowledgeable graduates for careers in academia, industry and Government sectors
- Encourage participation of young students in seminars/ workshops/conferences

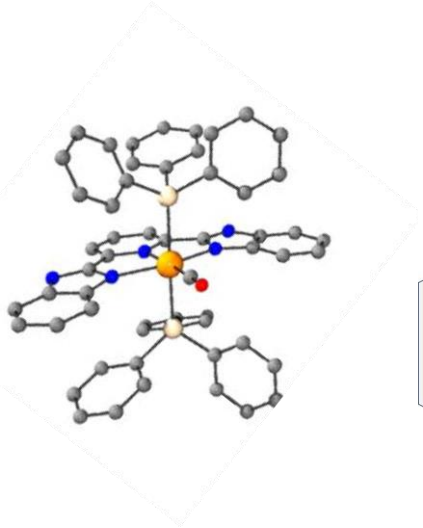
Objectives

The main objectives of the Centre involve,

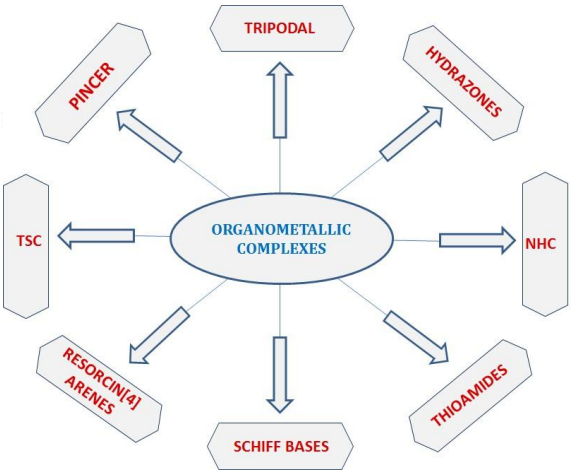
- Design and synthesize of new platinum group metals based organometallic compounds
- Generation of active and recyclable catalysts for organic transformations
- Organic synthesis via organometallic compounds
- Development of potential metallo drugs
- New materials such as sensors, switches, nanomaterials for diverse applications.

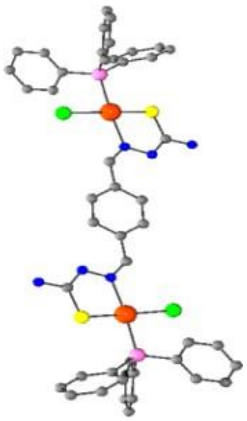
Synthesis

Centre for Organometallic Chemistry is mainly focusing on the synthesis of platinum group of organometallic complexes containing various multidendate ligands.These compounds have attracted much attention in organic synthesis, catalysis, materials and biology. In light of this, we have been actively working in the synthesis of Ru, Rh, Pd, Pt and Ni based complexes of carbonyls, tripodals, pincers, NHC, resorcin[4]arene, Schiff bases including TSC, hydrazones. Further, severalsub areas in this field were identified to advance environmentally friendly and sustainable processes and the research work is in progress.



Ru-Pincer complex

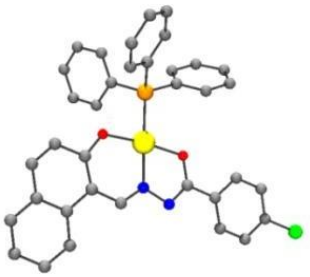




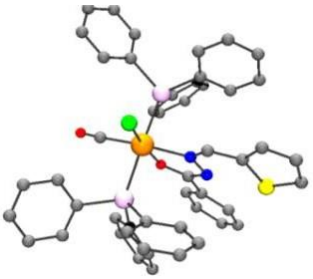
Pd-(Bis) TSC

Metal mediated organic synthesis

Transition metals especially platinum group metals open up new opportunities for organic synthesis. In search for unconventional and efficient approach towards metal mediated organic synthesis, our research group is actively involved in the development of flexible, efficient and environmental benign catalytic protocols for the synthesis of organic compounds, intermediates and pharmaceutically important targets. Our research group is engaged in the development of several new Ru catalysts for greener synthesis of amides and imines and Pd catalysts for C-C, (Suzuki-Miyaura, Heck), C-N (Buchwald-Hartwig), C-O, coupling reactions and various other reactions. Organic compounds were synthesized in excellent yield with low loading catalysts with high TON/TOF. Further, our goal is to develop new class of organometallic catalysts, which are expected to find widespread applications in the synthesis of organic materials and bioactive compounds.

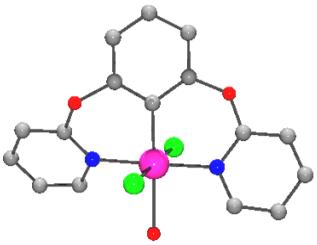


Pd- hydrazone

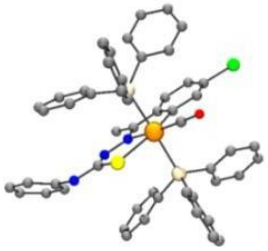


Ru-hydrazone

Catalytic organic transformations



Rh-Pincer complex

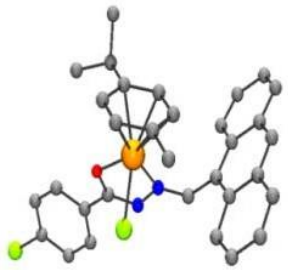


Cyclometallated Ru- TSC

Organometallic catalysts are able to efficiently promote different organic transformations. In this class, ketones and imines to alcohols/amines (transfer hydrogenation), alcohols to carbonyl compounds (oxidation), aldehydes to amides and olefin to aldehydes (oxidation) are powerful method for the synthesis of fine chemicals for both laboratory and industrial applications. In particular, ruthenium and rhodium catalyst containing pincer, Schiff base, thioamide, hydrazone and thiosemicarbazone ligands have proven to be effective catalysts for above organic transformations. Recently, we have developed ruthenium(II), ruthenium(III) and rhodium(III) catalysts for many organictransformations. Investigations are going on to improve catalytic activity with high product yield in open atmosphere, without usadditives. Notably, these protocol works well with ultra- low loading of catalysts with high turnover numbers in short time towards different substrates.

Bio-organometallic chemistry

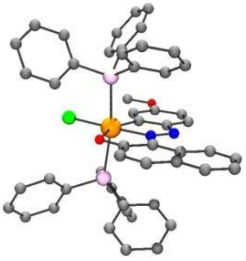
Bioorganometallic chemistry is an emerging area in chemical biology due to varied biological applications of organometallic compounds.Our current research goal is to design and study novel cytotoxic organometallic complexes for targeted therapeutic and diagnostic applications. We are engaged in the synthesis and development of specifically targeted cytotoxic metal complexes such as Cu, Ru, Ni for various therapeutic and diagnostic applications. Their detailed binding interaction studies with biological targets (nucleic acid, proteins etc.) and fate in biological medium were also investigated. Recently we have reported several ruthenium(II) arene complexes with excellent cytotoxicity than cisplatin against many human cancer cell lines and act as potential apoptosis inducers. Our primary objective is to generate active metallo drugs for various cancers without side effects.



Half-sandwich Ru-hydrazone complex

New materials

The research interests of the COMCincludes the preparation of inorganic, organic and polymer materials and to study of their performances in sensors, energy storage and, fluorescence materials and imaging and various biomedical applications. Many organoruthenium(II) complexes have been reported form our laboratory and are promising fluorescence materials at room temperature with high quantum yield. Development of new pincer ruthenium complexes is under progress towards their material science applications such as sensors, molecular switches etc.



Cyclometallated Ru-azo complex

Instruments Facilities

GAS CHROMATOGRAPH MASS SPECTROMETER (SHIMADZU GC-MS QP 2010 SE)

GAS CHROMATOGRAPH (BRUKER SCION 436-GC)

ELECTROCHEMICAL ANALYSER - SCANNING POTENTIOSTAT (CH INSTRUMENTS CHI600E)

ROTAVAPOR-II (BUCHI V-801 EACYVAC VACUUM MODULE)

SCHLENK LINE (NITROGEN LINE)

Research Projects

Sl. No	Title of Project	PI / Co-PI	Amount (Rs. In Lakhs)	Year of Completion	Funding Agency
1	Ru(II) Schiff base complexes: Synthesis, Characterisation and antimicrobial activity	PI	0.14	2001	UGC
2	Novel Ru(III) complexes of multidentate ligands: Synthesis, spectra, electrochemistry and bioactivity	PI	5.40	2002-2005	CSIR
3	New families of Ru(II) carbonyl complexes: Synthesis, spectra, redox and catalytic properties	PI	4.42	2003-2006	UGC
4	Synthesis of Uranium and Mercury Phosphoylide complexes: Reactivity towards carbonyl compounds, isocyanides and deprotonating agents	Co-PI	3.84	2004-2007	DST
5	Development of novel ruthenium pincer organometallic catalysts: Synthesis, structure and Catalytic transfer hydrogenation	PI	18.96	2007-2010	DST
6	Novel organo-ruthenium(III) metalla-cycles: New catalysts for transfer hydrogenation ketones	PI	14.36	2008-2011	CSIR
7	Novel binuclear ruthenium(III) complexes: Synthesis, structure, spectral, magnetic and electrochemical Properties	PI	8.25	2011-2014	UGC
8	Ru(II) complexes featuring N-heterocyclic carbenes: Synthesis, structure, redox properties and catalytic applications	PI	23.0	2013- 2016	CSIR
9	A new series of Ru(II) and Pd(II) aroylhydrazone complexes: Synthesis, structure, catalytic applications to transfer hydrogenation and carbon-carbon coupling reactions	PI	40.0	2013- 2016	SERB
10	Influences of the resorcin [4] arene on the catalytic outcomes	PI	189.64	2013- 2016	Indo-French
11	Development of new organoruthenium catalyst for direct synthesis of amide and amines/imines from dehydrogenation of alcohols	PI	32.0	2017-2020	SERB
12	Catalytic process for fine chemical synthesis- Heterocycles using alcohols	PI	16.04	2021-2022	RUSA 2.0
13	UGC-BSR Mid-Career research grant	PI	10.00	2021-2023	UGC
14	Pincer Supported Nickel(II) Catalysed Sustainable Synthesis of N-heterocyclic Compounds via Acceptorless Dehydrogenative	PI	34.5	2022-2025	SERB

	Coupling Strategy				

International Research Collaborations

1. Phong University of Science and Technology, South Korea.
2. University of Strasbourg, France.
3. Institute of High Energy Physics, China.
4. University of Zurich, Swiss.
5. University of Silesia, Poland.

National Research Collaborations

1. Indian Institute of Chemical Biology (CSIR), Kolkata.
2. Indian Institute of Science (IISc), Bangaluru.
3. University of Hyderabad, Hyderabad.
4. Bharathiar University, Coimbatore.
5. Cochin University of Science and Technology (CUSAT), Kochi.