Shri Vile Parle Kelavani Mandal's
Institute of Technology, Dhule

Dr. TUSHAR RAGHUNATH SHINDE

Coordinator, Applied Science and Humanities

18-B, Chandrawel Phase -3, Survey No- 97-2/2, Nakane Road, walwadi Dhule
Mob No:- 8208444438 Email:- tushar.shinde@svkm.ac.in, tusharshindeus1979@gmail.com

EDUCATIONAL DETAILS

2016 : **Post doctorate** in Physical chemistry from **North west University, Potchefstroom**, South Africa (Aug 2015 to July 2016)

2015 : **Ph.D. in Physical Chemistry** from **Charles University, Prague**, Czech Republic, Europe. (June 2010 to March 2015)

2008 : **M. Tech in Industrial Catalysis** from **Cochin University Of Science and Technology, Karla** (Aug 2006 to Sep 2008)

2002 : **M.Sc. in Polymer Chemistry** from **North Maharashtra University, Jalgaon**.

2000 : **B.Sc. in Chemistry** from **North Maharashtra University, Jalgaon**.

PROFESSIONAL EXPERIENCE

- **Assistant Professor and First year Co-ordinator**, at **Shri Vile Parle Kelavani Mandal's Institute of Technology, Dhule** from 28/08/2017 to till date.
- **Postdoctoral Fellow**, at **North West University, Potchefstroom** South Africa from 01/08/2015 to 31/07/2016.
- **Ph.D students** in **J Heyrovsky Institute of Physical Chemistry, Prague, Europe** from 02/06/2010 to 04/03/2015
- **Project Students** at **National Chemical Laboratory, Pune**, India from 01/07/2007 to 03/03/2008

❖ INDUSTRIAL /RESEARCH WORK LOCATION:

1. J. Heyrovsky Institute of Physical Chemistry, Prague, Czech Republic, Europe.

02/06/2010 to 04/03/2015

NATURE OF WORK:

Homogeneous and heterogeneous catalysis, olefin metathesis, ring opening metathesis polymerization, organometallic catalysts anchored on mesoporous molecular sieves, ring opening metathesis polymerization of vinyl norbornene.

❖ **RESEARCH PROJECT:**

"Ruthenium alkylidenes immobilized on mesoporous molecular sieves as catalysts for olefin metathesis".

Team: -

Description: -

The main emphasis of the dissertation focuses on the preparation of new heterogeneous metathesis catalysts, their characterization, and testing their activity and selectivity in different metathesis reactions. This work has been completed at the Department of Synthesis and Catalysis, J. Heyrovský Institute of Physical Chemistry, AS CR.

Hoveyda-Grubbs type catalyst **ZC** (Zhan catalyst 1-B) was immobilized on mesoporous molecular sieves of different architecture and pore diameter, *d*, (hexagonal: MCM-41, *d* = 4.0 nm; SBA-15, *d* = 6.8 nm; SBA-15 large pore (LP), *d* = 11.1 nm and cubic: MCM-48, *d* = 6.0 nm) and conventional silica (Merck) for comparison. The immobilization was done by simple mixing of **ZC** solution with appropriate support at room temperature. Ru loading in all immobilized catalyst was 0.93 wt%. The catalysts and supports were characterized by X-ray diffraction and nitrogen adsorption measurement. It was found that regular architecture and mesoporous character of supports were preserved during immobilization. Catalyst characterization was also done using X-ray photoelectron spectroscopy (XPS) and UV-Visible spectroscopy (UV-Vis). XPS and UV-Vis spectroscopic studies of **ZC** immobilized on SBA-15 (**ZC/SBA-15**) indicated the attachment of **ZC** on mesoporous sieve surface by non-covalent interactions because i) UV-Vis suggested no changes in the co-ordination sphere after immobilization and ii) XPS spectra showed the same binding energy of Ru '3d' electrons (281.2 ± 0.2 eV) and molar ratio Cl/Ru = 2.0 before and after immobilization. NMR spectroscopy showed that approximately 76% of Ru content was recovered from **ZC/SBA-15** as original **ZC** by washing **ZC/SBA-15** with tetrahydrofuran at room temperature.

The immobilized catalysts exhibited high activity and 100% selectivity in ring-closing metathesis of diethyl diallylmalonate and 1,7-octadiene, in metathesis of methyl oleate and methyl 10-undecenoate, and in the ring-opening metathesis polymerization of cyclooctene. Ru leaching was dependent on the solvent and substrate used for the reaction. In non-polar system Ru leaching was negligible (0.04% of starting Ru amount for ring-closing metathesis of 1,7-octadiene in cyclohexane), however, the highest Ru leaching was observed in polar system (14% for ring-closing metathesis of diethyl diallylmalonate in dichloromethane). The filtration experiment carried out for ring-closing metathesis of 1,7-octadiene and citronellene proved that the catalytic active species were completely bound to the solid phase in non-polar solvent.

A positive effect of the pore size of the supports on catalyst activity was observed for ring-closing metathesis of -(β)-citronellene, metathesis of 1-decene, acyclic metathesis polymerization of 1,9-decadiene, and ring-opening metathesis polymerization (ROMP) of cyclooctene. In all cases, the initial reaction rate increased with increasing pore size of the catalyst support; however, support architecture did not play any

important role. Mesoporous molecular sieves based catalysts were more active as compared to conventional silica based catalyst. In ROMP of cyclooctene, mesoporous molecular sieves based catalysts produced high molecular weight polymers (M_w about 300,000) in high yields (70–80%). However, in case of conventional silica based catalyst the polymerization stopped after 15 min of the reaction and only 40% yield of polycyclooctene was obtained. These results indicate the advantages of mesoporous molecular sieves based catalyst for ROMP. The effect of catalyst, substrate concentrations and temperature on the reaction rate was studied in ring-closing metathesis of citronellene and high TON (4010) was achieved using a very small amount of catalyst ($C°_{Ru}$ = 0.042 mmol/L). **ZC** catalyst was able to catalyze enyne cross-metathesis of aliphatic alkenes and alkynes but heterogeneous catalyst failed in this case.

The activity of a new heterogeneous catalyst, Grubbs second generation catalyst immobilized on SBA-15 via phosphine linker (**G.II/SBA-15**), and **ZC/SBA-15** was tested in metathesis and cross-metathesis of cardanol (the main component of Cashew Nut Shell Liquid). Both heterogeneous catalysts proved to be highly active and selective in cardanol metathesis and cross-metathesis with ethene and cis-1,4-diacetoxy-2-butene (DAB) (in cardanol metathesis, TON = 1125 and 2075 for **G.II/SBA-15** and **ZC/SBA-15**, respectively). In cardanol ethenolysis, 3-(non-8-enyl)phenol was isolated as a major product. In cross-metathesis of cardanol with DAB, 9-(-3-hydroxyphenyl)non-2-enyl acetate and non-2-enyl acetate were formed with high selectivity. 3-(non-8-enyl)phenol and non-2-enyl acetate found applications as detergent precursors and flavor and fragrance agents. Easy separation of both catalysts from products and low Ru leaching (0.5% for **G.II/SBA-15** and 2.5% for **ZC/SBA-15)** ensure the delivery of products of low contents of Ru residues.

2. National Chemical Laboratory, Pune

01/07/2007 to 03/03/2008

NATURE OF WORK:

- Biomass Conversion, Heterogeneous catalysis, Mesoporous molecular sieves

❖ **RESEARCH PROJECT:**

"Heterogeneous catalytic transformation of glucose / fructose into 5-hydroxymethyl furfural".

Team: - Two

Description: -

This Project was on biomass conversion into value-added chemicals, which I did in National Chemical Laboratory, Pune, India. I worked on preparation of some solid acid catalyst like, MCM-41, Al- MCM-41, Ga-MCM-41, Sn- MCM-41 and preparation of some supported metal catalyst. The characterization of the catalysts were done by using different techniques like, SEM, TEM, BET and XRD. Moreover, I have performed liquid phase reactions that lead to the transformation of biomass into chemicals.

In this work, it has been demonstrated that a single phase and biphasic system can be applied to process diverse feedstock molecules to produce HMF. After screening large number of catalyst under various reactions conditions it can be concluded that solid catalyst with low acidity, as shown by Ti-silicate (Both amorphous and crystalline with Si/Ti = 30 or less) and MCM-41 type materials like Al-MCM-41 (Si/Al =100) are best suited catalyst for Glucose / fructose conversion to 5-HMF. The large number of side product are formed in this reaction. The product was isolated and yield was calculated.

Barriers:

Difficult and tedious analysis and isolation methods very reactive and unstable nature of 5-HMF giving secondary product.

3. TATA Chemicals Innovation Research Centre, Pune

03/03/2008 to 13/08/2009

NATURE OF WORK:

- Biodiesel, Biolubricant, Heterogeneous catalysis.

RESEARCH PROJECT:

` **"Synthesis of biodiesel and biolubricant using solid catalyst"**

Team: - four

Description: -

Normally in case of Biodiesel, people use NaOH as homogeneous catalysts, which has some problem of catalyst –Product separation, and reusing but it could be overcome by using heterogeneous catalysts. Hence, in above project I have tried to use heterogeneous catalyst in the production of biodiesel and bio lubricant.

1. Patent

Sr. No.	Details of Publication	Application Number	Inventors
1	A process for production of biodiesel.	PCT/IN2009/000331	Dr. Tushar Shinde, Dr. Rajiv Kumar, Dr. Nawal kishor Mal, Dr. K S Nagabhushna
2	A process for production of biodiesel.	PCT/IN2009/000295	Dr. Tushar Shinde, Dr. Rajiv Kumar, Dr. Nawal kishor Mal, Dr. K S Nagabhushna

3	A process for production of biolubricant using fly ash as a catalyst.	PCT/IN2009/000586	Dr. Tushar Shinde, Dr. Rajiv Kumar, Dr. Nawal kishor Mal, Dr. K S Nagabhushna
4	Catalysed production of fatty acid alkyl esters from fatty acid glycerol esters and alkanols.	PCT/IN2009/000587	Dr. Tushar Shinde, Dr. Rajiv Kumar, Dr. Nawal kishor Mal, Dr. K S Nagabhushna

2. Research Papers Presented / Published:

Sr. No.	Details of Publication	National/International	Publisher, Vol, Indexing, impact factor	Author (s) / Editor (s)
1	Ring opening metathesis Polymerization of vinyl norbornene and following polymer modifications.	International	J. Polym. Res, 21 (2014) 557. **I.F. = 1.530**	Hynek Balcar, Tushar Shinde, Martin Lamač, Jan Sedláček
2	Metathesis of cardanol over Ru catalysts supported on mesoporous molecular sieve SBA-15.	International	Applied Catalysis A: General, 478 (2014) 138. **I.F. = 4.630**	Tushar Shinde, Vojtěch Varga, Miroslav Polášek, Michal Horáček, Naděžda Žilková and Hynek Balcar
3.	Hoveyda Grubbs types Metathesis catalyst immobilized on mesoporous molecular sieves – The influence of pore size on the catalyst activity	International	Catalysis Today, 179 (2012) 123. **I.F. = 4.888**	Tushar Shinde, Naděžda Žilková, Vladimíra Hanková, Hynek Balcar

4.	**.** Hoveyda Grubbs type metathesis catalyst immobilized on mesoporous molecular sieves MCM-41 and SBA-15.	International	Beilstein J. Org. Chem., 7 (2011) 22. **I.F. = 2.595**	Hynek Balcar, Tushar Shinde, Naděžda Žilková, Zdeněk Bastl

3. Workshop / Conferences / Seminars Attended

Sr. No.	Title of Paper	Name of Conference in which published	Date of Publication
1	Hoveyda –Grubbs metathesis catalyst immobilized on mesoporous molecular sieves MCM-41 and SBA-15. (Poster)	, 42 nd symposium on catalysis, Prague, CZ, Europe	1 to 2 November 2010
2	Ring opening metathesis polymerization of vinylnorbornene and following polymer modifications. (Poster)	Czech Italian Spanish conference, Prague, CZ, Europe	15 to 18 June, 2011
3	Hoveyda-Grubbs type metathesis catalyst immobilized on mesoporous molecular sieves: The influence of pore size on catalyst activity. (Poster)	ISOM 2011, University Rennes, France	10th to 15 July, 2011
4	Activity of non-covalently immobilized Hoveyda Grubbs type metathesis catalyst on mesoporous sieves. (Poster)	43 rd symposium on catalysis, Prague, CZ, Europe	7 to 8 November 2011
5.	Hoveyda-Grubbs second-generation type metathesis catalyst immobilized on different mesoporous molecular sieves: The influence of pore size on catalyst activity. (Poster)	Symposium on Homogeneous Catalysis, Toulouse, France	9th to 13 July 2012.
6	Ring opening metathesis polymerization of vinylnorbornene using molybdenum and ruthenium catalysts. (Oral)	, 44 th symposium on catalysis from, Prague, CZ, Europe	5 to 6 November 2012
7	Immobilization of ruthenium catalyst on SBA-15: Comparative study for the metathesis of cardanol. (Poster)	Balcar 45 th symposium on catalysis, Prague, CZ, Europe	4 to 6 November 2013

8	SBA-15 immobilized ruthenium alkylidene for metathesis of cardanol. (Oral)	School of molecular sieves 2014, Prague, CZ, Europe	March 17 to 18, 2014
9	Immobilization of ruthenium catalysts on inorganic support and testing thereof in cardanol metathesis. (Oral)	Uka Tarsadia University, Bardoli, Gujrat	February 22 - 23, 2019
10	Laboratory and Industrial Safety and Hazards (LISH – 2019) - Workshop	School of Chemical Sciences, KBC NMU, Jalgaon	March 13, 2019

4. Special Achievements:

- North West University Potchefstroom, South Africa 2015-2016
- Charles University Scholarship, Prague, CZ 2010-2014
- Research award for Biodiesel in TATA Chemicals Innovation Center, Pune, India. 2009
- National level UGC-PG GATE Scholarship, India 2006-2008

5. AREA OF INTEREST

Olefin Metathesis, Mesoporous Molecular Sieves, Heterogeneous catalysis, Homogeneous catalysis, Biodiesel, Biolubricant, Biomass Conversion, Adsorption and catalysis.