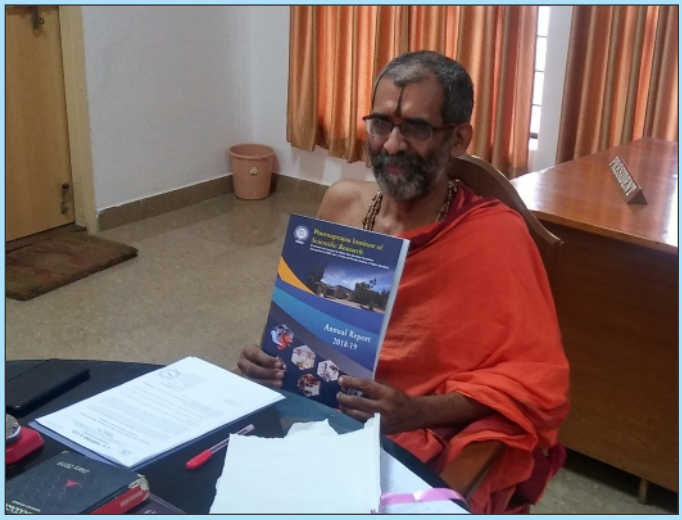
Poornaprajna Institute of Scientific Research

Promoted and managed by Admar Mutt Education Foundation
Recognized by DSIR, Govt. of India and Manipal Academy of Higher Education

Annual Report 2019-20



The Board of Trustees meeting was held on November 02, 2019 in the presence of H H Sri Vishwapriya Theertha Swamiji at Sadashivangar premises. The annual report for the year 2019 of the institute was released on the occasion.

In the presence of the Chairman H H Sri Vishwapriya Theertha Swamji at Bidalur campus enabled us to release the News Letter Volume X for the year 2019 along with the benediction from H H Sri Vishwapriya Swamiji.

A week long 02nd to 07th of December, 2019, Research Orientation Workshop for the students of Poornaprajna College, Udupi was organised at PPISR, Bidalur. This workshop was inaugurated by Prof. Pandurangappa, Registrar of Bengaluru University on 2nd of December, 2019 and the key note was delivered.

A team of forty members from Ramaiah Institute of Technology visited the campus in collaboration of Faculty Development Programme with PPISR. An overview of PPISR alogwith a brief note on the work carried out in PPISR was presented by the faculty members and in reciprocate, the visiting team members also presented their work. The members also visited the laboratories to have the glimpse of the instruments available in the labs.

Poornaprajna Institute of Scientific Research

Bengaluru, India

Annual Report 2019-2020

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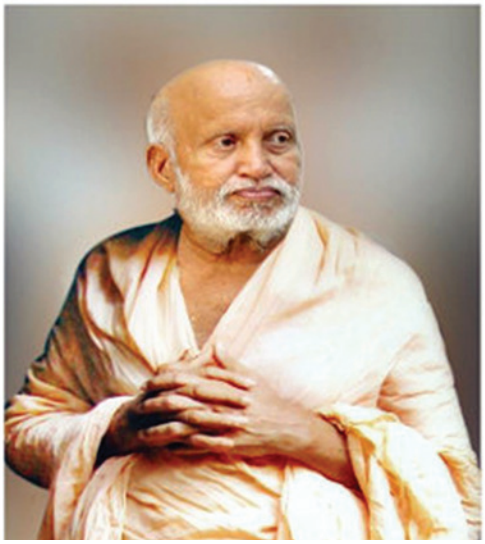
GOI and Manipal Academy of Higher Education (MAHE)

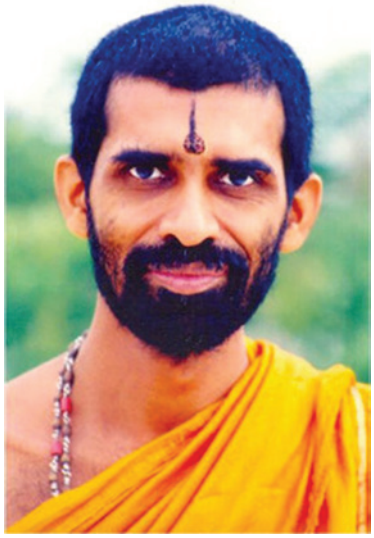
Founder's Message



Knowledge is Power! Providing facilities to conduct research in basic sciences has become very necessary. Our brilliant youth go outside the country to do research and settle there. Until we check this trend, India cannot make real progress in any field. Hence, an attempt is made to establish the Poornaprajna Institute of Scientific Research (PPISR) under the guidance of many eminent scientists of this country. More the investment by the nation in science and technology, the stronger the country will evolve. All well-wishers are hereby approached to assist in this grand endeavor to make Atmanirbhar Bharat equipped with skill and technology to lead and serve the world. I pray for divine guidance. May the Lord grant the necessary strength to develop this Institute for the benefit of the nation and the world alike.

H. H. Sri Vibudhesha Theertha Swamiji
Founder, PPISR

Chairman's Message



The Poornaprajna Institute of Scientific Research (PPISR), founded by my beloved Guruji, an illustrious predecessor, H. H. Sri Vibudhesha Theertha Swamiji, is often cherished as the crest jewel among the Poornaprajna academic family. PPISR is steadily yet firmly marching towards his dream of becoming a world-class research institute in the areas of Physical, Material, and Biological Sciences. The research work is carried out here with immense curiosity and spirit of service to the Motherland, just like the Rishis of yore into the spiritual sciences. The worldwide pandemic has not weakened the vigor of research activities and progress at PPISR but only altered how it is pursued with emphasis on the online interaction. The number of students who obtained their Ph.D. at PPISR has now increased to fifteen. Several new research projects have been initiated, with the possibility of the Theoretical Sciences group venturing into experiments to develop cutting-edge technology. I do not doubt that the stewardship of PPISR rests in the hands of capable and dedicated scientists and staff. Their hard work will one day fulfill H. H. Sri Vibudhesha Theertha Swamiji's vision of India playing a pivotal role in scientific contribution to the scientific world globally. May Lord Sri Krishna bless and guide all the members of PPISR!

H. H. Sri Vishwapriya Theertha Swamiji
Chairman, AMEF

H. H. Sri Eeshapriya Theertha Swamiji's message

Having an academic background both in traditional studies as well as in technology, I am delighted to share duties with my beloved Guruji H. H. Vishwapriya Theertha Swamiji in witnessing and overseeing the considerable educational and academic strides being made by the Poornaprajna Institute of Scientific Research (PPISR), founded by the patriot saint H. H. Sri Vibudhesha Theertha Swamiji.

Starting first with a modest size and having only the Theoretical Sciences department, we have now grown to include two currently well-established departments for Physical, Materials and Biological Sciences, where frontier research on industrial-grade catalysts and protein structure analysis are undertaken, among many others. It is especially noteworthy that, even while the core of our research is curiosity-driven, part of the research we undertake is devoted to societally useful issues, such as medicinal applications, green chemistry, solar energy use and cryptography.

I appreciate that now PPISR is making efforts to leverage their joint expertise in these diverse fields towards studies where machine learning and artificial intelligence (AI) can be applied in areas such as catalysis design, discovery of immunity-boosting molecular medical studies, novel solar energy materials and quantum technologies.

In view of the quality of publications and that of our research scholars, the management, for their part, has deemed it fit to support research at PPISR by making available funds for additional built-up area, faculty expansion and student scholarships. May the blessings of Lord Shri Krishna provide constant guidance to the PPISR family members both scientifically and spiritually!

H.H. Sri Eeshapriya Theertha Swamiji
Vice Chairman - AMEF

Contents

1. Message from Hon. Secretary, AMEC & AMEF

Uniquely among the heads of various spiritual organizations of this country, His Holiness Sri Vibudhesha Theertha Swamiji, the then chief Pontiff of Udupi Sri Admar Mutt, Udupi, not only conceived but also created the thriving scientific research institute that PPISR has today become. His interest and curiosity about scientific matters were such that he would enthusiastically interact with scientists, sometimes even placing himself in the position of a student attending science classes and lectures. His deep vision was not only for India's excellence in scientific research but for the unification of science and spirituality in the spirit of the ancient Rishis of this Country. While the thirty-three Poornaprajna Institutions or schools all founded by him all over the Country, each excels in its own right. Yet, for him, Poornaprajna Institute of Scientific Research established in Bidalur, Bengaluru during 1998, held a position of pride, a "choodamani" (a crest jewel). PPISR may thus rightly be considered tangible as symbolizing Saint's love for science. He was not only an idealist but a man with a practical bent of mind, who carefully planned the operational aspects of running such an institute as a premier research institute producing top quality Ph.D. students.

Since H.H. Sri Vibudhesha Theertha Swamiji attained the Lotus Feet of Lord Sri Krishna, the mantle of providing sacred guidance of PPISR has been graciously taken up by H.H. Sri Vishwapriya Theertha Swamiji, the present Pontiff of Sri Admar Mutt, Udupi, the President of AMEC and Chairman of AMEF. Since the setting up of Bharat Ratna Prof C. N. R. Rao Laboratory for Materials Science, the Materials Science division (since renamed as Materials Science and Catalysis Division) has expanded in inducting a new and able faculty member, Dr. D. H. K. Murthy, and produced two more excellent Ph.D. graduates, Dr. K. M. Archana and Dr. B. Vasudev. There can be little doubt that H. H. Sri Vibudhesha Teertha Swamiji is watching these developments from Above with joy and pride. PPISR has been pursuing a healthy mix of both fundamental ("blue sky") research as well as applied and applicable research. Among many achievements by PPISR over the past year, perhaps it is apt to especially mention that now 15 doctoral students have obtained their Ph.D. degrees with and moved on for a postdoc in reputed institutes in India or abroad and that PPISR has now crossed the milestone of 290 publications in peer-reviewed journals of international repute. In PPISR's journey in pursuit of the sacred, scientific vision set forth by H. H. Sri Vibudhesha Theertha Swamiji and guided by H. H. Sri Vishwapriya Theertha Swamiji and H.H. Sri Eeshapriya Teertha Swamiji, all activities of PPISR are being funded mainly by AMEF. At the same time, a larger part of student scholarships is obtained from academic and industrial projects. It is our fond hope that our achievements would inspire more members from the Corporate World and the General Public to support our activity for service to the world's scientific knowledge through Indian science.

Dr. K. Srihari
Professor (Rtd), UAS, Bengaluru
Hon. Secretary, AMEC and AMEF

2. Foreword from the Director

I have great pleasure in presenting the nineth Annual Report on the account of research and academic activities of Poornaprajna Institute of Scientific Research (PPISR) for the year 2019-20. PPISR is climbing the ladder of success steadily in highly competitive scientific research and is coming into the limelight on the national and international stage by maintaining the uniqueness in the research field. The Institute has chosen new frontier research areas in Materials Science, Catalysis, Biological Science, and Theoretical Sciences. PPISR successfully forges ahead through a fruitful academia-industry partnership by innovating, designing, and developing novel multifunctional materials with wide-ranging applications in catalysis, nanotechnology, to mention a few. Several new research areas have been initiated through the government agencies sponsored projects like DBT, DST, VGST, BRNS & DRDO. We have initiated three new projects on "Development of Catalyst and Process for specific co_2 transformation" sponsored by Hindustan Petroleum Corporation Ltd. (HPCL), "Development of zeolite-based catalyst for TM process sponsored by Deepak Novochem Technologies Ltd., Pune and "Structure Based Rational Design of Pd1 Mutants to Create Lead Molecules For Cancer Immunotherapy" sponsored by Bristol Myers Squibb, USA.

Dr. D. H. K. Murthy joined PPISR as an Assistant Professor to work in the area of Materials Sciences and Catalysis Division.

Mrs. Pavithra G.C. doctoral student from Biological Sciences Division guided by Dr. Udupi A Ramagopal, Mr. Pradeep Shanbhog, doctoral student in Materials Sciences Division guided by Dr. Nalini G Sundaram, Mr. Bakuru Vasudeva Rao from Materials Sciences division guided by Dr. Suresh Babu Kalidindi, and Ms. Kavitha Kesava Navada from Biological sciences division guided by Dr. Ananda K have awarded their Ph.D. degrees from Manipal Academy of Higher Education, (MAHE), Manipal during this period.

Dr. A B Halgeri received Lifetime Achievement Award from Material Society India for his contribution in "Materials Research and Process Development" during International Conference on Advances in Materials Research (ICAMR-2019).

Mr. Sathyapal, Ms Archana, Mr. Nagendra Kulal, Mrs. Vaishnavi B. J. and Ms. Marilyn DMello, have been awarded the prestigious CSIR Senior Research Fellowships and Mr. Shankar V Kundapura has been awarded the DST-PhD Fellowship by Karnataka Science and Technology Promotion Society (KSTePS).

Mr. Bakuru Vasudeva Rao, doctoral student, received the "Young Scientist Award of Citation 2018 and 2019" for outstanding achievement in chemistry- Runner Up-1 (2nd) of Dr.K.V. Rao Research Awards for the year of 2019 in Chemistry.

Two of our doctoral students Ms. Chethana A. and Mr. Shankar Kundapura visited Trieste, Italy, for conducting experiments.

A new analytical instrument STA-6000 (Perkin Elmer) to analyze TGA/DTA/DSC measurements was procured under the VGST CESEM project grant and was installed at Poornaprajna Analytics Centre.

In 2019-20 alone, the Institute has published 44 research papers in all areas of sciences and overall, PPISR has crossed 290 publications in peer-reviewed high impact factor international journals.

One US Patent, as well as one Indian Patent have been granted for the collaborative research programme on "A process for the preparation of isomers of xylene" sponsored by HPCL R&D Centre, Bengaluru, in which Faculty Members of PPISR in Catalysis group are Co-Inventors.

A Memorandum of Association between Indo-Korea Science and Technology and Poornaprajna Institute of Scientific Research was signed during this tenure.

Founder's Day celebration, a one-day symposium on Advances in Chemical Sciences in association with Reva University, a week-long Research Orientation Workshop for Undergraduate students of Poornaprajna College, Udupi, Outreach Programme for Poornaprajna School students, a two-day training course on the use of DFT for Computational Catalysis were conducted during this period.

Based on our ongoing research projects, Ms. Marilyn E. DMello, Ms. Vaishnavi B. J., Mr. Nagendra Kulal, Ms. Chethana A., Ms. Archana have presented their research papers at various National and International Conferences and have won best presentation awards. Several distinguished Professors and scientists from both India and abroad visited our Institute and have given lectures.

At a glance through this Annual Report we believe you will realize that PPISR is on the right path in realizing Paramapoojya Sri Sri Vibudhesha Theertha Swamiji's dream of creating a vibrant and flourishing institutional environment for scientists and research students. On the whole, the entire year 2019-20 was much more productive and successful with the unstinted support and blessings from H. H. Sri VishwapriyaTheertha Swamiji, H. H. Sri Eeshapriya Theertha Swamiji and also enthusiastic support from the management of Admar Mutt Education Foundation and Trustee members, and also with the support of all faculty members, students, and staff of PPISR.

Dr. A B Halgeri
Director

3. MEMBERS OF BOARD OF TRUSTEES/ MANAGEMENT

H. H. Sri Vishwapriya Theertha Swamiji Peetadhipathi, Sri Admar Mutt, Udupi	Chairman
H. H. Sri EeshapriyaTheertha Swamiji Sri Admar Mutt, Udupi	Vice chairman Junior Swamiji
Dr. K. Srihari, Professor (Rtd), UAS, Bengaluru	Hon. Secretary
Sri. M. Ashok Kumar, Chartered Accountant	Hon. Treasurer
Sri B.R. Prabhakara, IAS, Former Chief Secretary Govt. of Karnataka	Member
Sri V. V. Bhat, IAS, (Retd), Former Secretary to the Govt. of India	Member
Sri Rajendra J. Hinduja, Industrialist, Bengaluru	Member
Sri Laxmisha G. Acharya, Industrialist, Mumbai	Member
Dr. U. Shankar Rao, Medical Director, National Hospital, Chennai.	Member
Padma Shri Dr. V.R. Prahalada, Former Vice Chancellor, Defence Institute of Advanced Technology, Pune	Member
Sri. H. L. Suresh, Chairman, Axens India Pvt. Ltd., New Delhi	Member
Prof. V. Nagaraja, President, JNCASR, Bengaluru	Member
Dr. Anand B. Halgeri, PPISR	Director
Sri P. Sreenivasa Rao, PPISR	Financial Advisor
Padma Vibhushan Prof. P. Rama RaoFASc, FNA, FNASc, Ex. Secretary, Ministry of S &T, GOI	Special Advisor
Sri K. R. Prasad, Advocate, Bengaluru	Special Advisor

4. RESEARCH ADVISORY COMMITTEE

1. Padma Shri Dr. V. R. Prahalada, Former Vice Chancellor, Defence Institute of Advanced Technology, Pune
2. Prof. C. Sivaram, Professor, Indian Institute of Astrophysics, Bengaluru
3. Prof. Prof. S Natarajan,SSCU, IISc, Bengaluru
4. Prof. G. U. Kulkarni, Director CeNS and Professor, JNCASR, Bengaluru
5. Prof. A Jagannadha Rao, Professor, Raja Ramanna Fellow; DST, Department of Biochemistry, IISc, Bengaluru
6. Prof. T.N. Guru Row, Professor,SSCU, IISc, Bengaluru
7. Prof. Chandrabhas Narayana, Professor, CPMU, JNCASR, Bengaluru
8. Prof. S. Ramakumar, Professor, Bioinformatics Centre, IISc, Bengaluru
9. Prof Uday Kumar Ranga, Professor, MBGU, JNCASR, Bengaluru
10. Prof B Gopal, Professor, MBU, IISc, Bengaluru
11. Prof Jayanth Murthy, Professor, IIA, Bengaluru
12. Prof. A. B. Halgeri (Member Secretary), Director, PPISR

5. DOCTORAL ADVISORY COMMITTEE

1.	Prof. C. Sivaram	Indian Institute of Astrophysics, Bengaluru
2.	Prof. T. N. Guru Row	SSCU, IISc, Bengaluru
3.	Prof. S. Ramakumar	Physics Dept., IISc, Bengaluru
4.	Prof. A. J. Rao	Biochemistry Dept., IISc, Bengaluru
5.	Prof. S Natarajan	SSCU, IISc, Bengaluru
6.	Prof. Shivashankar	Materials Research Center (MRC), IISc, Bengaluru
7.	Prof. B. R. Jagirdar	IPC Dept, IISc, Bengaluru
8.	Prof. Anjali A Karande	Dept of Biochemistry, IISc, Bengaluru
9.	Prof. Dipankar Nandi	Dept of Biochemistry, IISc, Bengaluru
10.	Prof. Rajeev Ranjan	Materials Engineering, IISc, Bengaluru
11.	Prof. PrabeerBarpanda	Materials Research Centre, IISc, Bengaluru
12.	Prof. Chandrabas N.	JNCASR. Bengaluru
13.	Dr. Tapas Kumar Maji	CPMU, JNCASR, Bengaluru
14.	Dr. Sebastian C. Peter	JNCASR, Bengaluru
15.	Dr.Govindaraju T.	New Chemistry Unit, JNCASR, Bengaluru
16.	Dr.Meher K. Prakash	Biophysics group, JNCASR, Bengaluru
17.	Prof. Ramachandra	Chairman and Director, Centre for Fundamental Research and Creative Education, Bengaluru
18.	Prof. H. G. Nagendra	MVIT Engg. College, Bengaluru.
19.	Dr.R.Ravishankar	Deputy General Manager, HPCL, Bengaluru.
20.	Dr. G S. Rao	Sr. Scientist, SABIC Technology Centre, Bengaluru
21.	Prof. N. Nagaraju	St. Joseph College, Bengaluru
22.	Dr. Ramakrishna Matte	Centre for Nano and Soft Matter Sciences, Blru
23.	Dr. D. A. Nagegowda	Mol. Plant Biology & Biotech. group, GKVK, Blru
24.	Prof Rajeev Joshi	Central University of Karnataka, Kalburgi
25.	Prof. Y. S. Bhat	Emeritus Professor, PPISR and Former HOD, Chemistry Dept, BIT, Bengaluru.
26.	Dr. Shanti K.N.	PES University, Bengaluru
27.	Prof. S. K. Srivatsa	Atria Institute of Technology, Bengaluru
28.	Dr. G Mohan Rao	Indian Institute of Science, Bengaluru
29.	Prof Sundaresan A	JNCASR, Bengaluru
30.	Prof V Gayathri	Dept of Chemistry, Central College, Bangalore University

6. ORGANIZATION

Director:	Dr. Anand B. Halgeri
Financial Advisor:	Sri P. Sreenivasa Rao

Core Faculty:
Dr. Udupi A. Ramagopal
Dr. Sujit Sarkar
Dr. Srikanth R.
Dr. Ananda Kulal
Dr. Ganapati V. Shanbhag
Dr. Sanjeev P. Maradur
Dr. D. H. K. Murthy

Honorary Professor:
Dr. Rajappan Vetrivel

Administration:

Senior Administrative Officer	Mr. Kishore L. Gaikwad
Accounts Officer	Mr. Nagarajan R.
Sr. Secretary to Director	Mrs. Latha Srinivasan
Secretary to Financial Advisor	Mrs. Nandini S.

Support staff:
Mr. Vishwaprakash A.
Mr. Praveen Kadam
Mr. Sriramappa S.
Mr. Shashidhara
Mr. Basavaraj

7. ABOUT THE INSTITUTE

Poornaprajna Institute of Scientific Research (PPISR) is situated near Bengaluru International Airport on a sprawling campus spread over 32 acres. It was conceptualized and founded by the pontiff of Admar Mutt H. H. late Sri Vibudhesha Theertha Swamiji. His vision was to create a serene and congenial environment, where scientists would be inspired to carry out innovative and original research in fundamental and applied sciences. The foundation stone for the research campus was laid in 1998 by the then Prime Minister of India Sri Atal Bihari Vajpayee. The institute is recognized by the Department of Scientific and Industrial Research (DSIR), Govt. of India, New Delhi and Manipal Academy of Higher Education, Manipal, Karnataka, as an R&D centre. There are three departments; Theoretical Sciences, Materials Science and Biological Sciences, where advanced cutting-edge research activities are being conducted.

It is presently enthusiastically carried forward by the present Chairman H. H. Sri VishwapriyaTheertha Swamiji to make Poornaprajna Institute of Scientific Research a Centre of Excellence to realize the dreams of his Guruji H. H. Sri Vibudhesha Theertha Swamiji. H. H. Sri Vishwapriya Theertha Swamiji has a keen interest in the research activities of PPISR. The infrastructure is being constantly upgraded to meet the academic requirement and scientists and student activities. In a short span of three years, H. H. Sri Vishwapriya Theertha Swamiji had inaugurated the Biological Sciences laboratory, a new hostel building. Bharat Ratna Prof. C. N. R. Rao has donated a Materials Science Laboratory to carry out world-class research at Bidalur campus.

The Institute has eight core faculty members, several distinguished professors as an adjunct and honorary professor and 35 distinguished scientists from various renowned organizations. So far, fifteen students from PPISR have obtained their Ph.D. degree from MAHE, Manipal. Presently, 26 doctoral students and several project assistants are actively involved in research activities on many sponsored projects, both from Government agencies and as well as from industries. To date, the Institute has published more than 290 papers in International peer-reviewed journals. Three international patents have been filed in HPCL collaborative project, out of which two US patents have been granted. The average impact factor of our publications is >3.0 which is on par with many elite insitutes of the country.

PPISR is promoted and managed by Admar Mutt Education Foundation (AMEF). It is a part of a large family of sister institutions, including around thirty-three Poornaprajna Schools, Poornaprajna Institute of Management and the Poornaprajna Institute of Faculty improvement, governed by the Udupi Sri Admar Mutt Education Council (AMEC). All these developments would not have been possible without the guidance, support and blessings from H. H. Sri Vishwapriya Theertha Swamiji and H. H. Sri Eeshapriya Theertha Swamiji. The excellent support from the management of Admar Mutt Education Foundation, and with the cooperation of all faculty members, students, and staff of PPISR is greatly appreciated. They have immensely contributed to realise the vision of our founder Chairman H. H. Sri Vibudhesha Theertha Swamiji.

8. DIVISION STRUCTURE

Faculty	Research Scholars/ Project Students
MATERIALS SCIENCE AND CATALYSIS	
Dr. A. B. Halgeri (Catalysis) Professor and Director	-
Dr. G. V. Shanbhag (Heterogeneous Catalysis) Associate Professor	Mr. Nagendra Kulal, Mrs. Vaishnavi B. J., Mr. Manjunath D., Mr. Sujith S., Ms. Archana K. M., Ms. Chethana A., Ms. Marilyn E Dmello, Ms. Chaitra Mallannavar, Ms. Srinidhi Patil
Dr. Sanjeev P. Maradur (Heterogeneous Catalysis) Associate Professor	Mr. Satyapal Churipard, Mr. KempannaKanakikodi, Ms, Bhavana Kulkarni Mr. Puneeth Kumar
Dr. D. H. K. Murthy, Assistant Professor	
BIOLOGICAL SCIENCES	
Dr. U. A. Ramagopal (Structural Biology) Associate Professor	Mrs. Pavithra G. C., Mrs. Swetha L, Mr. Shankar Kundapura, Mr. Akshaya Bhat, Ms. Salima Parveen
Dr. K. Ananda (Microbiology) Associate Professor	Ms. Kavitha K. N., Mr. Kirana M. P. Ms. Shrilakshmi S.
THEORETICAL SCIENCES	
Dr. Sujit Sarkat (Condensed Matter) Associate Professor	Mr. Rahul Sharma, Mr. Ranjith Kumar R., Mr. Kartik Y. R.
Dr. R. Srikanth (Quantum Information) Associate Professor	Mr. Shrikant Utagi, Mr. Vinod Rao

9. MISSION

* To conduct research in the selected frontier areas of basic and applied sciences.

* To encourage and support sponsored research programs by giving necessary infrastructure to them.

* To encourage collaborations with industries for focused and application-oriented research.

* To promote collaborative research with scientists in academia in the country

* To produce PhDs of the highest caliber and to make them highly competitive for their future career.

* To provide a forum for scientific discussions on frontier scientific topics which are vital for the scientists of PPISR in particular and the institutes of the country in general.

* To organize periodic summer and winter schools for the young undergraduate and graduate students.

* To provide opportunities for talented young students to carry out short-term research projects.

* To provide facilities to visiting scholars and faculty from all over India and abroad to work with the institute's faculty.

* To publish research articles in reputed national/ international journals of high impact.

* To file patents on research findings of potential commercial applications.

10. CURRENT SPONSORED PROJECTS

Government sponsored projects

1. "Quantum non-Markovianity: characterization, measure and resources",
   Sponsored by Science & Engineering Research Board (SERB), DST, Govt. of India under MATRICS Scheme
   Principal Investigator Dr. Srikanth R.
   Duration: 2020-2023.

2. "Topological States of Superconducting Nanowires and interacting light matter systems at nano scales"
   Sponsored by DST-SERB, Govt. of India
   Principal Investigator: Dr. Sujit Sarkar
   Duration: 2018-2021

3. "Experimental realization of a quantum randomnumber generator and development of strategies for quantum hacking"
   Sponsored under Interdisciplinary Cyber Physical Systems (ICPS) programme of DST, Govt of India Collaborative project with JIIT, Noida
   Co-Principal Investigator: Dr. R. Srikanth
   Duration: 2019-2021

4. "Chemical fixation of CO_2 by converting into value added chemicals using metal-modified ordered nanoporous silicate catalysts"
   Sponsored VGST, Govt. of Karnataka under Centre of Excellence in Science, Engineering and Medicine (CESEM) grant
   Principal Investigator: Dr. Ganapati Shanbhag
   Duration: 2015-2021

5. "Structural and evolutionary investigations on antibiotic resistant conferring rRNA methyl transferases for designing novel strategies of drug development"
   Sponsored by DST, Govt. of India
   Principal Investigator: Dr. Udupi Ramagopal
   Duration: 2017-2020

6. "α-Amylase and α-glucosidase inhibitors from endophytic fungi for treating Type 2 diabetes"
   Sponsored by Vision Group for Science and Technology, Govt. of Karnataka (CESEE) Principal Investigator: Dr. Ananda Kulal
   Duration: 2017-2020

7. "Computational speed-up in generalized probability theories"
   Sponsored by DST-SERB, Govt. of India
   Principal Investigator: Dr. R. Srikanth
   Duration: 2017-2020

8. "Effect of electron beam radiation on endophytic fungi producing ligninase enzyme"
   Sponsored by Board of Research in Nuclear Sciences, DAE, Govt. of India
   Principal Investigator: Dr. Ananda Kulal
   Duration: 2014-2019

Industry-sponsored projects

1. Development Of Catalyst And Process For Specific Co_2 Transformation
Sponsored by: Hindustan Petroleum Corporation Ltd. (HPCL)
Principal Investigator: Dr. Ganapati V Shanbhag
Co-Investigator: Dr. Vetrivel and Dr. Sanjeev P. Maradur
Duration: 2020 – 2022

2. Structure Based Rational Design of Pd1 Mutants to create Lead Molecules for Cancer Immunotherapy
Sponsored by: Bristol Myers Squibb, USA
Principal Investigator: Dr. Udupi A Ramagopal
Duration: 2019 – 2020

3. Design and Development of A Catalyst and Process for Selective Methylation of Toluene to Produce *Para*-Xylene
Sponsored by GTC Technology, USA
Principal Investigator: Dr. Ganapati V. Shanbhag
Co-Investigator: Dr. Sanjeev P. Maradur
Duration: 2011-2019

4. Catalyst & Process Development for Aromatics Alkylation to make higher Aromatics
Sponsored by Deepak Novochem Technologies Ltd., Pune
Principal Investigator: Dr. Ganapati V. Shanbhag
Co-Investigator: Dr. Sanjeev P. Maradur
Duration: 2018-2019

5. Design & Development of A Catalyst & Process for Regioselective Nitration of Aromatics
Sponsored by Deepak Nitrite Ltd, Vadodara
Principal Investigator: Dr. Sanjeev P. Maradur
Co-Investigator: Dr. Ganapati V. Shanbhag
Duration: 2018-2019

11. NATIONAL AND INTERNATIONAL COLLABORATIONS

PPISR has MOU with many institutes for collaborative research like Argonne national laboratory, Chicago, IIT-Madras, Central University, Gulbaraga, MSRIT Bengaluru, Genelon institute of life science pvt ltd Bengaluru, Nagarjuna College of Engineering and Technology (NCET), Bengaluru, Sir M Visvesvaraya Institute of Technology, Bengaluru (SIR MVIT), and Niranthara Scientific Solutions Private Limited ("NSSPL")

NATIONAL COLLOBORATORS:

- Dr. C. S. Gopinath, HOD, Catalysis Division, CSIR-NCL, Pune
- Dr. G. Valavarasu, DGM, HP Green R & D Centre, Bengaluru
- Prof. ShubhangiUmbarkar, Sr. Scientist, CSIR-NCL, Pune.
- Prof. Rajendra Srivastava, Associate Professor, IIT-Ropar, Punjab
- Prof. A. Sakthivel, Central University of Kerala, Kasargod.
- Prof. Dinesh Rangappa, Professor & Chairman, VTU, Chikkaballapura
- Dr. Ankur Bordoloi, Sr. Scientist, CSIR-IIP, Dehradun
- Dr Jyoti Roy Choudhary, Department of Chemistry, BMSIT, Bengaluru.
- Prof. Dinesh Rangappa from VTU, Muddenahalli, Chikkaballapura

- Prof. Nagaraja. M from IIT Ropar
- Dr. Mahesh Padaki from Jain university, Bangalore
- Dr. Satadeep Bhattacharjee from IKST, Bangalore
- Prof. Ramakumar S., Indian Institute of Science, Bengaluru, India
- Prof. Udaykumar Ranga, JNCASR, Bengaluru, India.
- Prof. HemalathaBalaram, JNCASR, Bengaluru, India.
- Dr. Dibyendu Samanta, Indian Institute of Technology, Kharagpur, India
- St. Aloysius College, Mangalore
- Genelon Institute of Life sciences, Yelahanka, Bengaluru.
- Department of Chemistry, Manipal Institute of Technology, MAHE, Manipal.
- Prof. M. Kumar, S. N. Bose Centre, Kolkatta
- Prof. Prosenjit Singhadeo, S. N. Bose Centre, Kolkatta

INTERNATIONAL COLLOBORATORS:

1. Prof. Ajayan Vinu, University of Newcastle, Australia
2. Dr. Ding Zhong Yi, Technology Manager, PWT Inc, USA
3. Prof. Matjaž Spreitzer from Jožef Stefan Institute (JSI), Ljubljana, Slovenia.
4. Prof. Kazunari Domen from Shinshu University, Japan
5. Prof. C. D. Hu from The National Taiwan University.
6. Prof. Masaki Tesuzaka, Tokyo, Japan
7. Prof. Igor Goryni, Karlshrue, Germany.
8. Dr. Vinayak Jagadish & Prof. Francesco Petruccione of University of Durban

12. MATERIALS SCIENCE AND CATALYSIS DIVISION

Established in May 2010 by the present Director, Prof. A. B. Halgeri, with the help of the Executive Committee of AMEF, the department now consists of core faculty members hailing from a diverse backgrounds as industrial chemistry, catalysis, polymers and materials science. A new materials synthesis laboratory, with several sophisticated equipments, has been established in the division. Bright students passionate for research were interviewed and inducted into the Doctoral Programme in the Department. The research laboratories are now equipped with state-of-the-art instruments to give every advantage to the students and faculty pursuing research here. 9 students have obtained Ph.D. from PPISR during 2015-2020 and at present, there are several students pursuing research and diligently working towards their Ph.D. degrees. More than 100 publications have been published in reputed national/ international journals in the last nine years with an average impact factor of >3.0. About 25 students have received the best paper presentation awards at prestigious national/ international conferences. The faculties of the division have successfully completed 22 Govt & industry-sponsored projects till 2019. The division has organized several conferences and workshops.

12.1 The mission of the Division

1. To innovate, design and develop novel multifunctional materials with wide applications in various fields like heterogeneous catalysis, photocatalysis, nanotechnology, gas sensing, absorbents, photoluminescence, etc., and thus pave the way for fruitful academia-industry partnership.
2. The division is committed to training several doctoral students through a research program that promotes excellence and original thinking.
3. The division also plans to interact with many national and international academic research institutions through collaborations, educational training and other outreach activities.

Specific areas of research:

1. Heterogeneous catalysis
2. Shape selective acid-base catalysis
3. Novel micro/mesoporous materials for green chemical processes
4. Biomass conversion to value-added products
5. Catalytic CO_2 utilization by converting into useful chemicals
6. Mesoporous polymers for catalysis and other applications
7. Metal organic frameworks for catalysis and gas sensing
8. Functional inorganic nanomaterials as applied to photoluminescence
9. Gas sensing
10. photocatalytic H_2 generation
11. Solar cells
12. 2D materials for opto-electronics
13. Computational studies (DFT) for ‘structure-property’ correlations.

Academic and sponsored research highlights:

Dr. Ganapati Shanbhag's Group conducts frontier research in the area of catalysis for the design of novel catalysts for green chemical processes such as catalytic conversion of CO_2 into value-added chemicals, conversion of biomass by-products like glycerol and furfural to value-added chemicals, pore engineering of microporous materials for shape selective catalysis. It also works on novel materials design for photocatalysisand gas sensors. Till 2020, the group has published 25 research articles in internationally reputed journals, two book chapters and co-inventors in 4 patents. A US patent on "Catalyst composition for converting light naphtha to aromatic compounds and a process thereof" has been granted to HPCL as an outcome of PPISR-HPCL collaborative project. Three students, Mr. Nagendra Kulal, Mrs. Vaishnavi B. J. and Ms. Marilyn DMello, were selected for Senior research fellowshipby CSIR, Govt. of India, New Delhi in January 2020. PhD student, Ms. Chethana A. visited ElettraSynchrotron Facility, Trieste, Italy to carry out experiments sponsored by DST, Govt. of India.The research scholars have performed very well this year and won seven Best Presentation Awards in national and international conferences.Dr. Shanbhag was invited by C & EN Brand Lab, A subsidiary of ACS to contribute for an E-Book "The Case for Colloidal Silica-How its versatile chemistry can improve diverse products and processes" sponsored by W R Grace & Co company. Two publications in internationally reputed journals were published on CO_2 valorization as an outcome of the project sponsored by VGST, Govt. of Karnataka. A book chapter on *Tin Oxide Materials--Synthesis, Properties, and Applications* was published in a Elsevier book authored by Dr. Shanbhag and his student Dr. Manjunathan (currently working as Post-doctoral fellow in KRICT, South Korea). A new area of computational studies was initiated by this group with the purchase of material simulation software for performing DFT for catalysis. It is guided by Dr. R. Vetrivel, Emeritus Professor and an authority in this field. During this year, Dr. Shanbhag gave several invited talks in conferences and workshops, and also invited as PhD thesis examiner for the students of prestigious universities. He also worked as organizing committee member for two national conferences organized in Bengaluru by the prestigious institutes.

During 2019-2020, 4 sponsored projects were conducted by the Dr. Shanbhag's Group. The industry project on "Design and development of a catalyst and process for toluene methylation to make xylenes" sponsored by GTC Technology Inc, USA was successfully completed in July 2019. It was started in November 2010 and continued as a long term collaborative project for almost 9 years. Dr. Shanbhag was the principal investigator and Dr. Maradur was co-investigator of this project. Another industry project sponsored by Deepak Novochem Technologies Ltd., Pune on "Catalyst and process development for aromatics alkylation" was also successfully completed in October 2019. Later, a new proposal was submitted to DNTL by Dr. Shanbhag and the project was approved for the period of 1 year. Another new sponsored project on "Catalyst and process development for CO_2 hydrogenation" was sanctioned by Hindustan Petroleum Corporation Ltd. (HPCL), Govt. of India for a joint collaborative programme for the period of two years. A Govt. project sponsored

by VGST under CESEM grant on "Chemical fixation of CO_2 by converting into value-added chemicals using metal modified mesoporous silicate catalyst" is under progress. Overall, this year has been quite eventful for this group in academic and sponsored research programmes.

Dr. Sanjeev Maradur's group is working on biomass value addition projects. Mr. Satyapal. PhD student of Dr. Maradur has been awarded Senior Research Fellowship from CSIR, Govt of India for a period of 2 years from 2019. Dr. Maradur's group in collaboration with Scientists from Hindustan Petroleum Green R&D Centre has developed a polymer-based adsorbent for crude oil spill recovery and reuse which efficiently uptake the oil from oil-water mixture at room temperature. Further this adsorbent developed has a potential to be used in real time crude oil spill cleanup and recovery purposes thus helping the Sea water to get rid of the toxic oil which affect the marine animals. The major finding of this work has been published in Chemical Engineering Journal, an international journal of high repute with an impact factor of 10.62. Another work on conversion of phenol to value added products has been published in Microporous and Mesoporous Materials a journal of international repute. Another in-house collaborative work with Dr. Suresh K on metal organic framework (MOFs) catalysis for efficient solketal synthesis from glycerol acetalization has been published in Dalton Transactions Journal RSC Publications.

One Industry-sponsored project from Deepak Nitrite Ltd, Vadodara on "Design and development of a catalyst and process for regioselective nitration of O-Xylene to 4-NOX" has been successfully completed with Dr Maradur as PI and Dr. Shanbhag as Co-PI. Dr. Maradur gave several invited talks in and around Bengaluru as part of FDP programs conducted by various educational institutes. One PhD student, Ms. Bhavana Kulkarni has joined the group and she will be working on metal organic frameworks (MOFs) catalysis for valorisation of biomass platform chemicals. Two students from Department of Petroleum Engineering, Presidency University Bengaluru worked under the guidance of Dr Maradur for a period of two months as part of their Industrial Practice Course from June till August 2019. One Student from St. Aloysius College Mangalore worked as summer intern for a period of two months from May till July 2019.

Dr. D. H. K. Murthy's group works on designing semiconducting nanomaterials for advancing the solar energy conversion efficiency. The synthesis approach and desired properties (structural/electronic) of the materials are rationally tuned using the insights from computational and spectroscopy tools to deliver a high performance. Current emphasis is on developing visible-light absorbing photocatalysts for sunlight-driven hydrogen generation via water splitting, potentially utilized as fuel and feedstock in chemical industries. Besides, the group is actively expanding its research focus to gas sensing, wastewater treatment, machine learning, and DFT. The group has established many collaborations with various researchers in India (IISc, IIT Ropar, Jain university, and IKST) and abroad.

12.2 Faculty Profile

Dr. A. B. Halgeri

Professor and Director, PPISR
Email: abhalgeri@gmail.com, director@poornaprajna.org
Homepage: https://ppisr.res.in/faculty/b-halgeri/

EDUCATIONAL QUALIFICATIONS:

Master's Degree in Chemistry from Karnataka University, Dharwad
Ph.D. in Physical Chemistry (Heterogeneous Catalysis) from Bangalore University
Postdoctoral researcher under the UNESCO fellowship on Zeolite Catalysis at Department of Tokyo institute of Technology, Japan

AREAS OF INTEREST:

Dr. Anand B. Halgeri is currently working as Director of Poornaprajna Institute of Scientific Research and coordinating the entire research activity in Catalysis/ Materials science & Biological sciences. His area of interest includes Nano catalysis, Heterogeneous catalysis, mesoporous materials, novel Zeolites, Solid Acid/ BaseCatalysts, Industrial Refinery/petrochemical processes, adsorption, Eco-friendly processes, and Biodiesel/Biofuel, alternate energy feed stocks etc. He has taken several industrial research projects both from India and abroad in the area of Zeolite Catalysis and Materials Science.

CURRENT ACHIEVEMENTS:

Prof. Halgeri is actively involved in the industrial projects and, is responsible for getting sponsorships from the companies, like M/s GTC Technologies in USA, HPCL R & D, and Shell Technology India Pvt Ltd. The process technology for development of catalyst &process for the production of paraxylene which is raw material for polyester industry has been developed in association with GTC and is likely to be commercialized in PetroChina.

Industrial projects successfully completed under his dynamic leadership are as follows:

- Design and development of a catalyst and process for selective methylation of benzene/ toluene to produce *p*-xylene *(Sponsored by: GTC Technology, USA)*

- Post-synthesis pore engineering and surface treatment of zeolites and some oxide materials
- *(Sponsored by: Shell Technology Centre, Bangalore)*

- Development of Zeolite Modified Catalysts for the Hydrocarbon Conversions such as light naphtha aromatization and side chain alkylation of toluene.
- *(Sponsored by: HPCL R&D Centre, Bangalore)*

- **"**Development of a Novel Mesoporous Polymer Based Soild Acid Catalyst for Low Temperature Catalytic Applications" sponsored by HPCL (R&D)

- "Development of Novel Catalyst for light napthavolarisation" sponsored by HPCL (R&D)

- "Natural gas conversion to value-added chemicals" sponsored by to M/S. GTC Technology US LLC

- Catalyst evaluation studies for methanol reforming for fuel Cell applications (Sponsored by Thermax Industries Pune

ONGOING INDUSTRIAL PROJECTS:

1. "Development of Catalyst and Process for Specific Co_2 Transformation" **sponsored by: Hindustan Petroleum Corporation Ltd. (HPCL)**
2. Structure Based Rational Design ofPd1 Mutants to Create Lead Molecules for Cancer Immunotherapy" **sponsored by: Bristol Myers Squibb, USA**
3. "Design and Development Of A Catalyst And Process For Selective Methylation of Toluene To Produce *Para*-Xylene" **sponsored by GTC Technology, USA**
4. "Catalyst & Process Development for Aromatics Alkylation to make higher Aromatics" **sponsored by Deepak Novochem Technologies Ltd., Pune**
5. "Design & Development of A Catalyst & Process for Regioselective Nitration of Aromatics" **sponsored by Deepak Nitrite Ltd, Vadodara**

ONGOING GOVERNMENT AGENCY SPONSORED PROJECTS:

Several projects sponsored by government agencies like DBT, DST, BRNS, DRDO, VGST are being carried out at PPISR.

MAJOR ACHIEVEMENTS AT PPISR

1. During his tenure as the Director, 15 research scholars have obtained their Ph.D. degrees at PPISR
2. Successfully completed several industry-sponsored projects under his leadership
3. Under his leadership as a Chairman, several Workshops including prestigious 23nd National Symposium on Catalysis (CATSYMP-23) were successfully conducted.

PUBLICATIONS AND PATENTS

He has published 150 research papers in national and international peer reviewed journals and has also obtained 38 Indian and International patents.

PREVIOUS R & D ACCOMPLISHMENTS IN INDUSTRY

Dr. Halgeri joined a newly established Research Centre of the Indian Petrochemicals Corporation Ltd (IPCL), Baroda – Gujarat, in 1976. As a Vice President and Head of R&D Division of the Public Sector Indian Petrochemicals Corporation Ltd. Baroda, Gujarat, Dr. Halgeri provided sustained leadership to the large number of scientists engaged in research and Development activities. Later, Dr. Halgeri joined the Research and Development Centre of Reliance Industries Ltd, where he led a team of 150 Scientists and Engineers and coordinated the entire research and development activities on catalysts required for the Petrochemical units and Refineries. He also provided the research support for the Polymer Science and Technology, and Materials Science groups of all the units of Reliance Industries at different locations.

Before joining PPISR, Dr. Halgeri has worked extensively and achieved several milestones in the development and commercialization of catalysts for the petrochemical industry. Dr. Halgeri's contribution in the area of catalysts has helped putting India in the world map of petrochemicals. In recognition of his outstanding contribution, Dr. Halgeri has received several National awards and Honors for his achievements in Chemical Technology. Recetnly, he has received Lifetime Achievement Award from the Material Society India for his immense contribution in catalyst design and process development during the ICAMR-2019 conference.

Ph.D. students GUIDED:

Three doctorates under his guidance are:

1. Mrs. Swetha Sandesh (Guide)
2. Mr. Vijayakumar Marakatti (Co-Guide)
3. Mr. Janardhan H L (Co-Guide)

AWARDS AND HONOURS

In recognition of his outstanding contribution in the area of heterogeneous catalysis for over three decades, he has received several National awards and Honors for his achievements in Chemical Technology.

1] I.C.I. India Ltd Award of Indian Institute of Chemical Engineers has been conferred to him for Excellence in process/Product development for para-diethyl benzene

2] Hari Om Ashram Prerit- Prof. S. S. Bhatnagar Endowment Research Award for Excellence in Applied Catalysis

3] Lifetime Achievement Award "Eminent Scientist in Catalysis" by the Catalysis Society of India, Indian Institute of Technology, Madras

4] Elected as "Fellow of Institute of Chemical Engineer" by Indian Institute of Chemical Engineers, Kolkata

5] Vividhalaxshi Audyogik Samshodhan Vikas Kendra, Mumbai, VASVIK Industrial National Award in Chemical Sciences and Technology - 2005

6] Prof. K.G. Naik Memorial Gold Award of M.S. University, Baroda – 2007 for outstanding achievements in Chemical Sciences

7] Awarded as “Pride citizen of Baroda” for his significant contribution for Science & Technology from Community Science Centre/Rotary Club of Baroda-2008

8] Life time achievement award by CSI-Bengaluru Chapter for his contribution towards Catalysis research in India during CATSYMP-23 in January 2018.

9] Life time achievement award by Material Society India for his contribution in Materials Research during International Conference on Advances in Materials Research (ICAMR-2019) in July 2019.

He has extensively travelled and presented several lectures/papers in International and National conferences. Currently, he has been advisor for many Industrial R&D and also member of Board of studies in Chemical Engineering Departments in many Engineering Colleges.

RAJAPPAN VETRIVEL

Honorary Professor
Materials Science and Catalysis Division
Email: Rajappan.vetrivel@poornaprajna.org

Brief CV:

2007 – 2018: R&D Manager – Shell Technology Centre, Bangalore

2000 – 2007: Team Leader – GE Global Research Centre, Bangalore

1989 – 2000: Scientist – NCL, Pune

1986 – 1988: Research Fellow – University of Keele, Keele, UK

1984 – 1985: Research Officer – IPCL, Vadodara

1979 – 1984: Ph D (Catalysis) – IIT, Madras

1974 – 1979: B Sc & M Sc (Chemistry) – Madurai Kamaraj University

Research Expertise:

- "Structure-Property-Performance" correlations in catalyst materials
- Electronic properties of catalyst surfaces
- Modelling and simulation for design of materials for catalytic and related functions
- Materials of interest include catalysts, metal hydrides, zeolites, SWCNT & semi-conductors and devices such as VLSI, Al-CVD, OLED, organic-PV, Nano-PV, PEM based fuel cells, polymer membranes, gas sensors, hydrocarbons and energy materials.

Accomplishments and Recognitions:

- Visiting Associate Professor at Tohoku University, Sendai, Japan from 1993 to 1994 and conducted research under Indo-Japan collaboration program
- Visited University of Cambridge & University College London, UK to perform research studies in Indo-UK collaborative research program

- Visited 'Ecole NationaleSuperieure de Chimie', Montpellier, France in 1988 & 1989 for an Indo-French project
- Was conferred the Best Young scientist award – Gold medal (1998) of Catalysis Society of India
- Life member of the Catalysis Society of India, Elected executive committee member and Assistant Editor of Bulletin of the Catalysis Society of India.
- Life member of the Polymer Society of India
- Elected Fellow of the Maharashtra Academy of Sciences
- I supervised 3 research students of NCL, Pune who were awarded Ph D degree by University of Poona, Pune
- I published ~125 research articles in peer reviewed journals
- I have filed 7 global patents and 4 patent applications
- I obtained management recognition awards in the form of company shares for leading R&D projects that led to business benefits

PUBLICATIONS AND PATENTS

He has published 125 research papers in national and international peer reviewed journals and has also obtained Indian and International patents.

R. Vetrivel Et Al, J. Mol. Structure (Theochem), 94, 187 (1983).

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R. Vetrivel And Coworkers In: Polymer Science - Contemporary Themes, (Ed. S. Sivaram), Tata Mc Graw-Hill Publishing Co Ltd., New Delhi, 1991, P.630. (Proc. Polymers'91 Symp., Pune, India.)

R. Vetrivel, Zeolites, 12, 424 (1992)

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R. Vetrivel, And Coworkers, Proc. 10th International Conference on Advanced Materials (Iumrs-Icam 2007) Held in Bangalore, India, Oct. 2007

R. Vetrivel, 'Gtl Experience' Proc. 4th R&D Conclave (Organized byPetrotech Society) Held at Goa, India, Jan. 2010

R. Vetrivel, Invited Talk at JNCASR Winter School On "Materials and Processes for Applications in Energy and Environment", Bangalore, Jan. 2015

R. Vetrivel And Coworkers,

'How Supercomputers Help to Overcome the Technical Challenge of Keeping Satellites Working Smoothly Hundreds ofKilometers Above Earth?',

Shell Business Innovations; 2016.

Https://Www.Shell.Com/Inside-Energy/Smooth-Moves-In-Space.Html

R. Vetrivel And Coworkers, 'Computational Catalysis'

Proc. New Trends in Computational Chemistry for Industrial Applications, Expoquimia, Barcelona, Oct. 2017

Dr. Ganapati V. Shanbhag
Associate Professor and HOD
Materials Science and Catalysis Division
E-mail: shanbhag@poornaprajna.org

BRIEF CV:

- Jan 2018 – till date, Associate Professor, PPISR, Bengaluru, India
- 2010 – 2017: Asst. Professor, PPISR, Bengaluru, India
- 2008 – 2010: Research Scientist, Dept. of Chemistry, Korea Advanced Institute of Science and technology (KAIST), South Korea
- 2002 – 2008: Ph.D. CSIR-National Chemical Laboratory, Pune India
- 2000 – 2001: Research Associate, ICI India Ltd (MNC), Mumbai, India
- 1999 – 2000: Lecturer, M.M Arts & Science College, Sirsi, India
- 1999: M.Sc. Organic Chemistry, Karnatak University, Dharwad, India

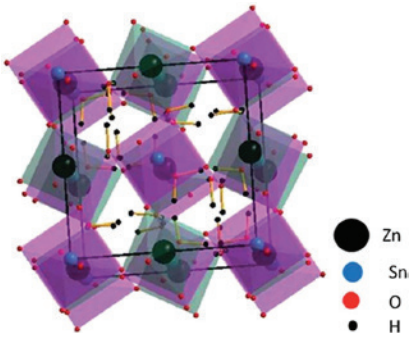
RESEARCH INTERESTS:

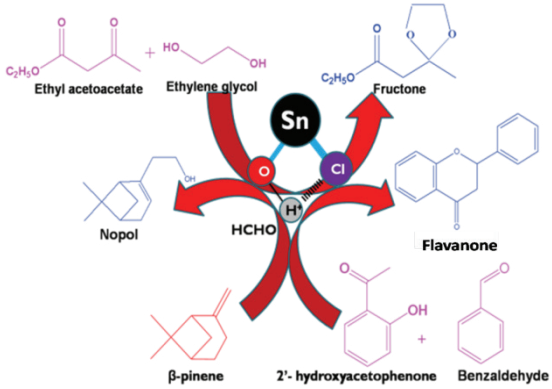
1) **Research on novel catalytic materials**

There has been an increasing interest in recent years in developing novel heterogeneous catalysts for the selective synthesis of fine and specialty chemicals. In such attempt, our group studied extensively several materials and able to discover two materials as solid acid and base catalysts for the first time. Both studies have been published in reputed RSC Advances journal. Metal hydroxy chlorides are well known as minerals found in various parts of the world. One such example is tin (II)hydroxy chloride, a mineral known by the name abhurite. The crystallographic and mineralogical properties of tin (II)hydroxy chloride are well understood but its application has been overlooked so far. Its

insolubility in water and organic solvents stimulated our curiosity to study its properties and application as a heterogeneous catalyst for Prins reaction.

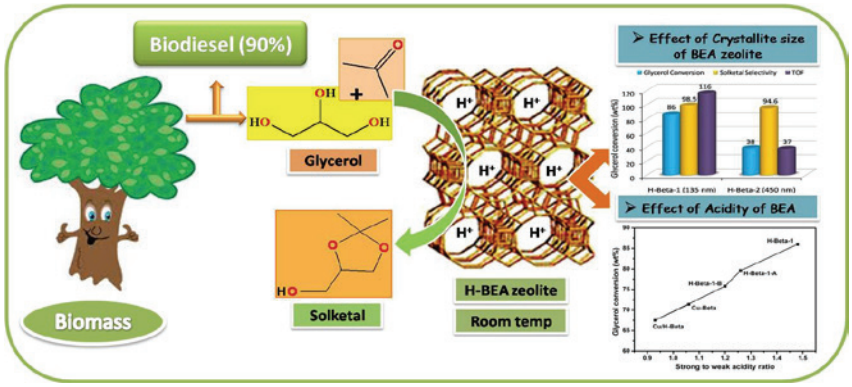
In another study, zinc hydroxystannate ($ZnSn(OH)_6$) has been reported for the firrst time as a solid bifunctional catalyst and has been applied for the synthesis of glycerol carbonate from glycerol and urea. It has a perovskite type crystal structure with metal atoms octahedrally coordinated with corner sharing hydroxyl groups to form $Sn(OH)_6$ and $Zn(OH)_6$octahedra. We found that it has a strong basicity along with Lewis acidic Zn which makes it a bifunctional heterogeneous catalyst. Its applications in other organic transformations are under progress.





2) **Designing catalysts for biofuel synthesis**

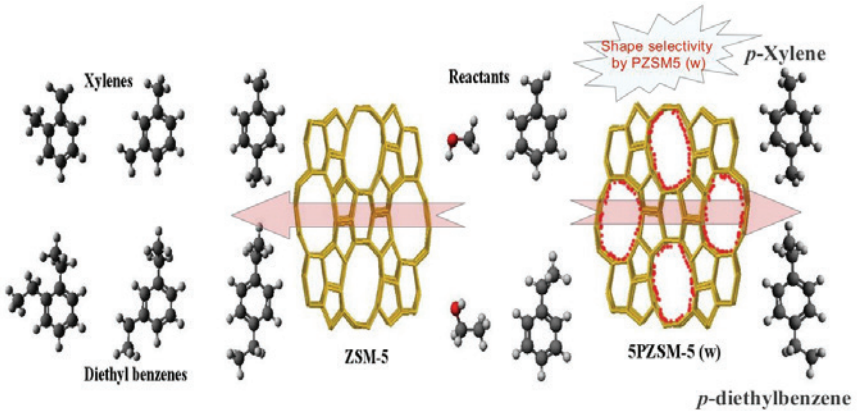
Increasing demand for petroleum fuels and depleting availability of crude oil has made to look for alternative sources of energy. The major challenge for scientific community is to develop a technology compatible with the existing source in terms of quality with an affordable price. Biodiesel is one such source which attracted many researchers since it can be easily synthesized by transesterification of vegetable oil with alcohol in presence of an acid or base catalyst. The widely known homogeneous base catalysts used since many years are NaOH & KOH because of their activity and affordable price. However, issues like difficulty in separation of catalyst from the product, contamination of product by alkali, generation of excess waste water during product purification, environmental problems in catalyst disposal and corrosion of reactor were observed. To overcome these issues, heterogeneous catalysts are being developed to make biodiesel synthesis, an eco-friendly process.



Catalytic conversion of waste bioglycerol from biorefinery to value-added chemicals

Glycerol is obtained as a by-product during transesterification of vegetable oil which accounts for one tenth of every gallon of biodiesel produced. Increasing availability of glycerol has made it an inexpensive and abundant raw material to synthesize value-added chemicals and hence it is a challenge for researchers to utilize this waste glycerol to transform into commercially important products. The major direct utilities of this compound are in cosmetics, personal care products and soaps. However, these sectors may not be able to consume tons of glycerol produced from biodiesel plants. Moreover, it is well known that glycerol can be converted into chemicals by catalytic processes namely, acetalization, oxidation, hydrogenation, esterification, etherification, transesterification, dehydration, oligomerization and pyrolysis. Hence, there is a great commercial interest to design green and chemoselective catalysts for these processes. Our group has reported KF/alumina, metal hydroxystannate and zeolite beta catalysts for transesterification, carbonylation and acetalyzation reactions respectively which published in reputed international journals *viz.* Catalysis Letters, RSC Advances and Journal of Molecular Catalysis A.

3) **Pore engineering of microporous materials for shape-selective organic transformations**



Vapor phase alkylation and disproportionation of aromatics are important reactions practiced in petrochemical industries. For these reactions, thermodynamic equilibrium mixtures of all the regioisomers are obtained with nonselective catalyst. Selectivity towards para-isomer can only be increased by the application of shape-selective catalyst. The para-isomer being commercially important than the other two for many organic reactions, post synthesis modification is desirable to improve the product selectivity. Zeolites are known as shape-selective catalysts due to the presence of micropores with pore diameter close to the molecular diameter of the products. However, pore modification is essential for substantially improving the shape selectivity towards a particular product. Post synthesis modification has been carried out by silanation, selective coking and metal/non-metal oxide impregnation. Phosphate modification was studied extensively by our group to explore the

generation of new active sites, correlation of shape selectivity with phosphate modification and several model reactions such as toluene alkylation, ethyl benzene ethylation and disproportionation and competitive reaction of meta xylene and ethyl benzene. Two of such works are published in Applied Catalysis A journal.

1) **Chemical fixation of CO_2 by converting into valuable chemicals.**

CO_2 activation and valorization into value-added products is an emerging area of research considering the increasing environmental concerns caused by the emission of CO_2 into atmosphere by various modes resulting in the greenhouse effect and health hazards. Designing catalysts for CO_2 fixation to produce important products like cyclic carbonate, substituted urea, cyclic urea, glycerol carbonate is challenging as the catalyst should activate CO_2 and enhance the activity & selectivity towards the essential product. Tuning the nature and number of active sites on the catalyst surface is vital for these carbonylation reactions as CO_2 and the substrate are activated by basic and acidic sites respectively. After receiving a project sponsored by VGST, GOK through CESEM grant, the design of solid acid-base bifunctional catalysts for CO_2 transformation into value added chemicals has been conducted since last few years. "Identification and tuning of active sites in selected mixed metal oxide catalysts for cyclic carbonate synthesis from epoxides and CO_2" has been published in a reputed international journal. Another work on "Rational design of bifunctional catalyst from KF and ZnO combination on alumina for cyclic urea synthesis from CO_2 and diamine" has also been published. Several other CO_2 transformations to produce chemicals like substituted urea, dimethyl carbonate, glycerol carbonate are under progress.

RECOGNITIONS/ACHIEVEMENTS/AWARDS/MEMBERSHIP:

1. Dr. Ganapati Shanbhag received Award for Research Publications (ARP) for the year 2016-17 for best publications during the past 3 years by VGST, Govt of Karnataka. It contains cash award + Citation.
2. 5 students have received Senior Research Fellowship from CSIR, Govt. of India so far from 2012-2020.
3. 14 Best Presentation Awards to students of Dr. Shanbhag for their research work presented in National and International conferences /workshops so far till April 2020.
4. Dr. Shanbhag was invited by C & EN Brand Lab, A subsidiary of ACS to contribute for an E-Book "The Case for Colloidal Silica-How its versatile chemistry can improve diverse products and processes" published in January 2020. It is Sponsored by W R Grace & Co a leading manufacturer of especially chemicals and Catalyst technologies.
5. Chemical Today magazine published an interview of Dr. Shanbhag in June 2016 issue.
6. Dr. Shanbhag and his group received plaques by GTC Technology Inc in 2012, 2014 and 2015 for successfully completing projects as PI and developing 1st and 2nd generation catalysts for toluene methylation process.

7. Dr. Shanbhag is the co-inventor in the two US patents (granted) filed by HPCL in the collaborative project.
8. Dr. Shanbhag worked as Co-convener and Chairman of Technical Committee for 23rd National symposium on Catalysis (CATSYMP-23) held during January 17-19, 2018 at Royal Orchid Convention Centre, Bengaluru.
9. Dr. Shanbhag was invited to become the member of the Technical Committee and Session Chair for National Conference on "Frontiers of Catalysis Science & Technology and its applications" held at St. Joseph's College, Bengaluru on January 10-11, 2020.
10. Dr. Shanbhag was the member of the technical committee and member of Panel Discussion for the "International Conference on Advances in Materials Research", organized by Ramaiah University of Applied Sciences, Bengaluru in July 25-27, 2019.
11. Dr. Shanbhag has delivered several invited talks at prestigious national/ international conferences such as 1) 3rd International conference on emerging advanced nanomaterials 2018 (ICEAN-2018)" organized by University of Newcastle, in Newcastle, Australia; 2) International Conference on World biodiesel Congress & Expo at San Antonio, USA, 2016; 3) 5th Indo-French symposium at CSIR-National Chemical Laboratory (NCL), Pune 2019;4) International conference on "Carbon capture &its Utilization" at CSIR-NCL, Pune conducted in association with Royal Society of Chemistry, 2018; 5) Asia-Pacific Congress on Catalysis (APCAT – 7) organized by ICT in Mumbai, 2017; 6) 23rd National symposium on Catalysis (CATSYMP-23) organized by Catalysis Society of India in Bengaluru, 2018; 7) National Workshop on Catalysis organized by Catalysis Society of India held at CSIR-Indian Institute of Chemical Technology (IICT), Hyderabad, 2016; 8) "National Training Course" on "Prerequisites to Resent Advances in Catalysis" held at Central University of Kerala, Kasargod, 2019; 9) National Conference on Frontiers of Catalysis Science & Technology and its applications held at St. Joseph's College, Bengaluru, 2020;10) KSTA sponsored workshop at Christ University, Bengaluru, 2018;International conference on Green Chemistry & Nanotechnologyheldat St. Aloysius College Mangaluru, 2017.
12. Dr. Shanbhag received International Travel Grant from SERB, DST, Govt. of India to travel to Australia to attend ICEAN conference in 2018.
13. Dr. Shanbhag was invited as PhD thesis Examiner by a reputed CSIR institute and prestigious universities.
14. Dr. Shanbhag worked as Member of the Syllabus revision committee for Chemistry for Siddaganga Institute of Technology (SIT), Tumkur 2013-2018.
15. Dr. Shanbhag has been the reviewer for international journals like Chemical Communications, RSC Advances, Catalysis Science and Technology, Applied Catalysis A, Catalysis Communications and Journal of Chemical Sciences, ChemCatChem., New Journal of Chemistry, ACS Sustainable Chemistry and Engineering etc., since the last 10 years.
16. Dr. Shanbhag was invited as resource person for FDP, Refresher, TEQIP and National Training Course programmes for degree and engineering colleges. Given several invited talks in these programmes.

17. Life member of International Zeolite Association (IZA) and Catalysis Society of India (CSI) and member of American Chemical Society.

STUDENTS:

	PhD students		**Project Fellows**
1	Mr. Manjunathan P.	6	Mr. Manjunath Doddamani
2	Mr. Nagendra Kulal	7	Mr. Sujith S.
3	Mrs. Vaishnavi B. J.	8	Mr. Pandurang Dalavi
4	Ms. Marilyn DMello	9	Mr. Subramanya K. S.
5	Ms. Chethana A.	10	Ms. Nimisha Simon
		11	Mr. Madhav Nayak
		12	Ms. Chaitra Mallannavar
		13	Ms. Shrinidhi Patil

GROUP ALUMNI:

1) PhDs

1. Dr. Vijaykumar Marakatti

PhD topic: Design of solid acid catalysts for Prins reaction and toluene methylation
PhD from: Manipal University
Guide: Dr. Ganapati Shanbhag
Co-guide: Dr. A. B. Halgeri
Date of Registration for PhD: 10th December 2011
Date of PhD Award: 28thApril 2015
Number of Publications: 08
Number of Patents: 01
Present Position: Marie Skłodowska-Curie Postdoctoral Fellow, Universitecatholique de louvain (UCLouvain), Belgium

2. Dr. Janardhan H L

PhD topic: Studies on pore modified zeolite catalysts for aromatization and aromatic substitution reactions
PhD from: Manipal University
Guide: Dr. Ganapati Shanbhag
Co-guide: Dr. A. B. Halgeri
Date of Registration for PhD: 10th December 2011
Date of PhD Award: 10th June, 2015
Number of Publications: 05

Number of Patents: 01
Present Position: Research Associate, HPCL, Govt. of India, Bengaluru

3. **Dr. Manjunathan P.**

PhD Title: "Designing Heterogeneous Catalysts for the Conversion of Glycerol & Furfuryl Alcohol into Value-Added Chemicals"
PhD from: Manipal Academy of Higher Education (MAHE, formerly Manipal University)
Guide: Dr. Ganapati V Shanbhag
Co-Guide: Dr. Sanjeev Maradur
Date of Registration for PhD: 12th December 2013
Date of PhD Award: 21st August, 2018
Number of Publications: 10
Award: Senior Research Fellowship 2016 (CSIR, Govt. of India)
Present Position: Post-Doctoral Fellow, Korea Research Institute of Chemical Technology (KRICT), South Korea.

4. Dr (Mrs). Swetha Sandesh
PhD topic: Novel eco-friendly catalysts for biodiesel synthesis and conversion of by-product glycerol into value-added products
PhD from: Manipal University
Guide: Dr. A. B. Halgeri
Co-guide: Dr. Ganapati Shanbhag
Date of Registration for PhD: 10th December 2011
Date of PhD Award: 09th May 2015
Number of Publications: 06
Award: Senior Research Fellowship 2012 (CSIR, Govt. of India)
Present Position: CEO, Niranthara Scientific Solutions Pvt Ltd

M. Tech Thesis:

1) **Mr. Satish Burla** from GVP College of Engineering (Autonomous), Visakhapatnam, Andra Pradesh; MTech (Chemical Engineering) Thesis Title "Gas-phase dehydration of glycerol over molybdenum trioxide supported on silica catalyst for the synthesis of acrolein". External Guide: Dr. Ganapati Shanbhag, 2011-2012. Currently, he is Scientist in SABIC Research Centre, Bengaluru

2) **Mr. Prashant Kumar K.** from Siddaganga Institute of Technology, Tumakuru; MTech. (Chemical Engineering) Thesis Title "Development of Novel Heterogeneous Base Catalyst for Eco-friendly Synthesis of Biodiesel from Transesterification of

Vegetable Oil". External Guide: Dr. Ganapati Shanbhag, 2012-2013. Currently, he is Scientist in SABIC Research Centre, Bengaluru

3) **Mr. Girish Kamath** from Manipal Institute of Technology, Manipal; MTech. (Chemical Engineering) Thesis Title: "Aromatization of C_5 rich light naphtha from refinery over non-zeolitic non-transition metal based mesoporous alumino silicate catalyst". External Guide: Dr. Ganapati Shanbhag, 2015-2016. Currently, he is pursuing his PhD at Univ. of Saskatchewan, Canada

Post-Doctoral Fellows:

1) Dr. Ramesh S.

He secured his PhD degree from VTU (work place BIT Bengaluru) in the area of heterogenous catalysis under the guidance of Prof. Y. S. Bhat and joined PPISR as RA in 2012. He worked in a project sponsored by Shell Technology Centre, Bengaluru and GTC, USA for the period of 1 year.

2) Dr. Prakash Chandra

He did PhD at National Chemical Laboratory, Pune in the area of heterogenous catalysis under the guidance of Dr. ShubhangiUmbarkar in 2014. He joined PPISR as Research Associate in 2015 and worked with Dr. Shanbhag in the project sponsored by PW Technology Inc, USA for the period of 1 year.

2) Dr. Subba Reddy Marri

He did his PhD in 2016 at National Institute of Science Education & Research (NISER), Bhubaneswar under the supervision of Dr. J. N. Behera on "Investigations of Open-Framework Metal Sulfates and Supercapacitors Based on Vanadium Chalcogenides-RGO/CNT Hybrids". He joined the group as Research Associate in the industry project sponsored by HP Green R & D Centre Bengaluru and worked during 2016-2017.

SHORT TERM PROJECT STUDENTS 2019-2020:

1.Mr. Ganesh Krishna N. S. the student of Mangalore University completed his project work on catalytic conversion of CO_2 via carbonylation reaction as a partial fulfilment of the requirement for the award of MSc under the supervision of Dr. G. V. Shanbhag from 3-6-2019 to 15-7-2019

2.Ms.P. Jyothi Bhat student of St Aloysius College, Mangalore worked on MSc project on catalytic conversion of furfuryl alcohol with acetic acid by esterification reaction under the supervision of Dr. G. V. Shanbhag from 10-5-2019 to 10-7-2019.

3. Mr. Sandeep Naik, Mr. Praveen K. Naik and Mr. Deepak G. V., students of M.V.J College of Engineering, Bengaluru conducted their B. Tech. (Chemical Engineering) project from 12-01-2020 to 31-03-2020 under the supervision of Dr. G. V. Shanbhag on "Catalysis design for dehydrogenation of ethyl benzene to produce styrene in vapour phase".

NATIONAL AND INTERNATIONAL COLLABORATORS:

1. Prof. Ajayan Vinu, University of Newcastle, Australia
2. Dr. Ding ZhongYi, Technology Manager, PWT Inc, USA
3. Dr. C. S. Gopinath, HOD, Catalysis Division, CSIR-NCL, Pune
4. Dr. G. Valavarasu, DGM, HP Green R & D Centre, Bengaluru
5. Dr. Raman Ravishankar, DGM, HP Green R & D Centre, Bengaluru
6. Prof. ShubhangiUmbarkar, Sr. Scientist, CSIR-NCL, Pune.
7. Prof. Rajendra Srivastava, Associate Professor, IIT-Ropar, Punjab
8. Prof. A. Sakthivel, Central University of Kerala, Kasargod.
9. Prof. Dinesh Rangappa, Professor & Chairman, VTU, Chikkaballapura
10. Dr. Ankur Bordoloi, Sr. Scientist, CSIR-IIP, Dehradun

PREVIOUS SPONSORED PROJECTS:

1. Design and development of a catalyst and process for selective methylation of toluene to produce *para*-xylene

Sponsored by GTC Technology Inc, USA
Principal Investigator: Dr. Ganapati V. Shanbhag; Co-investigator: Dr. Sanjeev P. MaradurDuration: 2011-2019

2. **High pressure liquid phase isomerization of xylenes using solid acid catalysts**

Sponsored by GTC Technology Inc., USA
Principal Investigator: Dr. Ganapati V. Shanbhag; Co-investigator: Dr. Sanjeev P. MaradurDuration: 2017-2018

3. Design and development of a catalyst and process for natural gas and LPG conversion into alkenes and aromatics

Sponsored by PW Technology Inc, USA
Principal Investigator: Dr. Ganapati V. Shanbhag; Co-investigator: Dr. Sanjeev P. MaradurDuration: 2016- 2018

4. Development of Novel Solid Catalysts for Light Naphtha Valorization

Sponsored by: Hindustan Petroleum Corporation Ltd. (HPCL)
Principal Investigator: Dr. Ganapati V. Shanbhag; Co-investigator: Dr. Sanjeev P. MaradurDuration: 2015-2017

5. Development of Zeolite Modified Catalysts for the Hydrocarbon Conversions

Sponsored by: Hindustan Petroleum Corporation Ltd. (HPCL)
Principal Investigator: Dr. Ganapati V. ShanbhagCo-investigator: Dr. Sanjeev P. MaradurDuration: 2012-2014

6. Post-synthesis modification and surface treatment of some solid catalysts

Sponsored by Shell Technology Centre, Bengaluru
Principal Investigator: Dr. Ganapati V. ShanbhagDuration: 2012-2013

7. Detection and estimation of halides

Sponsored by PX Oxidation Division, GTC Technology, USA
Principal Investigator: Dr. Ganapati V. Shanbhag, Year: 2012

RESEARCH:

CURRENT SPONSORED PROJECTS:

1. Design and development of a catalyst and process for toluene methylation to make xylenes

(Sponsored by: GTC Technology, USA) January 2011 to June 2019
Principal Investigator: Dr. Ganapati V Shanbhag
Co-Investigator: Dr. Sanjeev P Maradur
Project fellows: Manjunath Doddamani, Sujith S., Pandurang Dalavi, K. S. Subramanya and Madhav Nayak
The TM catalyst was very vigorously tested for toluene methylation in the absence of steam with more than 1000 h run and 21 times regeneration studies in a two-series reactor. Later, 1st and 2nd reactor catalysts were unloaded and characterized to know the structural and textural stability after the long run. Also, these catalysts were individually tested in a single reactor to know if they could retain their activity individually after several cycles. The catalysts were also tested with water as co-feed to understand if water can help in improving the performance of the catalyst. A detailed report has been prepared and submitted to GTC.
Status: Completed

2. Catalyst and process development for aromatics alkylation to make higher aromatics

(Sponsored by Deepak Novochem Technologies Ltd., Pune) from November 2018-October 2019)
Principal Investigator: Dr. Ganapati V Shanbhag
Co-Investigator: Dr. Sanjeev P Maradur
Project fellows: Dr. Manjunathan, Mr. Neehar P and Ms. Nimisha Simon

The catalyst developed by PPISR was tested for long time-on-stream study of 100 h at high pressure and then at atmospheric pressure to achieve good conversion and high selectivity for the desired product. DNTL sent their catalyst to test under lab conditions and compare with PPISR catalyst. Both catalysts were then compared under identical conditions for a long-time on-stream duration. It was confirmed through these testings' that DNTL catalyst gave higher selectivity for C10 product, whereas PPISR catalyst showed better stability for a long period of reaction in vapour phase conditions. As decided in the project review meeting with DNTL team at PPISR on September 12, 2019, the work is further continued by conducting reactions with DNTL and PPISR catalysts at atmospheric conditions for 100 h time on stream and regeneration studies. Eventually, the project is completed on October 31, 2019 and the detailed report is submitted to DNTL. Subsequently, a proposal for next one-year project has been sent to DNTL for approval.
Status: Completed

3. Catalyst and process development for CO_2 hydrogenation reaction
Sponsored by Hindustan Petroleum Corporation Ltd., Govt. of India, Duration: 2 years, 2020-2022
Principal Investigator: Dr. Ganapati V Shanbhag
Co-PIs: Dr. R. Vetrivel, Dr. S. P. Maradur
Research fellows: Mr. Sujith S., Ms. Chaitra Mallannvar, Ms. Shrinidhi Patil

The new HPCL sponsored collaborative project was initiated from January 2020 by hiring the project fellows and a detailed literature survey on the hydrogenation of CO_2 has been conducted. The required chemicals and labwares were procured and the experimental work was initiated. The software for DFT calculations has also been procured during this time. Several catalysts for CO_2 hydrogenation have been synthesized and characterized at PPISR. They were then sent to HP Green R & D Centre for catalyst testing experiments.
Status: On going

4. Rational design of bifunctional catalyst from KF and ZnO combination on alumina for cyclic urea synthesis from CO_2 and diamine
(Sponsored by: Vision Group on Science & Technology, Govt. of Karnataka, 2015-2021)Center of Excellence in Science Engineering and Medicine (CESEM), 60 Lakhs/ 3 years
Principal Investigator: Dr. Ganapati V Shanbhag
Research fellow: Mr. Nagendra Kulal
This study is mainly focused on the design of stable, active and selective catalyst for direct synthesis of 2-imidazolidinone (cyclic urea) from ethylenediamine and CO_2. Based on the rationale for the catalyst properties needed for this reaction, KF, ZnO and Al_2O_3 combination was selected to design the catalyst. $ZnO/KF/Al_2O_3$ catalyst was prepared by stepwise wet-impregnation followed by the removal of physisorbed KF from the sur- face. High product yield could be achieved by tuning acid-base

sites by varying the composition and calcination temperature. The catalysts were characterized by various techniques like XRD, N2-sorption, NH_3-TPD, CO_2-TPD, TEM, XPS and FT-IR measurements. It is shown that acidic and basic properties of the solvent can influence the activity and product selectivity for this reaction. Under optimized condition; 180 °C, 10 bar and 10 wt.% catalyst in batch mode, 96.3 % conversion and 89.6 % selectivity towards the 2-imidazolidinone were achieved.
Status: Published

5. Catalyst design for direct synthesis of dimethyl carbonate (DMC) from methanol and CO_2

Sponsored project CESEM, VGST, Govt. of Karnataka
Principal Investigator: Dr. Ganapati V Shanbhag
Research fellow: Mr. Nagendra Kulal

Conversion of CO_2 to dimethyl carbonate (DMC) has attracted interest as DMC is a green reagent/solvent, a raw material for manufacturing electrolytes used in lithium ion batteries and a potential gasoline additive with an annual demand of about 30 million tons. DMC is a precursor in the synthesis of polycarbonates and isocyanates. The traditional methods for DMC synthesis (phosgenation and oxidative carbonylation of methanol) are unsecure. Among several eco-friendly routes, its direct synthesis from methanol and CO_2 is atom-efficient and attractive.

Doping and supporting of selected metal on the CeO_2 possessed a higher amount of finely dispersed Co species, more oxygen vacancies and excellent redox ability. The surface oxygen vacancy act as Lewis acid sites and pays a key role in the adsorption and activation of CO_2. The catalysts were characterized extensively by XRD, TEM, N_2 sorption, XPS, H_2 - TPR, Raman spectroscopy, FTIR and NH_3 - CO_2 TPD techniques. 10% M^{n+}@CeO_2 nanorods which exhibited high activity for DMC synthesis also possess the highest concentration of oxygen vacancy sites. The XPS results showed that the addition of M-promotes the formation of Ce^{4+} on the surface of the CeO_2 catalyst. The transformation of Ce^{4+} in the CeO_2 to Ce^{3+} could compensate lattice contraction induced by slightly smaller radius of M. The results of this study provide an insight into the effect of M on CeO_2 nanorods catalysts for DMC synthesis and provide a technical basis for devising a new strategy to design high-efficiency CeO_2-based catalysts.

Status: Manuscript under preparation

6. Designing novel supported metal catalyst for synthesis of glycerol carbonate from glycerol and CO_2

Sponsored project CESEM, VGST, Govt. of Karnataka
Principal Investigator: Dr. Ganapati V Shanbhag
Research fellow: Mr. Nagendra Kulal

Glycerol carbonate (glycerin carbonate or 4-hydroxymethyl2-oxo-1,3-dioxolane) is a promising molecule which has gained much interest over the last 20 years for two main reasons: (1) its wide reactivity, implying numerous applications, (2) as a way to valorize glycerol, which is becoming widely available as a major biobased by-product

from the manufacturing of biodiesel and other chemicals. Glycerol carbonate can be converted into epichlorohydrin, a product that has a large industrial application, under very mild conditions. Because of a high boiling point (110–115 °C at 0.1 mmHg), high flash point (190 °C) and low volatility (vapor pressure is 8 mbar at 177 °C), glycerol carbonate and its esters are potential low Volatile Organic Compound (VOC) solvents for many applications looking for a bio-based alternative to organic solvents. Also, glycerol carbonate has a considerable possibility to become a major chemical intermediate, for instance in polymer production.

The development and design of heterogeneous catalyst for activation of CO_2 is a key challenge for the chemical industry. The doping of CeO_2 nanorod with divalent transition metal ions (M = Ni, Cu, Zn) has been shown to improve the activity due to oxygen vacancy. The results indicated that depending on the electronic structure of dopants and coordination can create the nature of active sites on the surface of catalyst. The catalysts were characterized extensively by XRD, TEM, N_2 sorption, XPS, H_2 - TPR, Raman spectroscopy, FTIR and NH_3 - CO_2 TPD techniques. FT-IR spectra showed that 2-cyanopyrridine and glycerol could be activated on the catalyst and intermediate ester was formed for the synthesis of glycerol carbonate. 2-cyanopyridine (dehydrating agent) react with water to give 2-picolinamide which influence the conversion of glycerol. Overall this study presents a strategy to design a high efficient CeO_2 based catalyst for glycerol carbonate synthesis from glycerol and CO_2.

Status: Ongoing

ACADEMIC PROJECTS

1. The effect of porosity, acidity and crystallite size of zeolite ZSM-5 catalyst for alcoholysis of furfuryl alcohol to produce butyl levulinates

Principal Investigator: Dr. Ganapati V Shanbhag

Research fellow: Ms. Vaishnavi B J

Alkyl levulinate is an important biomass derived product which has variety of applications such as fuel additives in transportation fuels, drug and chemical intermediates, flavors and fragrances, solvent and plasticizer industries. Zeolite with different Si/Al ratio and crystallite size was screened and best catalyst was further studied to optimize the reaction conditions. Effect of Lewis acidity, mesoporosity in microporous zeolites were also conducted. The ZSM-5 catalyst showed better catalytic performance compared to other conventional solid acid catalysts. Reaction was carried out by varying the alcohol at reflux condition where the catalytic performance increased with an increase in the alkyl group of the alcohol in the following order Butanol > propanol > ethanol > methanol. The catalyst ZSM-5 (SAR95) showed good reproducibility for 3 runs. Hence it can be concluded that the combination of the properties such as high thermal stability, good Brönsted acidity, micro porosity, good surface area inherited by the H-ZSM-5 makes it different from the other conventional catalyst. Considering the green chemistry principles such as moderate experimental conditions, low reactants mole ratio, catalyst loading and

excellent reusability, H-ZSM-5(SAR95) proves to be the best candidate for this transformation as it addresses all the drawbacks of the reported catalysts.

2. Designing a novel solid acid catalyst for esterification of furfuryl alcohol with acetic acid

Principal Investigator: Dr. Ganapati V Shanbhag
Research fellow: Ms. Vaishnavi B J

Furfuryl acetate, a product of esterification of furfuryl alcohol with acetic acid, is a popular flavor compound with a sweet, fruity banana like odor and has also been used as a furfural based platform molecule for the transformation into C_6 chemicals through direct CH oxidative carbonylation over $Pd(OAc)_2$ catalyst. To date, the synthesis of fururyl acetate has been performed homogeneously using acetic anhydride and tin(IV)tetraphenylporphyrin perchlorate giving 99% yield in 5 mins 53 and heterogeneously using acetic anhydride with a FC-72 catalyst in a single fluorous solvent system.Recently,iron exchanged heteropoly acid-encapsulated inside ZIF-8 MOF has been reported for this reaction. Overall, there has been a very less study conducted so far. The preparation and initial screening of various solid acid catalyst is currently under progress.

3. Graphene acid-NH_2-UiO-66 for Chemiresistive CO_2 gas sensing

Principal Investigator: Dr. Suresh B Kalidindi
Co-Investigator: Dr. Ganapati V Shanbhag
Research fellow: Ms. Marilyn E. DMello

Combining the uniqueness of 2D graphene layers and metal-organic frameworks, their hybridization is anticipated to impart novel properties for chemiresistive gas sensing. The integration of 2D graphene with functionalized MOF can improve the electrical conductivity of the non-conductive/low conductive MOF matrix. Meanwhile, embedding/integrating 2D graphene in MOF matrices can not only retain their large surface areas but also by appropriate choice of chemically stable and selectively good adsorbent-MOF for target analyte widens their scope in many electrical and sensing applications. In this work, we report the covalent attachment of basal plane carboxylate functionalized graphene to amine functionalized UiO-66 metal-organic framework (GA@UiO-NH_2). GA@UiO-NH_2 was explored for chemiresistive CO_2 gas sensing application.

4. Redox active conductive MOFs for the development of chemiresistive gas sensors

Principal Investigator: Dr. Suresh B Kalidindi
Co-Investigator: Dr. Ganapati V Shanbhag
Research fellow: Ms. Marilyn E. DMello

In recent studies, to boost electrical conductivity and long-range magnetic order in 2D MOFs, an excellent work has been done by K.S. Pederson et.al and group. They synthesized structurally simple layered coordination solid, $CrCl_2(pyz)_2$using transition chromium ion in conjugation with ditopic redox active ligand-pyrazine.

The claimed $Cr^{III}Cl_2(pyz)_2$ is generated by transition metal-ion reduction of pyrazine via formation of pyrazine anion radical. In our study, we present a feasibility study of a different approach on using redox active $CrCl_2(pyz)_2$ for an effective dispersion of palladium nanoparticles and studied for chemiresistive hydrogen gas sensing. Further we explored $Pd@CrCl_2(pyz)_2$ for chemiresistive hydrogen sensing and have established a proof-of concept that can be considered as an ideal solution to solve inherent issues associated with MOF-based chemiresistive sensors. Based on the results obtained in this study, one can expect that the use of ligand redox activity for metal@MOF hybrid systems-based sensors is a powerful approach to address the poor selectivity and reproducibility issues in palladium-based sensors.
Status: Ongoing

5. Exfoliation of Metal@2D MOF for highly selective hydrogen chemiresistive gas sensors

Principal Investigator: Dr. Suresh B Kalidindi
Co- Investigator: Dr. Ganapati V Shanbhag
Research fellow: Ms. Marilyn E. DMello
This is an extension work of project B. In this project, we have exfoliated the 2D conductive MOF- CrCl2(pyz)2 using acetonitrile solvent and loaded 1.8 wt% of palladium. The exfoliated Pd@CrPy is to be dropcasted on inter-dogitated electrodes and explores for hydrogen sensing. The synthesis and characterization (SEM, TEM) has been completed. Efforts in dropcasting on IDEs and sensing measurements are under progress. This work is carried out in collaboration with Dr. HSS Krishnamatte, CENS, Jallahalli.

6. Conductive Polymer@MOF Hybrids for the development of novel chemiresistive sensors and photocatalysis.

Principal Investigator: Dr. Suresh B Kalidindi
Co- Investigator: Dr. Ganapati V Shanbhag
Research fellow: Ms. Marilyn E. DMello
$PANI@NH_2$-UiO-66 was synthesized in bulk and characterized by powder X-ray diffraction and nitrogen sorption studies. This work is being carried out in collaboration with Prof. John Bosco BalaguruRayappan from CeNTAB, SASTRA Deemed to be University, Thanjavur and with Prof. Tapas Kumar Maji from CPMU, Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru. The samples have been submitted testing room temperature sensing of toxic gases at their facility.

7. Lanthanum based perovskite oxides for gas sensing applications

Principal Investigator: Dr. Nalini G Sundaram
Co-Investigator: Dr. Ganapati V Shanbhag
Research fellow: Ms. Chethana. A
The present work involves the designing of thin film sensor based on $La_{1-x}Ca_xFeO_3$ (x= 0.4) perovskite oxide. The motivation to prepare thin film sensor is to increase the sensitivity of gas detection and also for the miniaturization of devices. The

advantage of using thin films is that increase in surface area which in turn helps in the reduction of resistivity of the material. Also, the layer by layer deposition results in homogeneous distribution of particles throughout the films which helps in the enhanced conductivity. Further, these films were tested for their gas sensing properties in the gas sensing station at CeNSE, IISC, Bangalore. The films showed good response towards 3ppm SO_2 gas with a percentage response of 7.4% at 150 °C temperature. These films were also tested for CH_4 gas but the material was not showing any response towards CH_4 gas.

8. Synthesis of SnO_2-Ta_2O_5 metal oxide nano composites for gas sensing applications

Principal Investigator: Dr. Nalini G Sundaram
Co- Investigator: Dr.Ganapati V Shanbhag
Research Fellow: Ms. Chethana. A

SnO_2-Ta_2O_5 metal oxide nano composites were synthesized by hydrothermal method and studied their gas sensing applications. This material exhibited very good gas sensing properties towards 10ppm CO gas. From the optimization of experimental parameters we understood that 5 wt% Ta_2O_5 substituted SnO_2 shows higher gas sensitivity in the detection of 10ppm CO gas at an operating temperature of 50°C. In addition, from the literature we have studied that designing of thin films would further helps to bring down the operating temperature and to increase the gas sensitivity. Herein, our motivation is to decrease the operating temperature to room temperature with high sensitivity. Therefore, in this work we have made an attempt to design thin films of SnO_2-Ta_2O_5 on a silicon substrate by RF sputtering method and this work is in progress.

9. Synthesis of rare earth and transition metal ion substituted semiconductor Bi_2WO_6 oxide nanomaterial for multifunctional applications

Principal Investigator: Dr. Nalini G Sundaram
Co- Investigator: Dr. Ganapati V Shanbhag
Research Fellow: Ms. Chethana. A

The present work involves the synthesis of novel $Bi_{2-x}M_xWO_6$ ($0.2 \leq x \leq 1.0$) semiconducting metal oxide nanoparticles for multifunctional applications. The parent Bi_2WO_6 is very well known for its ferroelectric properties. The substitution of transition metal ion which has unpaired d_n electrons would further induce magneto electric effect to this compound. In view of this hypothesis we have crystallized $Bi_{2-x}M_xWO_6$ ($0.2 \leq x \leq 1.0$) nanoparticles by hydrothermal method. During the synthesis, the pure form of $Bi_{2-x}M_xWO_6$ ($0.2 \leq x \leq 1.0$) was obtained only above pH 7 and in the acidic pH an impure was obtained. Hence the experimental parameters were optimized and pure orthorhombic phases of $Bi_{2-x}M_xWO_6$ ($0.2 \leq x \leq 1.0$) were synthesized. Further, the as synthesized materials were studied for photo catalytic applications and these materials were showing visible light induced Congo red dye

degradation properties. Amongst all compositions, $Bi_{1.4}M_{0.6}WO_6$ was showing highest photo catalytic activity.

10. Synthesis of Hybrid SnO_2-Ta_2O_5 metal oxide composite with Conducting polymer (Polyaniline) for the gas sensing applications

Principal Investigator: Dr. Nalini G Sundaram

Co- Investigator: Dr.Ganapati V Shanbhag

Research Fellow: Ms. Chethana. A

The present work involves the synthesis of hybrid SnO_2-Ta_2O_5 metal oxide composite with conducting polymer (Polyaniline) for gas sensing applications. Polyaniline (PANI) a well-studied conducting polymer has received wide-spread attention because of its outstanding properties including simple and reversible doping–dedoping chemistry, stable electrical conduction mechanisms, high environmental stability and ease of synthesis, which drives it towards potential electrical device applications. Hence in our work we have chosen PANI to make a hybrid material with metal oxide composite SnO_2-Ta_2O_5. The polyaniline was synthesized by oxidative polymerization of aniline using ammonium persulfate in the presence of SnO_2-Ta_2O_5. This would develop a core shell structure and further the characterization and gas sensing studies of as prepared material needs to be done.

11. Synthesis of hybrid SnO_2-Ta_2O_5-Cu_3 $(HHTP)_2$MOF composite material for gas sensing applications

Principal Investigator: Dr. Nalini G Sundaram

Co- Investigator: Dr.Ganapati V Shanbhag

Research Fellow: Ms. Chethana. A

From the literature, it is very well known that high surface area and porous materials like 2D conductive MOF would help in the increased adsorption of gaseous molecules and thereby contribute in the enhancement of sensitivity of gas detection. With reference to this aspect, in the present work in order to increase the sensitivity of gas detection we have planned to design a hybrid material composed of both metal oxide composite (SnO_2-Ta_2O_5) and 2D conductive MOF. The metal oxide composites could help in the sensing mechanism in terms of heterojunction and also oxygen vacancies whereas conductive MOF would help in the adsorption of gas molecules as it has higher surface area and due to its porous structure. Hence in our work we have synthesized a hybrid material of SnO_2-Ta_2O_5 nano composite with conductive MOF $Cu_3(HHTP)_2$ by soft chemical approach. Further, detailed gas sensing studies needs to be carried out for this hybrid material.

12. Upconversion Green Fluorescence in NaLa $(WO_4)_2$:Er^{3+}/Yb^{3+} Nanoparticles: Synthesis, Structure, Computational and *In vitro* Imaging Studies

Principal Investigator: Dr. Nalini G Sundaram

Research Fellow: Ms. Archana K. M.

This work brings out the importance of NaLa $(WO_4)_2$ disordered host lattice to achieve efficient upconversion (UC) green fluorescence when co-substituted with

optimized concentration Er^{3+} and Yb^{3+} for *in vitro* cell-imaging applications. $NaLa(WO_4)_2$ (UC host), Er^{3+} and Yb^{3+} co-substituted $NaLa(WO_4)_2$ as UC Bulk and UC Nano materials were synthesized by template free hydrothermal method. Particle size dependent optical absorption and emission properties were ascertained by UV-DRS, UC fluorescence and life time decay studies. Both UC Bulk and UC Nano materials revealed an excitation (980 nm) power dependent upconversion weak blue, an intense green and red emission. Further, neutron diffraction studies were employed to probe the crystal structure of $NaLa(WO_4)_2$ host to investigate the significance of UC host lattice on the observed fluorescence properties. In addition, we have also attempted to deduce a plausible mechanism involved in UC process based on computational studies via calculating associated lattice phonon energies of UC host. Intense UC green emission is ascribed to the enhanced energy migration between Yb-Er pairs in a defined crystallographic site and to the modulation of lattice phonons in the disordered UClattice. On the other hand, we have also demonstrated the excellent biocompatibility of UC Bulk and UC Nano towards *Escherichia coli, Staphylococcus aureus, Candida albicans* and mammalian HeLa cell lines. Nevertheless, an *in vitro* fluorescent cell imaging applications of these biocompatible UC Nano is studied by probing their intracellular UC green fluorescence using HeLa cell lines up on 980 nm excitation.

13. Crystal Structure, Symmetry and Upconversion Red Fluorescence in $LiDy(WO_4)_2$: Yb^{3+}/Er^{3+} Polymorphs

Principal Investigator: Dr. Nalini G Sundaram

Research Fellow: Ms. Archana K. M.

Here, we present the polymorphsim in $LiDy(WO_4)_2$, Yb^{3+} and Er^{3+} co-substituted $LiDy(WO_4)_2$ materials prepared via simple sol-gel method for the first time. Detailed crystal structural studies of $LiDy(WO_4)_2$ polymorphs were carried out using powder neutron powder diffraction data. Existence of an irreversible and temperaturre dependent reconstrutive structural phase transition has been investigation as a function of calcination temperature in both the materials. In addition we have successfully controlled the concentration of $Yb^{3+}$and Er^{3+} in $LiDy(WO_4)_2$ polymorphs and tune the upconversion bright red emission up on 980 nm excitation. Additoanlly, significance of crystal structure and its symmtery on the observed upconverison red fluoresence of $LiDy_{0.7}Yb_{0.2}Er_{0.1}(WO_4)_2$ polymorphs were demonstarted. Among α and β-$LiDy_{0.7}Yb_{0.2}Er_{0.1}(WO_4)_2$ polymorphs, β-phase hase shown promising upconverison intense red emission owing to the lower monoclinic symmetry over tetragonal α-phase. Thus these new upconversion polymorphic materials could find potential application in solid state display systems as red phosphor materials.

14. White light properties of $ADy(WO_4)_2$:A=Na/K: Significance of Crystal Structure and Calcination Temperature

Principal Investigator: Dr. Nalini G Sundaram

Research Fellow: Ms. Archana K. M.

Phase pure and crystalline $ADy(WO_4)_2$ A=Na/K materials were synthesized by the modified citric acid assisted sol-gel method for the first time. The effect of calcination temperature revealed the formation of most stable Scheelite like tetragonal phase and increased crystallinity as function of temperature up to 1100 °C in the case of $ADy(WO_4)_2$. On the other hand, $KDy(WO_4)_2$ observed to crystallize in monoclinic crystal system even at 1100 °C. Further bang gap of all the materials was deduced via Tauc plot method using UV-DRS data. Wherein, not much difference in optical band gap is observed between $NaDy(WO_4)_2$ and $KDy(WO_4)_2$ as a function of calcination temperature. However, $NaDy(WO_4)_2$ and $KDy(WO_4)_2$ calcined at 900 °C has shown reduced band gap suggesting the formation of much larger particles at 900 °C and also indicated optimum calcination temperature to achieve efficient fluorescence. Accordingly, downconversion fluorescence studies revealed gradual improvement in fluorescence emission at 576 nm as a function of calcination temperature up to 900 °C, beyond which fluorescence was reduced irrespective of their crystal structure. However, emission spectral positions remained intact confirming the critical role of calcination temperature on fluorescence which could due to the particle size effect as seen in DRS analysis. In addition, the calculated CIE coordinates via CIE chromaticity diagram exhibited scattered color points from blue to near white region as a function of temperature, suggesting the significant role of calcination temperature to tune the white light properties of $ADy(WO_4)_2$ and coordinates also matches with the white light coordinates of commercially available white phosphor. Hence these new materials could be potentially applied for solid state display systems

EVENTS AND ACHIEVEMENTS:

A) Successful Completion of the Sponsored Projects

1. The industry project on “Design and development of a catalyst and process for toluene methylation to make xylenes” sponsored by GTC Technology Inc, USA was successfully completed in July 2019. It was started in November 2010 and continued as a long term collaborative project for almost 9 years. Dr. Ganapati Shanbhag was the principal investigator and Dr. Sanjeev Maradur was co-investigator of this project.

2. The new industry project sponsored by Deepak Novochem Technologies Ltd., Pune on “Catalyst and process development for aromatics alkylation to make higher aromatics” was successfully completed in October 2019. Dr. Ganapati Shanbhag was the principal investigator and Dr. Sanjeev Maradur was co-investigator of this project.

B) Sanction of new sponsored project

The sponsored project on "Catalyst and process development for CO_2 hydrogenation" has been sanctioned by Hindustan Petroleum Corporation Ltd. (HPCL), Govt. of India for a joint collaborative programme for the period of two years. An agreement has been signed between PPISR and HPCL in December 2019 and the project has been initiated. The project would be executed by Dr. Ganapati Shanbhag as Principal Investigator. Dr. R. Vetrivel and Dr. Sanjeev Maradur would work as Co-PIs in this project.

C) Publications

1) Kulal,N., John C.,Shanbhag,G.V.Rational design of bifunctional catalyst from KF and ZnO combination on alumina for cyclic urea synthesis from CO_2 and diamine (2020)*AppliedCatalysisA:General*, 598, 117550

2) Kulal,N.,Vasista,V.,Shanbhag,G.V. Identification and tuning of active sites in selected mixed metal oxide catalysts for cyclic carbonate synthesis from epoxides and CO_2 (2019)*Journal of CO_2 Utilization*, 33, pp.434-444.

3) Archana K. M., Joerg C. N., Yanda P., Sundaresan A., Kityk I. V., K. Ozga, J. J., Poornesh P., Ashok Rao, Sundaram N. G., Average Structure, Local Structure, Photoluminescence and NLO properties of Scheelite type $NaCe(WO_4)_2$, Crystal Growth & Design (2019), 19.11, 6082-6091

4) Archana K. M., Maurya S. K., Kaushal K., Navada K. K., Kulal A., Sundaram N. G., Scheelite like $NaTb(WO_4)_2$ Nanoparticles: Green Fluorescence and *In vitro* Cell Imaging Applications, Journal of Materials Science and Engineering-C (2020),106, 110182.

Book Chapter

Manjunathan, P., Shanbhag G. V. (Book Chapter) "Application of tin oxide based materials in catalysis (2020) *Tin Oxide Materials--Synthesis, Properties, and Applications*, (Elsevier) pp. 519-553

E-Book Contribution

Dr. Ganapati Shanbhag was invited by C & EN Brand Lab, A subsidiary of ACS to contribute for an E-Book "The Case for Colloidal Silica-How its versatile chemistry can improve diverse products and processes". It is Sponsored by W R Grace & Co a leading manufacturer of especially chemicals and Catalyst technologies. The e-book is published in January 2020.

D) Patents

1) US 10519387 B2 (granted) "Catalyst composition for converting light naphtha to aromatic compounds and a process thereof" Assignee: HPCL R&D Centre, Bengaluru. invented by Ravishankar Raman, Peddy Venkat Chalapathi Rao, NettemVenkateswarluChoudary, Shanbhag Ganapati, Janardhan Hodala, Halgeri Anand &GandhamSriganesh Grant date: December 31, 2019.

2) Indian Patent No. 329546 (Granted) “Catalyst composition for converting light naphtha to aromatic compounds and a process thereof” Assignee: HPCL R&D Centre, Bengaluru. invented by Ravishankar Raman, Peddy Venkat Chalapathi Rao, NettemVenkateswarluChoudary, Shanbhag Ganapati, Janardhan Hodala, Halgeri Anand &GandhamSriganesh Grant date: January 16, 2020

E) Papers Presented In Conferences

Best presentation awards:

1) Ms. Marilyn E. DMellowon BEST POSTER Presentation award for the poster titled, “Design and Development of Metal-Organic Framework based Materials for Gas Sensing Applications “at Nano India- Biennial National Conference 2019, held at Mahatma Gandhi University, Kottayam, Kerala. (26th -27th April 2019).

2) Ms. Vaishnavi B. J. received 1st prize for BEST ORAL presentation at 3-days International conference on "Emerging Trends in Catalysis" at Vellore Institute of Technology–Vellore campus, held during January 6-8, 2020, where Nobel laureate Robert Grubbs was the chief guest. This conference was organized in association with Royal Society of Chemistry (RSC), UK.

3) Mr. Nagendra Kulal and Ms. Vaishnavi BJ won BEST ORAL presentation award at National Conference on “Frontiers of Catalysis Science & Technology and its applications” held at St. Joseph's College, Bengaluru on January 10-11, 2020.

4) Ms. Vaishnavi BJ won BEST ORAL presentation award at National Conference on “Frontiers of Catalysis Science & Technology and its applications” held at St. Joseph's College, Bengaluru on January 10-11, 2020.

5) Ms. Chethana A. won BEST ORAL Presentation award “*Selective gas sensing of low concentration SO_2 gas using perovskite oxides*” at "International Conference on Advances in Chemistry (ICACSEM-2020) organized by University of Madras, Chennai held during the 9th and 10th of January 2020.

6) Ms. Archana received the BEST ORAL presentation award for the work *“LiLa $(WO_4)_2$ Polymorphs for Nonlinear Applications: In-situ Neutron Diffraction Study”* at ICMAT-2020 (2nd International conference on Advanced Materials & Technology) at JSS Science & Technology University, Mysore from January 16-18, 2020.

7) Mr. Nagendra Kulal has won BEST POSTER presentation at 11th Bengaluru India Nano, A prestigious International Conference on theme New Dimensions in Nano Science & Technology for his presentation on "*Transition metal doped CeO_2 nanorod*

as efficient catalyst for the direct carbonylation of glycerol with CO_2" Nagendra Kulal& Ganapati Shanbhag. held during March 2-3, 2020.

Other Presentations

1) Mr. Nagendra Kulal presented a poster titled "Chemical fixation of CO2 by converting into value-added chemicals using heterogeneous catalysts" in "Manipal Research colloquium-2019" 1-3, April 2019 in Manipal

2) Mr. Nagendra Kulal gave Oral presentation titled "Utilization of CO_2 by converting into dialkylurea via carbonylation reaction using Ni-Sn mixed oxide catalyst" in International Conference on Advances in Materials Research, 25 to 27, July 2019 in Ramaiah University of Applied Sciences, Bengaluru

3) Ms. Archana K. M. gave Poster presentation on "Upconversion Fluorescence in $NaLa(WO_4)_2:Yb^{3+}/Er^{3+}$ Nanoprobes: Synthesis and Computational studies for *in vitro* Bio-imaging Applications" and Participated in hands on training in *Bangalore Microscopy Course* (BMC-2019) jointly conducted by C-CAMP, inStem and NCBS during 15–22, September, 2019 in NCBS, Bengaluru.

4) Mr. Sujith S. gave an oral presentation on "*Aromatization of C_5 -rich light naphtha from refinery over non-zeolitic solid acid catalysts*" at National Conference on Frontiers of Catalysis Science & Technology and its applications held at St. Joseph's College, Bengaluru on January 10-11, 2020. This work was conducted in collaboration with HP Green R & D Centre, Bengaluru.

5) Mr. Nagendra Kulal gave a talk titled "Instrumental techniques for materials characterization" in Research Orientation Workshop 2019 for undergraduate students during 2-7, December 2019.

6) Ms. Archana K. M. gave a lecture on title "Overview of Nanomaterials: Significance and Applications" to undergraduate students during Research Orientation Workshop (ROW) 2-7 December-2019.

7) A talk on "Two dimensional materials: An overview" was given by Ms. Marilyn D Mello during Research Orientation Workshop (ROW) 2-7 December-2019 to undergraduate students.

F) Senior Research Fellowship Awards

Three students, Mr. Nagendra Kulal, Mrs. Vaishnavi B. J. and Ms. Marilyn DMello, students of Dr. Ganapati Shanbhag attended personal interview for Senior research fellowship at Council of Scientific and Industrial Research (CSIR), Govt. of India, New Delhi on January 6, 2020 and all the three were selected for prestigious CSIR-SRF award.

G) Invited Lectures in National Conference/Workshops/Endowment Series

- Dr. Ganapati Shanbhaggave an invited lecture titled “Novel mesoporous tin phosphate/oxide as catalyst for valorization of biomass derivatives” atNational Conference on “Frontiers of Catalysis Science & Technology and its applications” held at St. Joseph's College, Bengaluru on January 10-11, 2020.

- Dr. Ganapati Shanbhag was invited to present a lecture on “Biomass – Role of catalysts for its conversion into energy and chemicals” at Central University of Kerala, Kasargod during “National Training Course” on “Prerequisites to Resent Advances in Catalysis” held from December 16 to 20, 2019.

- Dr. Ganapati Shanbhag was invited to deliver prestigious "Late krishna T. Bhagwat Memorial Endowment Lecture Series" on 10-2-2020 at Dr. A. V. Baliga College of Arts & Science, Kumta.

- Dr. Ganapati Shanbhag gave a lecture on “"Concept and importance of heterogeneous catalysis in modern day research" in Research Orientation Workshop 2019 organized by PPISR for undergraduate students during 2-7, December 2019.

H) Thesis Examiner

- Dr. Ganapati Shanbhag was invited by Christ University, Bengaluru to be External Examiner for two of the research scholars from Department of Chemistry for their PhD synopsis defence. Dr. Shanbhag evaluated their synopsis and attended the defence on June 6, 2019 at Christ University, Bengaluru.

- Dr. Ganapati Shanbhag was invited by CSIR-CSMCRI, Bhavnagar, Gujarat to evaluate PhD thesis of a student as Examiner from Inorganic Materials & Catalysis Division in October 2019.
  Subsequently, he was invited as examiner for the PhD defence Viva held on January 8, 2020.

- Dr. Ganapati Shanbhag was invited as an examiner for the PhD thesis from Jain Deemed-to-be University, Bengaluru in January 2020.

I) Best Seminar award

Mrs. Vaishnavi B. J. won Best Seminar award for 2018-2019 for her presentation on “Hydrogen production from Biomass” on June 14, 2019 evaluated among the research scholars for PPISR weekly semiar Series 2018-2019. She received the award during Founder’s Day programme on July 5, 2019.

J) Abroad Visits by Ph.D. students

Ms. Chethana A. visited ElettraSincrotrone Facility, Trieste, Italy to carry out experiments from 13th to 22nd December 2019. Her accommodation and daily

expenses were covered by the Italian Government and managed by Elettra. The travel was sponsored by Dept. of Science and Technology, Govt. of India.

K) Organizing committee member of national/ international conferences

1. Dr. Ganapati Shanbhagwas invited to be the member of technical committee for the “International Conference on Advances in Materials Research”, organized by Ramaiah University of Applied Sciences, Bengaluru on 25–27, July 2019.

2. Dr. Ganapati Shanbhag was invited to become the member of the Technical Committee and Session Chair for National Conference on “Frontiers of Catalysis Science & Technology and its applications” held at St. Joseph's College, Bengaluru on 10-11, January 2020.

L) Ph.D. Colloquium

Colloquium for Pre-PhD thesis submission of Ms. Archana K. M., Materials Science & Catalysis Division was held at PPISR-Bidaluron January 20, 2019, Thesis Title: "Design of alkali rare earth double tungstates for photoluminescence, electrochemical and theranostic applications." The research was conducted under the guidance of Dr. Nalini Sundaram.

M) Project review meeting

The review of the project sponsored by Deepak Novochem Technologies Ltd (DNTL), Pune was held at PPISR on September 17, 2019. Mr. Shreekrishna Sawant, CEO and Dr. Anand Hunoor, Executive Director visited PPISR for the meeting. Dr. A. B. Halgeri, Dr. G. V. Shanbhag and Dr. S. P. Maradur attended the meeting from PPISR. Dr. Shanbhag, presented the work done during last 6 months for this project. DNTL team gave several suggestions to achieve the targeted performance and appreciated the overall progress made in the project.

N) Project Proposal meeting

Dr. Ganapati Shanbhag submitted a proposal for a sponsored project to HP Green R & D Centre and subsequently a meeting was held in HPCL for a technical review of the project on August 20, 2019. Dr. Halgeri, Dr. Shanbhag and Dr. Maradur attended the meeting. Dr. Shanbhag made a technical presentation to the HPCL team on the project proposal. There was a discussion on the technical aspects and HPCL team gave several suggestions to improve the proposal. The proposal was revised accordingly and submitted to HPCL after the meeting. It was granted later to start the new sponsored project from HPCL.

O) Research Advisory committee meetings

1) Research Advisory Committee meeting of Materials Science and Catalysis Division was held on May 3, 2019 at Devanahalli campus. The committee members Prof. T. N. Guru Row, IISc, Prof. Chandrabhas Narayan, JNCASR and Prof. K. R. Krishnamurthy, NCCR, IIT-Madras attended the meeting. Dr. A. B. Halgeri, Director was present in the meeting. Dr. Ganapati Shanbhag and his colleagues presented

their one year research progress and achievements and sought the suggestions from the committee to move ahead.

2) The annual review meeting of PPISR was held on 23rd October 2019 at Sadashivnagar campus to review all the research projects carried out by the faculty of PPISR. The meeting was chaired by Prof. Nagaraja, IISc, Bengaluru. Prof. A. B. Halgeri (Director, PPISR) and Prof. K. Srihari, Hon. Secretary AMEF represented the PPISR in the committee. Dr. Ganapati Shanbhag presented his one-year research progress during this meeting along with other faculty members.

P) New project proposal Meeting

Dr. Anand Hunoor, Executive Director, DNTL, Pune visited PPISR on January 31, 2020 for a new proposal meeting. Dr. Ganapati Shanbhag presented the previous highlights of successfully completed project and new proposal was discussed. Dr. Anand Halgeri. Director and Dr. Sanjeev Maradur, Co-PI were present in the meeting. Dr. Hunoor expressed his immense satisfaction for the concluded project and also suggested some changes in the proposal. Subsequently, a new project proposal on "Design and development of catalyst and process for alkylation of aromatics" was accepted by Deepak Novochem Technologies Ltd, Punefor a one-year term where Dr. Ganapati Shanbhag is Principal Investigator and Dr. S. P. Maradur is Co-PI.

Q) Doctoral Advisory Committee Meetings

- The 5thDoctoral Advisory Committee meeting for Ms. Marilyn E. DMello was conducted on 18th June, 2019 in PPISR auditorium. On she presented the six month progress to the DAC members, Prof. T. K. Maji, Dr. H. S. S. Rama Krishna Matte and Prof. Y. S. Bhat. Dr. Suresh Babu Kalidindi, Ph.D. Guide, Dr. Ganapati Shanbhag, Co-Guide, Dr. Udupi Ramagopal, Dean-Academics and Dr. Ananda Kulal, Ph.D. Coordinator were present. Dr. A. B. Halgeri, chaired the meeting. Proceedings of the meeting have been prepared and submitted to MAHE, Manipal.

- Chethana A. presented PhD progress report during 1st DAC meeting which was conducted on 4th April-2019. All the DAC members were present in her DAC and Dr. Nalini Sundaram, her guide and Dr. Anand Halgeri were also present in the meeting. DAC committee gave several suggestions to improve the work. Dr. A. B. Halgeri, Director and Chairman of the committee was also present and conducted the DAC meeting. Proceedings of the meeting have been prepared and submitted to MAHE, Manipal.

- DAC meetings of Ms. Nagendra Kulal and Mrs. Vaishnavi B. J. were held at PPISR, Sadashivnagar Campus on 5th August 2019. Subject experts and DAC members, Dr. Y. S. Bhat, Dr. Nagaraju N. and Dr. P. Manikandan were present in the meeting. Dr. G. V. Shanbhag, Guide was present and Dr. A. B. Halgeri

presided over the meeting. The PhD students gave presentations of their six months research work. DAC committee gave several suggestions and expressed their satisfaction on the progress made by the students during six months' time.

- Second DAC meeting of Ms. Chethana A. was held at PPISR, Sadashivnagar Campus on 15th November 2019 at 12:00 PM. Prof. Mohan Rao from IISc and Prof Sundaresan from JNCASR attended the meeting. Dr. Nalini Sundaram, Guide and Dr. G. V. Shanbhag, Co-guide were present and Dr. A. B. Halgeri presided over the meeting. Ms. Chethana gave presentation of her six month's research work. DAC committee gave several suggestions and expressed their satisfaction on the progress made by the student during six months' time.

- Fourth DAC meeting of Ms. Marilyn D'Mello was conducted at PPISR, Sadashivnagar Campus on 30th December 2019 at 2:00 PM. The meeting was attended by the external experts, Prof. Tapas Maji from JNCSR and Prof. Ramakrishna Matte from CeNS, Jalahalli. Dr. Suresh Babu, Guide and Dr. G. V. Shanbhag, Co-guide were present and Dr. A. B. Halgeri chaired the meeting. Ms. Marlyn presented her six month's research work. DAC committee gave several suggestions and expressed their satisfaction on the progress made by Ms. Marliyn during six months' time.

- DAC meetings of Ms. Nagendra Kulal and Mrs. Vaishnavi B. J. were held at PPISR, Bidalur on 7th February 2020. Dr. G. V. Shanbhag, Guide was present and Dr. A. B. Halgeri presided over the meeting. The PhD students gave presentations of their six months' research work. DAC committee gave several suggestions and expressed their satisfaction on the progress made by the students during six months' time.

R) MOU signed between PPISR and IKST

Memorandum of understanding (MOU) between Poornaprajna Institute of Scientific Research and Indo-Korea Science and Technology Center (IKST), Bengaluru was signed on December 20, 2019 at IKST campus. The Directors, Dr. A. B. Halgeri (PPISR) and Dr. Seung Cheol Lee (IKST) signed the MOU on behalf of their respective organizations. Both the institutes have agreed to work together on joint research projects, exchange of researchers, joint events etc. This MOU would help in establishing a close cooperative relationship between the two institutes with an aim of further growth of both organizations. Dr. R. Vetrivel and Dr. Ganapati Shanbhagfrom PPISR, and Dr. Satadeep Bhattacharjee Head-R&D, IKST and Mr. Mithun Suresh, Executive Operations, IKST were present on this occasion.

S) New Analytical Instrument

A new analytical instrument STA-6000 (Perkin Elmer) to analyze TGA/DTA/DSC measurements was procured under the VGST CESEM project grant (GRD 307) and was installed at PoormaprajnaAnalytical Centre in November 2019.

T) New Recruitments

- Ms. Chaitra Mallannavar, MSc graduate from JSS college, Gokak joined Dr. Shanbhag's group as Research Fellow under HPCL sponsored project in December 2019.

- Ms. Shrinidhi Patil, BE (Chemical Engineering) from SDM Engineering College, Dharwad joined PPISR as Research Engineer in January 2020 to work under the guidance of Dr. Ganapati Shanbhag in a project sponsored by HP Green R & D Centre.

U) Short term project internship

1.Mangalore University, Dept. of Chemistrystudent Mr. Ganesh Krishna N. S**.** completed his project work on catalytic conversion of CO_2 via carbonylation reaction as a partial fulfilment of the requirement for the award of MSc under the supervision of Dr. G. V. Shanbhag from 3-6-2019 to 15-7-2019

2.Ms.P. Jyothi Bhat student of St Aloysius College, Mangalore worked on MSc project on catalytic conversion of furfuryl alcohol with acetic acid by esterification reaction under the supervision of Dr. G. V. Shanbhag from 10-5-2019 to 10-7-2019.

3. Three B. Tech. Chemical Engineering students from MVJ College of Engineering, Bengaluru Mr. Sandeep, Mr. Praveen and Mr. Deepak worked for their B. Tech. project thesis under the guidance of Dr. Ganapati Shanbhag on the project "Designing Catalyst for dehydrogenation of ethylbenzene to produce styrene using CO_2 as mild oxidant" from January-April 2020.

V) Other scientific activities undertaken

- As a Project Coordinator of VGST sponsored CESEM Project, Dr. Ganapati Shanbhag submitted the highlights of the entire project work to VGST in the form of Poster to present at Bengaluru India Nano conference from March 2-4, 2020. VGST was the co-organizers of this event.
- Ms Archana K. M. applied for *Raman-Charpak Fellowship-2019* based on my PhD work carried on Alkali rare-earth double tungstates to work in *Henry Fischer* Group, Head of ILL Graduate School (IGS), The Institut Laue–Langevin (ILL), Grenoble, France.Title: Probing Structure-Property Correlation in LiRE $(WO_4)_2$ Luminescent Nanomaterials via Combined Scattering, Spectroscopic and *Ab-initio* Studies
- Ms. Marilyn E. DMellohas applied for DST-Augmenting Writing Skills for Articulating Research-AWSAR Award-2019. The title for her article is "*Electronic Nose (E-Nose) that can take a good sniff of highly flammable and odourless gas before it can go BOOM!*"
- Ms. Marilyn E. DMello has applied for DST-DSG Award for Participating in the 70th Meeting of Nobel Laureates and Students at Linda, Germany- from 28th June- 3rd July 2020.

- Ms. Archana K. M. attended the "Royal Society of Chemistry Road shows-2019" at JNCASR Bangalore Nov-2019.
- Ms. Marilyn D'Mello applied for DST Scholarship for Research Students of Ph.D. in Science and Engineering, Govt. of Karnataka, India, October 2019.
- Ms. Archana K. M. submitted her proposal titled "Structural diversity in $ARE(WO_4)_2$(A=Li/Na): Investigation of Structure-Property Correlation by Combined Scattering, Spectroscopic and ab initio Studies" on 17th Oct-2019 for Ludo-Frevel scholarship-2021.
- Archana's mail-in proposal based on $LiLa(WO_4)_2$ polymorphs was accepted to collect neutron diffraction data on NOMAD instrument ORNL, US in order to investigate local structure distortions in $LiLa(WO_4)_2$ Polymorphs to correlate with the observed nonlinear properties.
- Ms. Vaishnavi gave weekly-seminar at PPISR on the topic "Selective hydrogenation over supported metal catalysts: From nanoparticles to single atoms" on March 13, 2020.

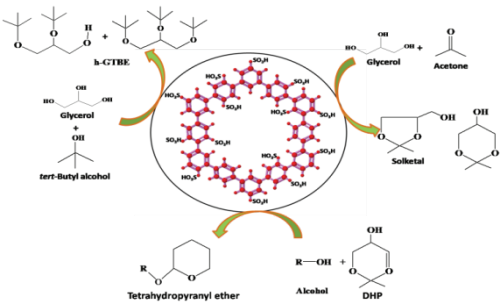
Dr. Sanjeev P. Maradur
Associate Professor
Materials Science & Catalysis Division
E-mail: sanjeevpm@poornaprajna.org

BRIEF CV:

1. 2020-Present: Associate Professor, PPISR, Bangalore, India
2. 2012-2019: Assistant Professor, PPISR, Bangalore, India
3. 2011-2012: Postdoctoral Research Associate, Dept. of Chemistry, University of Oklahoma, USA
4. 2010-2011: Postdoctoral Student, Alan MacDiarmid Energy Research Institute (AMERI), Chonnam National University, Gwangju, South Korea
5. 2009-2010: Postdoctoral Scientist, Dept. of Chemistry, Korea Advanced Institute of Science and technology (KAIST), Daejeon, South Korea
6. 2007-2009: Research Scientist, Jubilant Life Sciences Ltd, Noida, India
7. 2006-2007: Senior Research Fellow, Dept. of chemistry, IIT-Bombay, Mumbai, India
8. 2003-2006: Ph.D. Dept. of Chemistry, Shivaji University Kolhapur, India

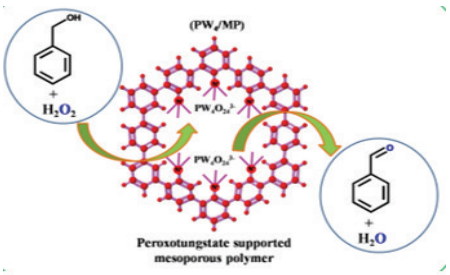
RESEARCH INTERESTS

Nanoporous Materials:



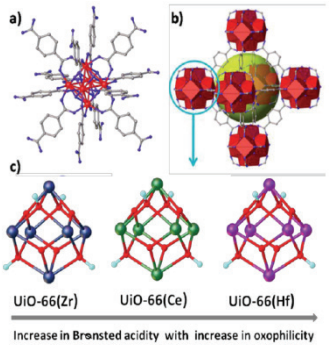
Nanoporous materials have gained scientific and technological importance because of their pore structures of tunable dimensions at nanometer scales. Over the last few decades, there has been an ever-increasing interest and research effort in the synthesis, characterization, functionalization of nanoporous materials. The main challenges in research include the fundamental understanding of structure-property relations and tailoring of nanostructures for specific properties and applications. The main research focus of our group is the synthesis and characterization of nanostructured catalysts for various applications. Among the priorities are the development of materials with organic framework, search for new and improvement of existing catalytic systems, and studies of intimate mechanisms of heterogeneous reactions and reactant-to-surface reactions, identification of active sites.

Heterogenization of homogeneous catalysis & its application on various chemical processes



The development of new, highly efficient heterogenized catalysts is an active and important area in fine chemical synthesis. Though homogeneous catalysis has witnessed significant growth in the last few decades in terms of high selectivity, TON and TOF's, however, the success in catalyst and process development has not been in parallel by similar growth on an industrial scale. Supports play a significant role in such systems. The microenvironment of the catalyst's active site will be the deciding factor in achieving high conversions with high selectivity. Heterogenization of homogeneous catalysts onto supports such as zeolites, nanoporous materials like silica and polymers would be of much interest in the design and development of processes for fine chemical production. The current focus of our group is to utilize mesoporous polymers as catalyst support for heteroligation of homogeneous catalyst and utilize them for important organic transformations such as oxidations with environmentally benign oxidants for e.g. hydrogen peroxide (H_2O_2).

Synthesis and Catalytic Applications Metal Organic Framework (MOFs)



The metal organic frameworks (MOF's) are advanced materials with exceptional textural properties. Catalysis by MOFs mainly depends on the active sites, both metal centres and organic linkers. Organic bridging linkers are used as scaffolds to which distinct catalytic complexes, biomolecules, and homogeneous catalysts can be immobilized or encapsulated. These materials are known for their textural properties such as high surface area, intrinsic porosity, a high percent of transition metal content, and accessibility of guest molecules into the pores. The beneficial properties of the MOFs made them excellent material for catalytic applications. In the last two decades, MOFs have presented a significantly amplified role in heterogeneous catalysis as they have been considered eco-friendly alternatives for catalysis. The ongoing research work in our group aims at the synthesis of MOFs with good thermal stability and high surface area. In addition, MOF-derived carbon-based materials are used in the proposed organic transformations.

ACHIEVEMENTS/RECOGNISTIONS/AWARDS/MEMBERSHIP:

1. Received Seed Money for Young Scientist Research Program Award from Vision Group on Science and Technology, Govt of Karnataka in 2014.
2. Received a plaque from GTC Technology Inc. USA in 2014 & 2015 in recognition of the milestones achieved by the group in developing a modified zeolite catalyst for aromatics technology.

3. Co-inventor in 2 Korean patents on a). Preparation of novel mesoporous polymer and b). Low cost carbon-fiber technology with two different research groups of South Korea.
4. Life member of International Zeolite Association (IZA) and Catalysis Society of India (CSI) and member of American Chemical Society.
5. Resource Person invited talks/faculty development programmes in Various institutions in Bangalore.
6. Five industry project and one VGST have been successfully completed from our group.
7. PhD Scholar from our group Mr. Satyapal received prestigious Senior Research Fellowship from CSIR, Govt of India

STUDENTS

	PhD students
1	SathyapalChuripard. R.
2	Kempanna S. Kanakikodi
3	Bhavana Kulkarni
4	Puneeth Kumar

M.Tech. project students

a. Manish Kumar, Chem Engg Dept, Manipal University, Manipal (Present: PhD Scholar, NIT-Trichy)
b. Sharath Ravi Chem Engg Dept, Manipal University, Manipal (Present: Research Engineer, Shell Technology, Bengaluru)

Summer Internship Students

1. Ms. Nileena Jose**,** M.Sc Project, St. Aloysius College (AUTONOMOUS), Mangalore From May-Jul 2017.
2. Mr. Abdul MueedMoulana& Aditya Sharma,B. Tech Petroleum Engg , Presidency University, Bengaluru Industrial Practice Course Project, From June-Aug 2017.
3. Ms. Komala Y**,** M.Sc Project, Government Science College (Autonomous), Bengaluru From May-Jul 2018.
4. Mr. Mohammed Touheed V I & Mr. Mohammed Farhan Jameel,B. Tech Petroleum Engg , Presidency University, Bengaluru Industrial Practice Course Project, From June-Aug 2018
5. Ms. Ramabai, M.Sc Project, St. Aloysius College (AUTONOMOUS), Mangalore From May-Jul 2019.
6. Mr. Dheer Rambia, B. Tech Summer intern, Department of Chemical Engineering, MSRIT, Bengaluru. From June to August 2019.
7. Mr. Harsha, M.Sc. Project, Department of Chemistry, St. Joseph College Bengaluru. From March to April 2020

NATIONAL AND INTERNATIONAL COLLABORATORS

A. Dr. Ding Zhong Yi, Technology Manager, PWT Inc, USA
B. Dr. Raman Ravishankar, Chief Manager, HP Green R & D Center, Bengaluru
C. Dr. Nagesh Kini, Senior Manager, R&D, Thermax Industries Ltd., Pune
D. Dr Jyoti Roy Choudhary, Department of Chemisty, BMS Institute of Technology, Bengaluru.
E. Dr. Hemandra. C. Pahcholi, Head R&D, Deepak Nitrite Ltd. Vadodara, Gujarat

RESEARCH ACTIVITIES

SPONSORED PROJECTS:

1) **Design and development of a catalyst and process for regioselective nitration of O-Xylene to 4-nitro-o-xylene (4-NOX)**

(Sponsored by **Deepak Nitrite Ltd, Vadodara, India)**
PI: Dr. Sanjeev P Maradur Co-PI: Dr. Ganapati V Shanbhag
Project Fellow: Arpana Hegde, Puneeth Kumar
Date: 2019-2020

The objective of the project is to develop a catalyst for the regioselective nitration of o-xylene selectively to 4-nitro-o-xylene. Nitration of aromatic substrates is one of the widely studied organic reactions as nitro aromatic compounds are industrially important intermediates during the synthesis of dyes, plastics and pharmaceuticals. The nitro derivatives of xylene isomers are used as intermediates for the production of vitamins, agrochemicals, fragrance and dyes. The classical nitration with a mixture of concentrated nitric and sulfuric acid gives predominantly *ortho and para* products in 2:1 ratio. *As para* nitro-products are commercially more useful, *para selective* nitration is desirable.

2) **Catalyst evaluation studies for methanol reforming for fuel Cell applications** *(Sponsored by* **Thermax Industries Pune, India)**

PI: Dr. Sanjeev P Maradur Co-PI: Dr. Ganapati V Shanbhag
Project Fellow: Mr. Kempanna S. Kanakikodi and Jemin Joy
Date: 2017-2018

Scope of the Project: Catalyst evaluation studies for the reforming over a fixed bed catalyst testing. Catalyst performance, establishment of conversion, selectivity and mass/carbon balance of more than 95% was the target and achieved successfully.

3) **Development of Novel Mesoporous Polymer Based Catalysts for Low Temperature Catalytic Applications"** Sponsored by **Hindustan Petroleum Green R&D Center, Bangalore**

PI: Dr. Sanjeev P Maradur Co-PI: Dr. Ganapati V Shanbhag
Project Fellows: Sathyapal Churipard. R and Mr. Kempanna S. Kanakikodi
Date: 2016-2018

This project research involves the preparation of a new class of advanced structured polymers as heterogeneous catalysts which may overcome the problems and limitations of the commercial polymeric supports for low temperature catalytic applications. A novel mesoporous polymeric solid acid

catalyst will be prepared by incorporation of suitable acid functionality either during polymerization or post synthetic modification and will be applied for important organic transformations *viz.* oligomerization of olefins and etherification of glycerol by *tert*-butanol to produce *tert*-butyl ethers of glycerol, a potential fuel additive. In addition to the main objectives of the project the mesoporous polymer based adsorbent was developed for crude oil spillover recovery and reuse for environmental remediation. The novelty of the developed adsorbent selectively uptakes oil from oil water interphase system at room temperature. And the oil can be reoveredupto 95% and the adsorbent was able to resue for more than 5 times without any loss.

4) **Design and development of a catalyst and process for C1-C3 hydrocarbon conversion to olefins and aromatics** *(Sponsored by:* ***PW Technology, USA****)*

PI: Dr. Ganapati V Shanbhag Co-PI: **Dr. Sanjeev P Maradur**

Project fellows: Mr. Santosh Kumar, Mr. Saikiran, Mr. Manjunath D., Mr. Mahesh Kumar, Ms. Anusha R; Date: 2016-2017

5) **Design and development of a catalyst and process for selective methylation of benzene/ toluene to produce *p*-xylene**

(Sponsored by: ***GTC Technology, USA****)*

PI: Dr. Ganapati V Shanbhag; Co-PI: Dr. Sanjeev P Maradur

Research Fellows: Mr. Santosh Kumar, Mr. Saikiran and Mr. Kempanna

Date: 2011-2019

6) **Conversion of Waste Plastics into Fuels"** Short Term Project Sponsored by Thermax Industries Ltd, Pune

PI: Dr. Sanjeev P Maradur; Co-PI: Dr. Ganapati V Shanbhag

Project Fellow: Manish Kumar

Date: 2015

Scope of the project: Design and development of a best catalyst for the conversion of waste plastics to fuel grade oil. For fabrication of proto-type machine which may be useful in urban apartment complex for handling plastic waste on site demand.

7) **Design of Mesoporous Polymers as Catalyst for the Synthesis of Glycerol Derivatives: A Potential Fuel Additive Molecule for Diesel and Gasoline** Sponsored by Vision Group on Science and Technology, Govt of Karnataka (2014-2015)

PI: Dr. Sanjeev P Maradur

Development of novel mesoporous polymer based solid acid catalyst for value addition of glycerol to produce fuel additive molecules to blend in diesel and biodiesel fuels. Novel mesoporous polymeric catalysts were developed and applied for the value addition of bio-glycerol to value addied products which are potential fuel additive molecules for diesel and biodiesel. Two articles have been published in international journals of high repute based on the outcome of the project findings.

Project Proposal to be submitted

1) Selective Hydrogenation of Aromatics in batch/continuous process
(Possible Sponsorship by: ***Sravathi Advanced Process Technologies Pvt Ltd****)*
The main objective of this proposal is the selective hyderogenation of aromatic compounds in batch or continuous mode. Scope of the project involved screening of commercially available hydrogenation catalysts and to establish the best process conditions in batch mode initially and to extrapolate the results in continuous mode at the latter stage.

2) **Design, Synthesis of Functional Inorganic-Organic hybrid Materials & their Catalytic Applications in Green Chemical Synthesis**
(Possible Sponsorship by: ***CSIR Research Grant 2020****)*
The main objective of the proposed project is to design and synthesis of hybrid porous materials in particular metal organic frameworks (MOFs) and porous polymers and to utilize them for catalytic applications.
The metal organic frameworks (MOF's) are the advanced materials with exceptional textural properties. Catalysis by MOFs mainly depends on the active sites, both metal centres and organic linkers. Organic bridging linkers are used as scaffolds to which distinct catalytic complexes, biomolecules, and homogeneous catalysts can be immobilized or encapsulated. These materials are known for their textural properties such as high surface area, intrinsic porosity, a high percent of transition metal content, and accessibility of guest molecules into the pores. The beneficial properties of the metal organic frameworks made them excellent material for catalytic applications. The proposed research aims at the synthesis of MOFs with good thermal stability and high surface area. In addition, MOF-derived carbon-based materials are used in the proposed organic transformations.

ACADEMIC PROJECTS:
Project 1: Synthesis of 2,6-dimethylphenol (2,6-DMP) from methanol and cyclohexanol
Research Scholar: Mr. Sathyapal R Churipard
Internship Student: Mr. Harsha
2,6 DMP can be synthesized by using methanol and cyclohexanol/cyclohexanone. 2,6-Dimethylphenol is useful as a precursor for the manufacture of polyphenylene oxide which is an important engineering plastic. Industrially this is produced via a liquid phase methylation of phenol using Al_2O_3 catalysts. This process not only needs a high pressure and temperature but also produces a wide range of products, including various isomers of xylenol. There are several reports on use of titanium oxide-supported vanadium oxide catalyst for the selective synthesis of 2,6-dimethylphenol from methanol and cyclohexanone in one step. But still there is scope for improvement in catalyst systems. Herein, we have used chromium impregnated magnesium oxide catalysts for the selective synthesis of 2,6 DMP.

Project 2: Polyoxotungstate[$PO_4\{WO(O_2)_2\}_4]^{3-}$ Immobilized on Mesoporous Polymeric support for Selective Liquid-Phase Oxidation of alcohols using H_2O_2

Research Scholar: Mr. Sathyapal R Churipard

Oxidation reactions are one among the most significant reactions in organic synthesis. However, they are amongst the most hazardous and problematic processes which often entail high E-factor and environmental risks. Oxidation of alcohols particularly benzyl alcohol to benzaldehyde is one of the key transformations in organic synthesis because benzaldehyde has several applications in perfumery, dye, pharmaceuticals and agricultural industries. Tungsten based catalysts are known to be one of the best oxidation catalysts. Therefore in the present study, we synthesized a mesoporous polymer (MP) by free radical polymerization of divinylbenzene and vinylbenzyl chloride. The chloromethyl groups of the MP were reacted with trimethylamine to functionalize into ammonium groups. A peroxotungstate anion, $[PO_4\{WO(O_2)_2\}_4]^{3-}$ (PW4), was supported as a counter ion to the ammonium group The PW_4/MP catalyst prepared herein was evaluated as a potential catalyst for green oxidation of alcohols using H_2O_2. The concentration of quaternary functional groups in the material was varied to investigate the effect of hydrophilic environment on the substrate wettability and catalyst activity.

Project 3: Synthesis of Alkyl Levulinates from Furfuryl Alcohol using Sulfonic Acid Functionalized Mesoporous Polymer

Research Scholar: Mr. Sathyapal R Churipard

Alcoholysis of furfuryl alcohol was conventionally done using homogeneous acids such as HCl and H_2SO_4. However, the hazardous nature of these catalysts stimulated the researchers to explore environmentally friendly heterogeneous catalysts for this transformation. Several solid acids catalysts such as ion-exchange resins, zeolites, organic–inorganic hybrid acid, porous aluminosilicate, etc have been recently reported for the alcoholysis of FA to alkyl levulinates. In spite of good catalytic activity exhibited by these catalysts, they are still not suitable catalyst for this reaction because these catalysts undergo rapid deactivation due to the adsorption of carbonaceous products formed by furfuryl alcohol. In many of the reports higher catalyst amount and very high mole ratios of the reactants were used to get high yield of alkyl levulinates which is not economically favourable.

Furthermore, several green, efficient and reusable catalysts including sulfonic acid functionalized ionic liquids, double SO_3H-functionalized ionic liquids and organosulfonic acid functionalized organosilica hollow Nanospheres have been reported. These catalysts are expensive and their application on an industrial scale is a challenge. In this context, the development of a more facile, cheap, efficient and stable catalyst system for the alcoholysis of FA to produce alkyl levulinates is still remains a challenge. Current research is focused on alcoholysis of furfuryl alcohol to value added products like alkyl levulinates using sulfonic acid functionalized mesoporous polymers. This catalyst is easy to synthesize and economical. The use of the polymeric support may enhance the catalytic activity in the synthesis of alkyl levulinates.

Project 4: Carboxymethylation of alcohols with dimethyl carbonate over solid acid catalysts under mild conditions

Research Scholar: Mr. Kempanna S. Kanakikodi& Mr. Sathyapal R. C.

Acid catalyzed carboxymethylation of alcohols is an emerging organic transformation that has grabbed the attention of scientific community in recent years. In the present study, sulfonated mesoporous polymer (MP-SO_3H) is presented as a highly active solid acid catalyst to convert a wide range of alcohols into alkyl methyl carbonates. The remarkable catalytic activity of MP-SO_3H is comparable to that of reported homogeneous acid catalysts. A good correlation was established between the catalytic activity and textural properties of the material. An exceptional catalytic activity of MP-SO_3H was observed for DMC mediated carboxymethylation of bio-derived alcohols which is unmatchable to conventional resins and zeolites. This superior activity of MP-SO_3H is ascribed to its intrinsic mesoporosity, high acid strength and uniform coverage of surface area by active sites. The catalyst is recyclable, resistant towards leaching and can be used in successive runs without losing the original activity. To the best of our knowledge, MP-SO_3H is the first solid acid catalyst to exemplify highest activity for the synthesis of different alkyl methyl carbonates using DMC. The protocol developed herein opens up new avenues to transform wide range of bio-alcohols into useful organic carbonates in the future.

Project 5: Production of biofuel intermediates via aldol condensation of furfural with acetone over γ-alumina supported sodiumaluminate

Research Scholar: Mr. Kempanna S. Kanakikodi

Internship Student: Rama Bai

The production of higher value products from simple molecules originating from biomass is of interest today. Herein, the γ-Al_2O_3 supported sodium aluminate catalysts were prepared by simple and green approach and used in aldol condensation of furfural with acetone. The SA/γ-Al_2O_3 catalysts were characterised by different techniques such as temperature programmed desorption, X-ray analysis, BET analysis, FTIR, and Pyridine-IR. The different reaction parameters such as effect of SA loading, catalyst concentration, mole ratio, reaction time and temperature on product distribution was investigated systematically. The SA/γ-Al_2O_3 demonstrated the highest conversion of furfural (99.5%) with 90% selectivity to FAc within 60 minutes of reaction time under mild reaction conditions contrast to the reported literature. The textural properties of SA/γ-Al_2O_3 are in good corelation with the observed catalytic activity of the material. This remarkable activity of material is ascibed to its high surface area, strength of basic sites and inherent mesoporosity. The various mesoporous and microporous materials have been screened to compare the catalytic activity of SA/γ-Al_2O_3. The catalytic activity of SA/γ-Al_2O_3 is far superior to the screened materials. On top of it, leaching and recycling experiments proven that the material is stable and resistant towrds the leaching of active sites.

Project 6: Selective hydrogenation of Phenyl Acetylene to Styrene on Pd-supported Metal Organic Frameworks

Research Scholars: Mr. Kempanna S. Kanakikodi & BakuruVasudevarao

The selective removal of the acetylenic hydrocarbons from the olefins is a challenging task but crucial to achieve high purity monomers. Currently, this problem is solved by the hydrogenation of acetylene derivatives in presence of Pd and Ag based materials. Despite of high activity and selectivity, they are rapidly deactivated/poisned by oligomers of the acetylene formed during the course of reaction. Therefore, it is still a challenging problem to find new approaches to the synthesis of highly efficient and selective hydrogenation catalysts. Pd/Hf-MOF demonstrated the good catalytic activity with high selectivity to the styrene. The reaction parameters are optimised to get the better conversion selectivity. The experimental part of this work is completed and preparation of manuscript is in progress.

Project 7: Etherification of glycerol with *tert*-butyl alcohol/iso-butylene over highly efficient P-SO_3H catalyst to produce oxygenated fuel additives

Research Scholars: Mr. Kempanna S. Kanakikodi & Mr. Sathyapal R. C.

Etherification of glycerol with alcohols/olefins is of great importance in the chemical processing industry and valorization of biomass derived streams. Here, the polymer based catalysts are synthesized solvothermally and characterized by different techniques to understand the physico-chemical properties of the materials. Etherification of glycerol with *tert*-butyl alcohol/isobutylene was studied in the high pressure stirred autoclave using P-SO_3H catalyst. The material (P-SO_3H) exemplified the complete glycerol conversion with very high yield of desired product. The characterization data reveals that the mesoporosity, surface area, hydrophobic nature and acid strength of the material are responsible for this good catalytic activity of the material. The material exemplified >88% yield of h-GTBE which is the best result ever reported for the etherification of glycerol with minimum amount of catalyst. The material is efficient and resistant towards leaching of active sites. The results achieved herein presented P-SO_3H as an efficient catalyst which can be used for the large-scale synthesis of potential blending stocks for diesel.

Project 8: Catalytic performance of MIL-101(Cr) Metal organic framework in nopal production by Prins condensation

Research Scholars: Bhavana B. K. & Kempanna S. K.

Terpenes find their wide application in the synthesis of a variety of products such as food additives, pharmaceuticals, agrochemicals and aromas. Pinene, a major composition of the pine tree, is an inexpensive and worldwide availableterpene. Therefore, conversion of pinenes into value addedchemicals is an interesting area of research. The synthesis ofnopol is an acid catalysed C–C bond forming reactionbetween alkene and aldehyde known as the Prinsreaction.Prins reaction in a homogeneous phase exhibits significant selectivity to side products while the absence of a catalyst requires high temperatures. For those reasons, the use of a heterogeneous catalytic system represents a promising alternative way for nopol production due to easy isolation of the products, minimization of the waste, and

possibility to reuse the materials.In this context, metal–organic frameworks (MOFs) can be leading materials, given their chemically modulable nature and structural diversity, and their already proved suitable performance as solid heterogeneous catalysts for specific liquid phase chemical transformations. Herein we have synthesised MIL-101(Cr) and explored its catalytic activity for nopol synthesis by prins reaction.

Project-9: Conversion of ethanol to higher alcohols over metal oxide wet impregnated zeolites catalysts

Research Scholars: Mr. Puneeth kumar M. S, Mr. Sujith & Mr. Sathyapal

Upgrading of bio-ethanol to n-butanol via homogeneous or heterogeneous catalytic reactions has received great attention in both academic and industrial fields owing to the advantages of n-butanol over bio-ethanol as a sustainable fuel. Since heterogeneous catalysts are more preferred in industry, several heterogeneous catalysts have been comprehensively investigated for n-butanol production from ethanol in the last decade.

Project-10: Synthesis of ionic liquid functionalized mesoporous polymer for versatile catalytic applications.

Research Scholars: Mr. Puneeth kumar M. S & Mr. Sathyapal

Replacement of homogeneous liquid catalysts by heterogeneous solid catalysts has received much attention because of the current interest in green or sustainable chemistry for catalyst recovery, operation and anticorrosion in continuous reactors, reactivation, and reuse. In particular, ionic liquids (ILs) supported on porous materials and polystyrene-based polymers are used as efficient catalysts for the production of fine chemicals and have good recyclability. However, to the best of our knowledge there is no report in which they have functionalized acidic, basic and redox functionality in the same polymer in single report for versatile catalytic applications.

RESEARCH HIGHLIGHTS

Published papers (2019-20)

1. "Porous polydivinylbenzene (PDVB) as an efficient adsorbent for hydrocarbons: Effect of porogens on adsorption capacity".Sathyapal R Churipard, Kempanna S Kanakikodi, Dheer A Rambhia, Ch Siva Kesava Raju, AB Halgeri, Nettem V Choudary, Gandham Sri Ganesh, Raman Ravishankar, Sanjeev P Maradur *Chemical Engineering Journal* 380 (2020) pp. 122481

2. Tuning Acidity in Sulfonated Mesoporous Polymer (MP-SO_3H) for Efficient Tetrahydropyranylation of Alcohols at Room Temperature" Sathyapal R. Churipard, Kempanna S. Kanakikodi, Nileena Jose and Sanjeev P. Maradur *Chemistry Select,* 5(2020) 293-299.

3. "Catalytic tertiary butylation of phenol over sulfonated mesoporous polymer catalyst (MP-SO3H): Exceptional selectivity towards 2, 4-di-t-Butylphenol".

Kempanna S Kanakikodi, Sathyapal R Churipard, AB Halgeri, Sanjeev P Maradur., *Microporous and Mesoporous Materials* 286 (2019) pp.133

4. "Exploring the Brønsted acidity of UiO-66 (Zr, Ce, Hf) metal–organic frameworks for efficient solketal synthesis from glycerol acetalization". Vasudeva Rao Bakuru, Sathyapal R Churipard, Sanjeev P Maradur, Suresh Babu Kalidindi. *Dalton Transactions* 48 (2019) pp. 843

Papers presented in Conferences

1. Mr. Kempanna attended the **International Conference on Advances in Chemistry with specific reference to Catalysis, Sensors, Drug Delivery and Energy Materials (ICACSEM) attended – 9th – 10th January 2020** was hosted by physical chemistry department, University of Madras and he has given a oral presentation.

2. Mr. Sathyapal has given a oral presentation at **A national conference on frontiers of catalysis science and technology and its applications**. Hosted by the department of chemistry, St. Joseph's college in association with Catalysis Society of India, Bangalore Chapter

1) Review meetings:

Project Review Meetings

- Scientists from Deepak Nitrite Ltd, Baroda, visited PPISR on September 2019 for project review meeting of sponsored project. Dr Maradur also made a new project proposal which has been technically sanctioned but is kept on a hold for some unavoidable circumstances.

- Dr. Maradur visited Sravathi Advanced Process Technologies Bengaluru on 26th February 2020 for technical discussion on hydrogenation of aromatic compounds for possible industry funding. Project is yet to initiate from June 2020

Dr. D. H. K. Murthy

Assistant Professor

Materials Science & Catalysis Division

E-mail: murthydhk@gmail.com

Brief CV

- 2020-Present: Assistant Professor, PPISR, Bangalore, India
- 2019-2020: Research Fellow, NTU, Singapore.
- 2015-2019: AIST Special Researcher, National Institute of Advanced Industrial Science and Technology, (AIST), Tsukuba, Japan.
- 2014-2015: Research Associate, CPMU, JNCASR, Bangalore, India.
- May 2009-Sep 2013: Ph.D. candidate, Dept. of Chemical Engineering, Delft University of Technology (TU Delft), the Netherlands.

Research interests

Our research group innovates novel photocatalysts that exploits abundantly available solar energy to produce useful chemicals/fuels (NH_3, H_2, hydrocarbons etc). Our strategy revolves around artificial photosynthesis principle which can efficiently transform various molecules to value-added chemicals *via* photocatalytic water splitting, CO_2 reduction, nitrogen fixation, photocatalytic reforming of bio-mass, etc.

We emphasize on understanding of the relation between material properties (electronic, structural and photophysical) and the activity. Such rational insight will help us in understanding the factors limiting the efficiency of a given materials while providing ideas on how to further tune the materials properties. In this direction, we also work on elucidating charge carrier dynamics using time-resolved laser spectroscopy. Other areas of research that are currently being explored are lead-free 2D perovskite-type solar cells and 2D materials/oxides for gas sensing application.

ACHIEVEMENTS/RECOGNISTIONS/AWARDS/MEMBERSHIP

Invited lecture at Jain University, global campus near Kanakapura on 27th February, 2020. The title of the talk was “Large-area photocatalyst panels for solar H_2 production using aluminum-doped $SrTiO_3$: Insights from spectroscopy on material design”

Summer internship students

Ms. Akanksha Shetty, Ms. Rithisha Shetty and Ms. MrunaliniGowda from RV College of Engineering, Bangalore (Feb - May 2020)

National& International collaborators

1. Prof. Dinesh Rangappa from VTU, Muddenahalli, Chikkaballapura
2. Prof.Nagaraja. M from IIT Ropar
3. Dr. Mahesh Padaki from Jain university, Bangalore
4. Dr. Satadeep Bhattacharjee from IKST, Bangalore
5. Prof. Akihiro Furube from Tokushima University, Japan

Academic projects

Principal Investigator: Dr. D. H. K. Murthy

Research students: Ms. Akanksha Shetty, Ms. Mrunalini Gowda and Ms. Rithisha M.

Project 1: Synthesis and characterization of g-C_3N_4 for photocatalytic H_2 and NH_3 production

Graphitic carbon nitride (g-C_3N_4) is one of the promising visible-light absorbing semiconductor for various application in solar energy conversion and battery. We have successfully prepared this material by urea and/or thiourea decomposition at 400° C temperature. XRD patterns matched correctly with that of earlier literature reports. UV-Vis diffuse reflectance spectrum (DRS) was reminiscent to earlier reports. Pt nanoparticles were deposited on the surface of these materials using wet impregnation method. A reduction in the intensity of the photoluminescence signal after Pt loading indicated less recombination of charge carriers which is beneficial for photocatalytic reaction. This family of materails are intensively investigated for NH_3 formation.

Project 2: Synthesis and characterization of visible/NIR light absorbing Ir-doped $SrTiO_3$ for enhancing the photocatalytic H_2 evolution

$SrTiO_3$ is one of the extensively studied materials for photocatalytic water splitting application. However, major challenge with $SrTiO_3$ is its band gap of 3.2 eV which can only absorb ultraviolet light which forms less than 5% of the solar spectrum. Hence, it is essential to extend the spectral response towards visible/NIR light by doping. The process of doping is to introduce impurities within the forbidden region of the band gap to elicit optical response in the visible/NIR region. Such approach is investigated by using Ir metal as a dopant during the preparation of $SrTiO_3$ by solid state reaction. Both XRD data and optical absorption data (UV-Vis-NIR DRS) of the prepared Ir-doped $SrTiO_3$ clearly indicated the introduction of Ir dopant to the host lattice and thereby shortening the band gap. Thus, this material has the promise to realize efficient H_2 evolution from water splitting.

Project 3: Synthesis and characterization of aluminum doped $SrTiO_3$ for fabricating large-area photocatalyst panels for water splitting

Aluminum doped $SrTiO_3$ material was prepared by solid state reaction by combing $SrCO_3$ and TiO_2. Al doping is introduced by adding few mol% of Al_2O_3 to the reaction mixture. XRD patters confirmed that Al-doping did not affect the crystallinity in a significant way. Besides Al as a dopant, other trivalent metals such as La and Bi were also investigated. Motivation of this project was to prepare 10 g of Al-doped $SrTiO_3$ to make panels to demonstrate the feasibility of large-scale solar H_2 production.

13. BIOLOGICAL SCIENCES DIVISION

13.1 Mission and research progress

Biological science division works inkey areas such asuse of active biomolecules from endophytic fungi against diabetes, bioremediation using fungal enzymes, cancer immunotherapy, novel antibiotics against purine and pyrimidine pathways of pathogenic microorganisms, and chemical modification of proteins for therapeutic purpose. The division possess facilities for gene cloning, protein expression, refolding, purification and crystallization of biomolecules. Facilities for the isolation of endophytic fungi, molecular identification, bulk extraction of secondary metabolites and their respective assay's have also been upgraded. The research activities in the department are supported by PPISR and as well as grants from government funding agencies such as Department of Biotechnology (DBT), Board for Research in Nuclear Science (BRNS), Vision Group On Science and Technology (VGST) and Department of Science and Technology (DST).

The biological sciences division offers Ph.D. programmes in Structural biology, Biochemistry and Microbiology. The structural biology group headed by Dr. Udupi A. Ramagopal works on structure-based rational modification of T-cell co-stimulatory molecules to generate lead molecules for autoimmune disorders and cancer. Enzymes having biological and therapeutic importance like enzymes involved in purine metabolism, methyltranseferases implicated in antibiotic resistance are also of interest. The microbiology group headed by Dr. Ananda K., mainly focuses on finding natural inhibitors from medicinal plants and their endophytic fungi, for the enzymes involved in carbohydrates metabolism and insulin for treating diabetes. Dr. Ananda's group are also interested in laccase enzymes and their role in bioremediation. Till now, four students obtained their PhD degree from Biological Science division registered under Manipal Academy of Higher Education (MAHE), Manipal.

Major Areas of Research

1. Structure guided modification of T-cell costimulatory molecules to generate lead biologics to treat autoimmunedisorders and cancer.
2. Structural and functional studies of antibiotic resistance conferring methyltransferasesand enzymes involved in purine metabolism.
3. Natural inhibitors from plant and endophytic fungi for treating diabetes.
4. Laccase from fungi for bioremediation of textile and pharmaceutical wastes.
5. Modification of therapeutic protein for their novel applications

13.2 Faculty profile of Dr. Udupi A. Ramagopal

Associate Professor & Dean-Academics
Email: udupi.ramagopal@poornaprajna.org
Lab Website: https://ppisr.res.in/udupi-ramagopal/

Education
PhD: Indian Institute of Science, India – 2001

H-Index= **28**, I_{10} index= **40**, Publications =**51**, Citation/article ~ <**55**>

https://scholar.google.co.in/citations?hl=en&user=d7t9weUAAAAJ&view_op=list_works

Brief CV

1. Associate Professor (2014 to 2020) and Dean Academics (2018-Current), Poornaprajna Institute of Scientific Research, Bangalore, India.
2. Assistant Professor 2011 – 2014, (Ramalingaswami Fellow – DBT, 2011-2016), Poornaprajna Institute of Scientific Research, Bangalore, India.
3. Visiting Faculty, 2011 – Present: Albert Einstein College Of Medicine, New York, USA.

http://www.einstein.yu.edu/home/faculty/profile.asp?id=9276

4. 2009-2011: Instructor (Faculty), Albert Einstein College Of Medicine, New York, USA.
5. 2005-2009: Associate of Biochemistry (Faculty), Albert Einstein College Of Medicine, New York, USA.
6. 2003-2005: Senior Research Associate, Department of Biochemistry, Albert Einstein College Of Medicine, New York, USA.
7. 2001-2003: Visiting Fellow, National Institute of Health, USA.

Awards and Recognitions/Achievements

- **Ramalingswami fellow, DBT**, India (2011 - 2016).
- Best thesis "**Kumari L. A. Meera Award and a Gold Medal**", 2001, **IISc**, India.
- **Visiting Fellow** (2001 – 2003, NIH, USA).
- **Visiting Faculty** (Albert Einstein College of Medicine, 2011 – current).
- Invited Instructor (2003-2010) at *RapiData*, a comprehensive course offered at Brookhaven National Laboratory for budding crystallographers around the world (http://www.bnl.gov/rapidata/).
- Proposal reviewer: Macromolecular Crystallography, APS, Argonne National Laboratory.
- Served in the "User Executive Committee 2002-2003" of National Synchrotron Light Source, Brookhaven National Laboratory, USA.
- Jeffery Award (poster award - IUCr 2002, co-author).

- Contributed >**250** protein structures to World Wide Protein Data Bank (wwPDB).
- Referee for various International Journals such as *Acta-D, Protein Science, BioChem Journal, Nature Scientific Reports* and so on.
- Doctoral Advisory committee member for few students registered under Manipal University
- Scientific Advisor "Genelon Life Science Ltd.", Yelahanka, Bangalore
- Established the Biological Science Division at PPISR where Biology was a new word.
- Collaborated/collaborating with pharmaceutical industries working towards novel biologics for auto-immunity and cancer.
- Coauthored publications with **Prof. James Allison, Nobel Laureate** in Physiology and Medicine 2018.

NATIONAL AND INTERNATIONAL COLLABORATORS

Prof. Steven C. Almo, Albert Einstein College of Medicine, New York, USA.
Prof. Ramakumar S., Indian Institute of Science, Bengaluru, India
Prof. Udaykumar Ranga, Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru, India.
Prof. Hemalatha Balaram, Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru, India.
Dr. Dibyendu Samanta, Indian Institute of Technology, Kharagpur, India

RESEARCH INTEREST:

- Modification of immune checkpoint blockade receptors for cancer immunotherapy.
- Structural and functional characterization of phosphoribosyltransferases from pathogenic bacteria.
- Structural and functional characterization of antibiotic resistance conferring methyltransferases from *Mycobacterium Tuberculosis*.
- *De novo* structure determination of proteins and methodology development in the are of protein crystallization.

Lab Members/Mentoring Experience:

PhD Students:
Ms. Swetha Lankipalli (graduate student)
Mr. Shankar Kundapura (graduate student)
Mr. Akshaya Bhat (graduate student)
Ms. Salima Parveen (graduate Student)

Alumni and Post-Doctoral Fellows

Dr. Pavithra G. C. (2012-2019, Ph. D., PPISR, Bangalore, currently working at NCBS, Bangalore, India)
Dr. Raghurama Hegde 2012-2018 (Ph. D., IISc, Bangalore, currently working at Elletra, Trieste, Italy)

Dr. Debayan Day (PhD. D.IISc, Bangalore, worked as a DBT-Research Associate and currently working at Emory University, USA, debayan.dey@emory.edu).
Dr. Srinivasulau (PhD, Krishnadevaraya University, Andrapradesh, Currently Dr. K. S. Kothari postdoctoral Fellow, IISc)

MS Thesis
Mr. Saurav Kampa (2016, Geetham University)
Mr. Deepak K.J (2019, Bangalore University)
Ms. Kalpana Chaco (2020, Amrita University
Ms. Shythya Murali (2020, Amrita University)

Past Mentoring Experience:
I have co-mentored several students and post-doctoral fellows on the structural-immunology projects at Albert Einstein College of Medicine, including Students:

1. Dr. Erhu Cao (Julius Marmar Award for best thesis, currently faculty at University of Utah, erhu.cao@biochem.utah.edu).

2. Dr. Rotem Rubinstein (Julius Marmar Award for best thesis, *rotem.rubinstein*@phd.einstein.yu.edu)

3. Dr. DibyenduSamanta (Post-Doctoral Fellow, Albert Einstein College of Medicine), currently faculty at IIT Kharagpur, India.

Recent publications:(2017-2019, *corresponding author)

- The CC' loop of IgV domains of the immune checkpoint receptors, plays a key role in receptor:ligand affinity modulation, **2019**, Shankar Kundapura and **Udupi A. Ramagopal***, ***Scientific Reports***. Dec 16;9(1):19191. doi: 10.1038/s41598-019-54623-y.

- Liu W, Garrett SC, Fedorov EV, **Ramagopal UA**, Garforth SJ, Bonanno JB, Almo SC, Structural Basis of CD160 HVEM Recognition, (2019), ***Structure***, 6;27(8):1286-1295.

- Pavithra GC and **Ramagopal UA***, Crystal structures of APRT from *Francisellatularensis*: An N-H···N hydrogen bond imparts adenine specificity in adenine phosporibosyltransferases, (2018), FEBS J, 285(12):2306-2318.

- Ghosh A, **Ramagopal UA**, Bonanno JB, Brenowitz MD, Almo SC. **2018,** Structures of the L27 domain of Disc Large homolog 1 protein illustrate a self-assembly module, Biochemistry. ***Biochemistry***, 57 (8), pp 1293–1305.

- Raghurama P. Hegde, Pavithra G. C., Debayan Dey, Ramakumar S, **Ramagopal UA***, **2017**, " Can the propensity of protein crystallization be increased by using systematic screening with metals?, Invited review/perspective with our experiments and database analysis, ***Protein Science,*** 26(9), 1704-1713.

- **Ramagopal UA**, Liu W, Garrett S, Yan Q, Srinivasan M, Wong S, Bell A, Mankikar S, Vangipuram R, Deshpande S, Korman A, Almo, SC. **2017**, Structural basis for cancer immunotherapy by the first-in-class checkpoint inhibitor Ipilimumab. ***Proc. Nat. Acad. Sci. (USA)***, 114(21), E4223-E4232. (This article is highligted in "In this Issue" section of PNAS).**Comments and media coverage:**http://www.deccanherald.com/content/623201/bodys-battle-against-cancer.html and https://medicalxpress.com/news/2017-05-cancer-immunotherapy-drugs-x-ray-crystallography.html and https://immuno-oncologynews.com/2017/06/06/insights-into-yervoy-and-target-molecule-may-improve-immunotherapies/andhttps://www.natureindex.com/article/10.1073/pnas.1617941114 and http://cancerimmunolres.aacrjournals.org/content/5/7/515.

- Raghurama P. Hegde, Fedorov, A.A., Sauder, J.M., Burley, S.K., Almo, S.C. &**Ramagopal UA***, **2017**, The hidden treasure in your data: phasing with unexpected weak anomalous scatterers from routine data sets., ***Acta Cryst F,*** *73*, 184-195.

- Samanta D, Guo H, Rubinstein R, **Ramagopal UA***, Almo SC, **2017**, Biochemical and Structural studies reveal a canonical mode of molecular recognition between immune receptor TIGIT and nectin-2, ***Molecular Immunology*** 81, 151-159.

- Lázár-Molnár E, Scandiuzzi L, Basu I, Quinn T, Sylvestre E, Palmieri E, **Ramagopal UA**, Nathenson SG, Guha C, Almo SC. **2017,** Structure-guided development of a high-affinity human Programmed Cell Death-1: Implications for tumor immunotherapy. ***EBioMedicine***, 17:30-44.

Grants:

1. Ramalingaswami Fellowship titled "Co-stimulatory molecules: Biology and therapeutic intervention", Department of Biotechnology (DBT), New Delhi, India (completed).
2. Design of modified B7-1 (CD-80) and B7-2 (CD86) molecules to create potential reagents for cancer and auto-immune disorders", Vision Group on Science and Technology (VGST), Karnataka (completed).
3. Structural and evolutionary investigations on antibiotic resistance conferring rRNA methyltransferases for designing novel strategies of drug development, Department of Science and Technology, India.
4. Structure based rational design of PD-1 mutants to create lead molecules for cancer immunotherapy, BristorMayersSqibb, USA.

Other activities/achievements:

- **Dr. Ramagopal's** proposal for the experiment at **Elettra Synchrotron Facility, Trieste, Italy, was approved by DST grant administered by IISc.,** Mr. Shankar Kundapaura visited the facility and conducted the experiment at Elettra, from Dec 4-8th, 2018.

- **Dr. Pavithra**a graduate student Dr. Ramagopal's lab successfully defended her thesis on 25th July 2019 and **awarded doctoral degree** by MAHE, Manipa.
- **Udupi A. Ramagopal,** submitted a TATA-Innovation grant to Department of Biotechnology, India.

- **Udupi A. Ramagopal**, as a co-PI submitted a program grant for DST, India., together with eight eminent scientists from India headed by Prof. Udaykumar Ranga (JNCASR) and Prof. Thapas K. Kundu (Director, CDRI , Lucknow)

- **Dr.Ramagopal's** proposal for the experiment at **Elettra Synchrotron Facility, Trieste, Italy, was approved by DST grant administered by IISc.,** Mr. Shankar Kundapaura visited the facility and conducted the experiment at Elettra, from Dec 4-8th, 2018.

- **Dr.Ramagopal's** proposal "Structure based rational design of PD-1 mutants to create lead molecules for cancer immunotherapy", is approved by **Bristol Myers Squibb, USA.**

- **Dr.Ramagopal** delivered a talk titled "Cancer Immunotherapy: Manipulating our own immune system to cure cancer" at GITAM Deemed to be University, Bengaluru Campus.

- **Dr.Ramagopal** delivered a talk titled "Checkpoint blockade immunotherapy", Faculty Development Program on Recent Trends in Biological andEnvironmental Sciences, (RTBES-2020) at Ramaiah Institute of Technology, Bangalore, on 18th, January 2020.

- **Ms. Swetha Lankipalli** attended a two-day workshop on "Indo-Italian Elettra beamline user meeting and workshop" at AIIMS, NewDelhi on November-11th and 12th, 2019.

- **Mr. Shankar kundapura** visited IIT-Kharagpur from November 2019 for two months to conduct experiments on refolding of PD1 mutants and to study its interaction with PD-L1 at Prof. Dibyndu Samatha's lab.

- A manuscript titled "Phylogenetic, sequence and structural analysis of Insulin superfamily proteins – A new tale of tremendous Lilliputs " **Ms. Shrilakshmi S. Kundapura S., Debayan Dey, Ananda K and Udupi A. Ramagopal**is uploaded to***Biorxiv***doi: https://doi.org/10.1101/769497.

- A manuscript titled “Cryptic association of B7-2 molecules, implication for B7-2 clustering,by **Swetha Lankipalli, Dibyendu Samantha and Udupi A. Ramagopal**is under final stage of preparation and will be communicated soon.

- A manuscript titled “conserved water dictates substrate specificity in XGPRT from Yersinia pestis and exerts evolutionary constraints” by **Gowribidanur C. Pavithra[#], Swetha Lankipalli[#], Debayen Dey and Udupi A. Ramagopal**under final stage of preparation and will be communicated soon.([#] Equal contribution).
- **Mr. Shankar Kundapura**, co-authored a manuscript titled “Structural insights into N-terminal IgV domain of BTNL2, a T cell inhibitory molecule, suggests a non-canonical binding interface for its putative receptors” with our collaborators from IIT-Kharagpur (Currently under consideration at Journal of Molecular Biology).

Current Research Projects:

1. **Design of modified B7-1 (CD-80) and B7-2(CD86) molecules to create potential reagents for cancer and auto-immune disorders.**

Modulation of T-cell co-stimulatory/inhibitory pathways has been proven to be one of the main immunotherapeutic approaches in the treatment of cancer. CD28/CTLA-4: B7-1/B7-2 family of molecules being one of the key proteins in the T-cell co-stimulatory/inhibitory pathway, they are the most explored targets for immune checkpoint inhibitors. This project aims at the structure-guided rational modification of human B7-2 and B7-1 proteins, to create economically viable and more efficacious immune-modulator than the existing antibody-based drugs. Other than designing lead molecules for immunotherapy this project works on fundamental aspects such as oligomerization and their association into clusters, understanding of which plays a critical role in signalling. Towards this goal, we have done an extensive structural analysis of molecules involved in T-cell signalling and their preferred association into 1D and 2D cluster. Together with structural analysis, bioinformatics, biochemical and biophysical studies have revealed, how the clustering of cell-surface molecules, in some cases, hide the ligand-binding surface and avoid spurious signalling and produce robust and reproducible signals. While the research is of both fundamental and of medicinal importance in nature, such an endeavour requires facilities and collaborations to produce these molecules and to test *in vitro* and *in vivo* efficacy. We are looking for funding opportunities to pursue research in the area of exemplary importance.

2. **Rational modification of immune checkpoint receptors of PD-1 pathway for cancer immunotherapy**

Treatment of cancer has been given a new lease of life by immune checkpoint inhibitors since the early 2010s. Most of these immune checkpoint inhibitors are monoclonal antibodies and were found to be effective. Further, the majority of approved checkpoint-blockade antibodies are the blockers of this PD1:PD-L1/PD-L2 pathway and are found to be effective. This project aims at the structure-guided

rational modification of PD-1, to create lead molecules that are expected to be more efficacious immune-modulators with fewer side-effects than the existing antibody-based drugs. To design these mutants, as a first step, we have done a critical analysis of structures of immune receptor complexes. It was observed that although IgV domains of antibodies and immune receptors share a very high structural similarity, the binding of IgV domain of immune receptor reveals specific differences in the mode of binding to their cognate partner in comparison to the interaction observed between the IgV domains of light and heavy chains of the antibody. This work has been published in the prestigious journal *Scientific Reports* (Nature group). Based on this analysis, we have created several mutants of PD-1 to mimic the function of anti-PD-L1 (PD-L1 is a cognate receptor of PD-1) antibodies. Biophysical experiments confirm that several of these PD-1 mutants are showing an expected higher binding affinity to PD-L1. The efficacy of these PD-1 mutants in the context of the cell should be tested and their ability to block PD-L1 should be ascertained yet.

3. **Structural and evolutionary investigations on antibiotic resistant conferring rRNA methyltransferases for designing novel strategies of drug development.**

Methyltransferases (Mtases) are enzymes which transfer methyl group onto various substrates including RNA, DNA, proteins and many other small molecules. They play a key role in various biological functions such as epigenetic modifications, biosynthesis of ribosomes and nucleoprotein complexes, signal transduction, protein repair, chromatin regulation, etc. It has been also realized that they play a critical role in the emergence of antibiotic resistance.

Along with the development of antibiotics in the last decades, various strains of antibiotic-resistant bacteria have evolved and are presently threatening our present healthcare system. It is estimated that more than a million people die due to drug-resistant bacteria every year. Combined with the lack of facilities to probe drug resistance, poor sanitation and cheap antibiotics without any regulatory mechanism, India has become a literal petri dish for the emergence of drug-resistant bacteria. With this understanding, we are left with possibly two options i) discovery of new antibiotics directed towards novel targets or ii) to break the mechanism of antibiotic resistance with novel drugs and to use them in conjunction with existing antibiotics. Considering this, several groups and companies are using the later of the two approaches to develop inhibitors against those pathways responsible for antibiotic resistance; they are called antibiotic resistance breakers. Since many antibiotics are directed towards ribosome[2] and also has been realized that the mechanism of resistance to this class of antibiotics are a result of rRNA modifications that are carried out by Mtases, make these proteins attractive targets for discovery of resistance breakers. Based on our evolutionary and comparative sequence/structural studies, we have initiated our work on few rRNA Mtases including those from Mtb (discussed later) that are similar to already known antibiotic resistance-conferring Mtases. In the present project, we envisage understanding the molecular mechanism of rRNA methyltransferases and hence utilize such understanding towards the design of effective antibiotic resistance

breakers. It is interesting to note that although the role of rRNA Mtases to confer antibiotic resistance is known, to our knowledge there is no attempt to develop antibiotic resistance breakers directed towards rRNA Mtases.

4. **Structural studies of purine phosphoribosyltransferase from pathogenic bacteria**

The objective of the work presented in this project is to understand the structure and function relationship of purine phosphoribosyltransferases involved in the purine salvage pathway from three pathogenic bacteria, *Yesinia pseudotuberculosis/pestis*, *Francisellatularensis*and*Helicobacter pylori*. As we all know, nucleotides play a vital role in many biochemical processes. Nucleotides and their derivatives act as precursors/building blocks for DNA and RNA synthesis, as components of co-enzymes (NAD and FAD), secondary messengers in cell signaling and also as metabolic regulators in higher organisms. Hence, nucleotides are critical for every aspect of cellular life. There are two pathways for the synthesis of nucleotides: the *de novo* and the salvage pathways. The *de novo* pathway for purine synthesis utilizes amino acids, CO_2, ribose-5-phosphate and NH_3 as precursors. In the salvage pathway, the enzymescatalyze the metal-dependent transfer of phosphoribosyl group from 5-phospho-α-D-ribosyl-1-pyrophosphate (PRPP) on to available purine bases, resulting in the formation of purine monophosphate. Some protozoan parasites and few pathogenic bacteria possess only salvage pathway which utilizes freely available purine bases from the host and lacks *de novo* purine synthesis. Thus, the enzymes involved in the salvage pathway are considered as potential chemotherapeutic targets against pathogens that lack *de novo* pathway. In general, enzymes involved in the salvage pathway are ubiquitous and are important, independent of whether the *de novo* pathway exists or not. Understanding their structure-function relationship and the architecture of the active site of these enzymes paves the way for effective drug-design. We have determined the structures of several of these enzymes and characterized their function. Future projects are directed towards the design of effective blockers, those that can inhibit several of these enzymes involved in both *de novo* and salvage pathways at once. Such molecules are expected to effective anti-bacterial lead molecules.

Faculty Profile

Dr. Ananda K
Associate Professor
Biological Sciences Division
E-mail:ananda@poornaprajna.org
ananda@ppisr.res.in

BRIEF CV:

2018- Onwards: Associate Professor, PPISR, Bengaluru
2011-2017: Assistant Professor, PPISR, Bengaluru, India
2010-2011: Faculty Fellow, PPISR, Bengaluru, India
2004-2010: Post-Doctoral Fellow, Albert Einstein College of Medicine, NY, USA
2004-2004: Lecturer, P A College of Engineering, Mangalore, India
2003-2004: Project Associate, IWST, Bengaluru, India
1999-2003: Administrative Supervisor, KSRTC, Govt. of Karnataka, India
1996-2001: PhD, Mangalore University, Mangalore, India.
1995-1996: Project Assistant, College of Fisheries, Mangalore, India
1993-1995: MSc, Biosciences, Mangalore University, Mangalore, India

Training of Students:

PhD Awarded	: 02
PhD thesis Submitted	: 01
MSc Project completed	: 03
BSc/BE Project completed	: 08
BSc Inspire students	: 03
PhD students working	: 02
MSc Project working	: 01

RESEARCH INTERESTS:

1. **Laccase producing fungi and applications of fungal laccase**

Synthetic dye manufacturing has become a massive industry. Unfortunately, synthetic dyeing can also pose significant environmental threats due to its recalcitrant nature if disposed un-treated. Amongst synthetic dyes triphenyl methane class of dyes (Malachite green, crystal violet, aniline blue, acid violet, basic green and more) are extensively used in industrial processes like textile dyeing, biological stains, leather industries, paper colorants and many more. These dyes contribute momentous hazard as they are potent carcinogen to animals and confer toxicity to the growth of plants and micro-organisms as well. White-rot fungi are profuse producers of laccase which efficiently decolorize triphenyl methane dyes. There are reports on radiation as one of the techniques used for enhancement of enzyme production, thereby increasing the biodegradation of dyes. We at PPISR, would like to use the electron beam radiation, gamma readiation and UV radiation

as a tool for increasing the laccase production in fungus and thus increase their rate of dye degradation capacity.

2. **Natural Enzyme Inhibitors from plants and endophytic fungi for controlling type 2 diabetes**

Type 2 diabetes mellitus (T2DM) is characterized by constant hyperglycaemia due to the condition called insulin resistance in targeted organs and pancreatic β cell dysfunction, leading to deterioration in insulin secretions. Amongst the plenty of oral drugs for T2DM, the partial inhibition of starch digesting enzymes such as alpha-amylase and intestinal alpha-glucosidase enzymes being focused to control the postprandial hyperglycaemia. These enzymes exclusively catalyse the hydrolysis of α-1,2, α-1,4 and α -1,6-glucosidic linkages in oligosaccharides and thereby release absorbable monosaccharides. Many of the plant extracts have been used in the treatment of diabetes. Medicinal plants are considered as the primary source of therapeutically important secondary metabolites. Medicinal plants are used for various disease treatment because of their safety, low cost, more effective and availability. About 200 compounds have been purified from plants that are found to be hypoglycaemic. If the medicinal plants are utilized continuously for the natural treatment of diabetes there will be a threat for these herbs due to over exploitation. Therefore, endophytic fungi are one of the alternative natural resources for new anti-diabetic compounds. Endophytic fungi are defined as microbes that inhabit healthy plant tissues in their life cycle without causing apparent harm to their host. In this context, the endophytes are a promising source since these fungi have evolved the ability to produce several novel metabolites vested with different bioactivities. Endophytes can be used as a source of machinery for the production of novel drugs as they are fast growing, easy recovery of products and culture condition can be optimized inside the lab. Endophytes are also known to produce secondary metabolites similar to that of their host plant secondary metabolites. In this area of research, we are isolating secondary metabolites from selected medicinal plants and from their endophytic fungi. Then, we are purifying inhibitors for digestive enzymes thus study their *in-vitro, in-silico* and *in-vivo*properties using commercially available enzymes. Further, we want to explore on the interactions of natural digestive enzyme inhibitors with genetically cloned, expressed and purified human enzymes.

3. **Rational modification of Insulin to improve its half-life and other therapeutic properties**

Controlling diabetes is one of the major issues for a diabetic patient. Once all oral drugs fail to control the blood glucose level, insulin therapy will be initiated in case of type-2 diabetes similar to type-1 diabetes. Though there are many insulin analogues, the half life of these are not more than 24 hrs in many cases and still few leads to other complications after continuous intake. There is high demand for novel insulin analagues or for its modified forms which should have low production cost, lesser side effects and longer half life than any of the existing insulin in the market. Rational modification of insulin to produce a novel type of insulin or its bio-conjugates or PEGylated insulin is one of the concepts we are working at PPISR.

RECOGNISTIONS/ACHIEVEMENTS:

1. Recognised as Visiting Professor of Dept. of Biochemistry, Mangalore University, Mangalore since 2020.
2. PhD Co-coordinator at PPISR for Manipal University, Manipal
3. Life Member of Mycological Society of India
4. Life member of Association of Microbiologist of India
5. Postdoctoral Senate member in Faculty Senate, Quality of Life Committee and of Committee on Committees of Albert Einstein College of Medicine 2007-2009.
6. Working experience as Administrative supervisor in KSRTC, Karnataka, India.1998-2003
7. President of Mangalore university researcher's forum (MURF) during the period of Ph.D. for a year.
8. Member of New York academy of science, NY, USA.2006-2008
9. Member of Protein Society, San Diego. USA 2006.

STUDENTS

Ph.D. students

1. Mr. Kirana M P
2. Ms. Shrilakshmi S

Project Fellows

1. Ms. Anusha, B.E, N.M.A.M. Institute of Technology, Nitte, Karkala,Udupi
2. Ms. Arye Sudershan, MSc. AMRITA VISHWA VIDYAPEETHAM, Kerala

RESEARCH

SPONSORED PROJECTS (ongoing):

A. "α-amylase and α-glucosidase inhibitors from endophytic fungi for treating Type 2 diabetes" funded by VGST-Karnataka for the year 2016-17 for 3 years (Rs.30 lakhs).

ACADEMIC PROJECTS:

1. Effect of electron beam radiation on endophytic fungi producing ligninase enzyme. PI:Dr.Ananda, K. ; Research Scholar: Ms.Kavitha KN
2. Alpha glucosidase enzyme inhibitors from *Simarouba glauca* and from its endophytic fungi. PI: Dr.Ananda K, Reseach Scholar: Mr.Kiran M P
3. Site specific modification of insulin for increasing its half-life and pharmacological properties. PI: Dr.Ananda K. ; Research Scholar : Ms. Shrilakshmi S
4. Production of vanillin from green coconut husk by *Trameteshirsuta* and its potentiality as drug for Alzheimer's disease" PI: Dr.Ananda K. Summer project Student: Anusha .H, B.E. Biotechnology Nitte Engineering College, Udupi
5. Applications of secondary metabolites from medicinal plants and their endophytic fungi. PI: Ananda K. MSc Project student Ms. Arya Sudersan. MSc in Microbiology, Amrita School of Biotechnology, AMRITA VISHWA VIDYAPEETHAM, Kerala.

RESEARCH HIGHLIGHTS

- **Published papers: (2019-20)**

1. Kavitha Keshava Navada and Ananda Kulal, (2020). Enhanced production of laccase from gamma irradiated endophytic fungus: A study on biotransformation kinetics of aniline blue and textile effluent decolourisation. *Journal of Environmental Chemical Engineering*, 8(2), 103550.

2. Archana K. M, Maurya, S.K., Kumar, K., Kavitha Keshava Navada and Ananda Kulal, Nalini.G. Sundaram (2020). Scheelite like NaTb(WO4)2 nanoparticles: Green fluorescence and in vitro cell imaging applications. *Materials Science and Engineering: C*, 106, 110182.

3. Kavitha Keshava Navada and Ananda Kulal, (2019). Enzymatic degradation of chloramphenicol by laccase from Trameteshirsuta and comparison among mediators," International Biodeterioration & Biodegradation 138, 63-69.

4. Nagaraja, Akshatha, Yashoda Malgar Puttaiah gowda, Ananda Kulal, AjithkumarManayanParambil, and ThivaharanVaradavenkatesan. (2019) "Synthesis, Characterization, and Fabrication of Hydrophilic Antimicrobial Polymer Thin Film Coatings." *Macromolecular Research*: 1-9.

5. Jalageri, Manohara Dhulappa, Yashoda MalgarPuttaiahgowda, Ajithkumar Manayan Parambil, and Ananda Kulal. (2019)"Design of multifunctionalized piperazine polymer and its activity toward pathogenic microorganisms." *Journal of Applied Polymer Science*: 47521.

6. Sunil Kumar, A., J. Kudva, B.R. Bharath, K. Ananda, R. Sadashiva, S. Madan Kumar, B.C. Revanasiddappa, V. Kumar, P.D. Rekha, and D. Naral. 2019. Synthesis, structural, biological and in silico studies of new 5-arylidene-4-thiazolidinone derivatives as possible anticancer, antimicrobial and antitubercular agents. *New Journal of Chemistry* 43:1597-1610.

- **Papers presented in conferences:**

1. Dr. Ananda K, conducted one day workshop on “Culturing of microorganisms and antimicrobial activity” for the PUC students of Govt. Pre-university College, Hiriyadka, Udupi on February 29, 2020. It was covered in daily news Udayavani: http://epaper.udayavani.com/ArticlePage/APpage.php?edn=sudina(Udupi)&articleid=UVANI_SUDP_20200307_5_13

2. Dr. Ananda K actively participated in 3 days conference on “New Dimensions in Nanoscience and Nanotechnology for industry 4.0” at “11thBengaluru INDIA NANO 2020” on March 4-6, 2020.

3. Ms. Shrilakshmi S presented a poster titled “Chemical modification and bioconjugation of insulin for therapeutic applications” in the Manipal research colloquium held from April 1st-3rd organized MAHE, Manipal.

4. Mr. Kirana M. P. presented a poster titled “Studies on alpha glucosidase inhibitors isolated from medicinal plants and their endophytic fungi” in the Manipal research colloquium held from April 1st-3rd organized MAHE, Manipal.

5. Ms. Shrilakshmi S, attended the Fourth school on Population Genetics and evolution conducted by ICTS Bengaluru from 27th January-7th February 2020 and presented a poster on “*In-silico* analysis on insulin super family proteins”.

- **Other Scientific Activities**

1. Dr. Ananda K, Associate professor, gave four lecturers as visiting Professor to MSc students of Biochemistry at Mangalore University, Mangalore on “Diabetes and cancer biology” in the month of February and March 2020.

2. For animal Studies, ethical clearance discussion was held from 10-12th January 2020 and the presentation meeting was held on 29.1.2020 and we have obtained approval at St. Aloysius College, Mangalore for analyzingbioconjugated samples of Ms. Shrilakshmi. S.

Research Collaboration

- St. Aloysius College, Mangalore
- Genelon Institute of Life sciences, Yelahanka, Bengaluru.
- Department of Chemistry, Manipal Institute of Technology, MAHE, Manipal.

14. THEORETICAL SCIENCES DIVISION

Mission and research progress Theoretical science seeks to unravel the scientific and mathematical structure underpinning Nature and Her physical laws, and how these relate to the macro-world in a testable way. The broad research areas of the Division include quantum many-body and mesoscopic physics, nanoscience, quantum information theory, quantum foundations and Solar physics. Currently, there are five PhD students in the group, Mr Rahul S, Mr Ranjith Kumar R and Mr Y R Kartik with Dr S. Sarkar and Mr Shrikant U and Mr Vinod N Rao with Dr R. Srikanth. Two students have already obtained their PhD with Dr. R. Srikanth, and a postdoc had worked under Dr S. Sarkar. The students were all hired under DST/SERB or DRDO projects. All of our former students have moved on either to postdoctoral work in eminent research groups or taken up faculty positions in a university.

The Doctoral Advisory Committee (DAC) members overseeing the current set of students are Prof. C. Sivaram (Emeritus, IIA, Bangalore), Prof. B. S. Ramachandra (Director, CFRCE, Benaluru), Prof. Rajeev Joshi (Dept. of Physics, Central University of Karnataka, Dharwad) and Dr S. K. Srivatsa (DEPA, Bengaluru), whose areas of expertise span theoretical astrophysics, black hole cosmology, soft condensed matter and crystallographic studies.

14.1 Mission & Goals

- Probing the nature of the quantum state by operational means including cryptography and measurement disturbance, rather than a specific ontological framework.
- Exploring the interplay of topology and interactions in light-matter systems, and its specific manifestations such as Zak-Berry phase
- Exploring theoretical and experimental issues pertaining to practical quantum information processing, in particular in the context of quantum open systems and quantum cryptography.
- Temporal and spatial analysis of Solar supergranulation.

Glimpses of Current Research

- Quantum criticality of geometric phase in coupled optical cavity arrays under linear quench
- Temporal self-similarity as a strong witness of quantum non-Markovianity
- Counterfactual quantum digital signatures
- Solitons and spin transport in an antiferromagnetic spin chain
- Generating non-Markovianity and even singularities by mixing Pauli qubit channels
- An interplay of topology and quantized geometric phase for two different symmetry-class Hamiltonians
- Fractal dimension of Solar supergranulation

14.2 Faculty Profile

Dr. Sujit Sarkar

Associate Professor

- E mail: sujit@poornaprajna.org
  sujit.tifr@gmail.com

http://www.ppisr.res.in/faculty/sujit-sarkar

BRIEF CV:

- Associate Professor, PPISR: Jan 2018--present

1) Assistant Professor, PPISR: 2007 -- 2017
2) Faculty Fellow, PPISR: 2005 -- 2007
3) IISc Physics Department (year 1997-1998)
4) Bar-Ilan University, Physics Department (year 1999-2000)
5) Max-Planck Institute, Germany as a Guest Scientist (year 2000-2002)
6) The Weizmann Institute of Science (year 2002-2005).
7) Associateship position at S. N. Bose National Centre for Basic Sciences (since 2016 and continue)
8) Visiting Scientist Positions: Tata Institute of Fundamental Research (Mumbai) National Centre for Theoretical Science (NCTS, Taiwan), Karl-shrue Institute of Technology, Germany.

RESEARCH INTERESTS:

(1). Quantum Many Body Physics and Quantum Field Theoretical Studies of Quantum Matter.
(2). Cavity Quantum Electrodynamics.
(3). Non-Equilibrium Statistical Physics.
(4). Quantum Phase Transition and Topological Quantum Phase Transition.
(5). Geometric Structure of Space-Time and Quantum Geometrical Tensor.
(6). Non-Hermitian Physics for Quantum Many Body System.
(7). Conformal Field Theory Study for Topological State of Matter.

RECOGNITIONS/ACHIEVEMENTS:
Seminars, Lectures, Workshops and Conferences:

(1). International Meeting on Many Body Localization at ICTS, November'2019.

(2). International Meeting on Quantum Phases for Quantum Matters, December'2019.

(3). Seminar given in ICTS on "Emergent of Parity-Time Symmetry at Quantum Criticality" on 21st February 2020, in Indian Statistical Physics Community Meeting.

(4). "Bangalore Statistical Physics School" at the ICTS, June (2019).

(5). Seminar: S. N. Bose Centre October'2019.

Current PhD students

- Mr. Rahul Sharma (JRF Student)
- Mr. Ranjith Kumar R (JRF Student)
- Mr. Y. R. Kartik (JRF Student)

CURRENT RESEARCH PROJECTS:

1. DST PROJECT: Topological States of Superconducting Nanowires and interacting light-matter systems at nano scales.
Principal Investigator: Sujit Sarkar
Project Students: Mr. Rahul Sharma (JRF Student), Mr. Ranjith Kumar R (JRF student).

Research Highlights:

(1). The Physics of different physical systems at nanoscale are interesting in their own right. This research project has few scientific objectivesfor answering fundamental questions currently debated in the literature onthe topological properties in superconducting nanowire and interacting light matter physics.

(2). The description of topological excitations like quantum phase slip center in disordered superconducting nanowire and the appearance of Berezinskii-Kosterlitz-Thouless transition in interacting light-matter physics areamong the most important problems of topological quantum phase transition.

(3). Find the relation between the topological invariant number and thephysical quantity of the system.

(4). The objective of this project is to find the answers of these questions*and if possible the interrelations between them.*

Published Papers in 2019-2020:

(1). An interplay of topology and quantized geometric phase for two different symmetry-class Hamiltonians
Rahul S, Ranjith Kumar R, Y R Kartik, Amitava Banerjee and Sujit Sarkar, Phys. Scr. 94 (2019) 115803 (12pp).

(2). Ranjith Kumar R & Sujit Sarkar (2020): Emergence of a new symmetry class for Bogoliubov–de Gennes (BdG) Hamiltonians: expanding 10-fold symmetry classes, Phase Transitions, DOI: 10.1080/01411594.2020.1723588 .

(3). A Study of Interaction Effects and Quantum Berezinskii- Kosterlitz-Thouless Transition in the Kitaev Chain: Sujit Sarkar, Nature Scientific Reports |(2020) 10:2299 | https://doi.org/10.1038/s41598-020-57796-z

(4). Quantum Berezinskii–Kosterltz–Thouless transition for topologicalinsulator: Ranjith Kumar R , Rahul S, Surya Narayan Sahoo and Sujit Sarkar
PHASE TRANSITIONS https://doi.org/10.1080/01411594.2020.1765349

(5). A Differential Geometric Study for Two Different SymmetryClasses of Hamiltonian: Y R Kartik, Ranjith Kumar R, Rahul S, and Sujit Sarkar
(accepted for publication in January'2020 in the conference proceedings of InternationalConference on Statistical Physics)

Current Academic Projects with Students and Collaborators:

1). Long range pairing and hopping of the Kitaev chain:
We analyze a generalization of the Kitaev chain for fermions with longrange p-wave pairing, which decays with distance as a power law with exponent. Using the integrability of the model, we demonstrate the existenceof two types of gapped regimes, where correlation functions decay exponentially at short range and algebraically at long range (alpha is greater than1 or purely algebraically (alpha is less than 1. Most interestingly, alongthe critical lines, long-range pairing is found to break conformal symmetryfor sufficiently small. For exponentially-decaying hopping amplitudes, thetopological sector can be significantly augmented as the penetration lengthincreases, something ex- perimentally achievable. For power-law decaying superconducting pairings, the massless Majorana modes at the edges get pairedtogether into a massive non-local Dirac fermion localized at both edges ofthe chain: a new topo- logical quasiparticle that we call topological massiveDirac fermion. This topological phase has fractional topological numbers asa consequence of the long-range couplings.

(2). Curvature function renormalisation, topological phase transitions and multicriticality:
A recently proposed curvature renormalization group scheme for topological phase transitions defines a generic curvature function as a function of the parameters of the theory and shows that topological phase transitionsaresignalled by the divergence of this function at certain parameters, calledcritical points, in analogy with usual phase transitions. A renormalizationgroup procedure was also introduced as a way of flowing away from the critical point towards a fixed point, where an appropriately defined correlationfunction goes to zero and topological quantum numbers char- acterisingthephase are easy to compute. In this paper, using an inversion symmetry broken model in one dimension as an example, we show that there are caseswhere the fixed point and the critical point appear to intersect, which turnout to be multi-critical points and focus on understanding its implications.

(3). Topological Phase transition Across Gapped Phases in presence of Dissipation:
We study the behavior of the non Hermitian extended Kitaev chain by introducing the dissipative term γ. We observe an emergence of a gapless regionbetween gapped topological phases during the topological phase transition.These gapless region can be characterized as topological and non- topological 1d semimetalic phase depending on whether it supports Majorana zeromodes (MZMs) or not. We calculate critical lines in presence of dissipativeterm and observe that these critical lines shift from their Hermitian ones

(4). A study of topological characterization and symmetries fora quantum simulated Kitaev chain:
An attempt is made to quantum simulate the topological classification,such as winding number, geometric phase and symmetry properties for aquantum simulated Kitaev chain. We find, α (ratio between the spin-orbitcoupling and magnetic field) and the range of momentum space of consideration, which plays a crucial role for the topological classification. We showexplicitly that the topological quantum phase transition does not occurs atk = 0 limit for the quantum simulated Kitaev chain. We show explicitlythat the quasi-particle mass of the Majorana mode plays the significant rolein topological quantum phase transition. We also show that the symmetryproperties of simulated Kitaev chain is the same with Kitaev chain. We alsofind the exact solution of simulated Kitaev chain. This work provides a newperspective on new emerging quantum simulator and also for the topologicalstate of matter.

Significant Publications:

(1). Sarkar, S. Quantum phase diagram of granular superconducting quantum dots (2008) Nuclear Phyics B 795, pp 569 -578

(2). Sarkar, S. Quantum Phase Diagram of a Spin-1/2 Antiferromagnetic Chain with Magnetic Impurities (2008), Nuclear Physics B 801, 346-354

(3). Sarkar, S. Quantum phases in superconducting quantum dots array (2007), Phys. Rev. B 75, 014528-014532.

(4). Sarkar, S. Quantum phase diagram of superconducting quantum dots array (2006), EuroPhysLett 76, 1172-1177.

(5). Sarkar, S. Critical and off-critical properties of an anisotropic (XYZ) spin 1/2 chain under a transverse magnetic field (2006), Phys. Rev. B 74 052410-74052418

(6). Sarkar, S. Physics of Majorana modes in interacting helical liquid (2016), Sci. Rep. 6, 30569 doi:10.1038/srep30569.

(7). Sarkar, S. Topological Quantum Phase Transition and Local Topological Order of Light in a One Dimensional Array of Nonlinear Cavities (2017), Sci. Rep. 7, 4159 doi:10.1038/srep41598

(8). Sarkar, S. Quantization of geometric phase with integer and fractional topological characterization in a quantum Ising chain with long-range interaction (2018) Sci Rep DOI:10.1038/s41598-018-24136-1.

(9). Sarkar, S. A Study of Interaction Effects and Quantum Berezinskii- Kosterlitz-Thouless Transition in the Kitaev Chain (2018) Sci Rep https://doi.org/10.1038/s41598-020-57796-z

Scientific Collaboration:

(1). Prof. C. D. Hu (The National Taiwan University).
(2). Prof. Masaki Tesuzaka (Tokyo, Japan).
(3). Prof. Igor Goryni (Karlshrue, Germany).
(4). Prof. M. Kumar (S. N. Bose Centre).
(5). Prof. ProsenjitSinghadeo (S. N. Bose Centre)
(6). Prof. Prabir Mukherjee

Dr. R. Srikanth

Associate Professor

E-mail:srik@poornaprajna.org

Homepage:http://www.ppisr.res.in/faculty/r-srikanth

BRIEF CV:

Associate Professor, PPISR: Jan 2018--present
Assistant Professor, PPISR: 2010 -- 2017
Faculty Fellow, PPISR: 2006 -- 2010
RA, Raman Research Institute, Bengaluru: 2003--2006
RA, CTS, IISc, Bengaluru: 2001--2003
RA, IIA, Bengaluru: 2000--2001

RESEARCH INTERESTS:
1. Quantum information theory: Memory effects in quantum channels; mixing of (non-)Markovian channels, counterfactual quantum cryptography; entanglement dynamics in two-qubit systems; noiseless quantum attacks on cryptography, quantum hacking and privacy amplification.

2. Foundations of quantum mechanics: Operational characterization of quantum state reduction and nonlocality; study and classification of entanglement of quantum identical particles;

3. Solar physics: Latitude and rotation dependence of Solar supergranular fractal dimension; magnetic activity level across the Solar cycle and supergranular structure.

4. Cognition: Free will, consciousness, Identity and individuation; quantum cognition, decision making.

RECOGNITIONS/ACHIEVEMENTS:

Various invited talks and lectures. Most recently:

Consciousness reconciles causality and free will. Nalanda Dialogue XIV: Nava Nalanda Mahavihara, Bihar, India. Jan 18, 2020

Convex combination of quantum channels. QFF2020, RRI, Bengaluru. Jan 14, 2020

Quantum information processing: a mini course. Faculty Development Program, Indian Institute of Technology, Jodhpur, Jodhpur, Rajasthan Aug 27--Sep 3, 2019
Quantum cryptography. QuNu Labs, Bengaluru. July 24, 2019
Quantum information processing: a brief invitation. Faculty Development Program, Reva University, Bengaluru July 23, 2019

Editor (Quanta, quanta.ws)
Reviewer (Entropy, Phys Rev A, Quantum Information Processing, PhysicaScripta, Int. J. Theoretical Physics, Quanta, etc.)

STUDENTS
Current PhD students
U. Shrikant
N. Vinod Rao
G. M. Sowmya (part-time, jointly with Prof U. Paniveni, shortly registering VTU)
G. Rajni (part-time, jointly with Prof U. Paniveni, shortly registering VTU)
M. Yamuna (part-time, jointly with Prof U. Paniveni)

PROJECT STUDENTS:
Revanth Badveli (BITS-Pilani, Goa)
Akash Kundu (LPU, Jalandhar)
Akshaya S. (LPU, Jalandhar)
Past PhD students
AmkarSrikrishna (2016)
S. Aravinda(2017)

PUBLICATIONS (in peer-reviewed international journals) : 7 papers

RESEARCH
CURRENT ACADEMIC PROJECTS:
1. Quantum non-Markovianity: characterization, measure and resources
Principal Investigator: Dr. R. Srikanth
Funding Agency: DST/SERB, India

2. Computational speedup in quantum mechanics and generalized probabilistic theories" --
Principal Investigator: Dr. R. Srikanth
Student: U. Shrikant
Funding agency: DST-SERB, India (just cmpleted)

Current projects:
Interplay of non-Markovianity and singularities in Pauli dynamical maps: Quantum non-Markovianity (even the eternal or quasi-eternal kind) can be produced by mixing Markovian channels, as recently observed by various authors. On the other hand, as shown here, singularities in the generator of a general Pauli dynamical map cannot

be produced by mixing Pauli channels that lack a singularity. Interestingly, mixing the channels that individually possess singularities can lead to an elimination of any singularity in the resultant dynamical map. Finally, an arbitrary Pauli dynamical map may not be obtainable by mixing individual Pauli evolutions. We prove and illustrate these ideas with a few simple examples. Noiseless attacks on a class of quantum key distribution protocols: In a quantum key distribution (QKD) protocol, a fraction of the sifted bits is publicly agreed upon by the sender (Alice) and receiver (Bob) to estimate error rate e in the quantum channel. If e is not too large, then the sifted key is error-corrected and subsequently subjected to privacy amplification (PA), whereby Alice and Bob distill a final, smaller key about which the potential eavesdropper (Eve) has exponentially little knowledge. Implicit in this is the inverse idea that if $e=0$, then PA is not required. Here, to the contrary, we show that for a class of QKD protocols, specifically those involving interaction-free measurement, the eavesdropper can obtain partial information without introducing any error. Thus, PA is required even in the noiseless case.

Ping-pong quantum key distribution with trusted noise: non-Markovian advantage: The Ping-pong protocol adapted for quantum key distribution is studied in the trusted quantum noise scenario, wherein the legitimate parties can add noise locally. For a well-studied attack model, we show how non-unital, quantum non-Markovianity of the added noise can improve the key rate. We also point out that this noise-induced advantage cannot be obtained by Alice and Bob by adding local classical noise to their post-measurement data.

Mixing Markovian Pauli channels which are not semigroups: Conventionally, non-Markovianity is indicated by CP-indivisibility. There are good reasons, both historical and structural, for regarding the quantum dynamical semigroup as the quintessential quantum Markovian channel. Yet, we will find in the context of mixing the three Pauli channels, that the closer the three mixing components are to the semigroup form, counterintuitively, the larger is the measure of the non-Markovian channels produced by the mixing.

On entangled correlations and not-completely-positive maps: The problem of conditions on the initial correlations that lead to CP or NCP maps has been debated or studied by various authors. Here we point out that the problem is fundamentally concerned with an interplay between the initial correlations and the unitary applied. In particular, for any initial correlated state (barring maximal entanglement) |Y>_SE, one can furnish a two-body unitary U_SE that generates CP dynamics on the system S by tracing out the environment E, and for any given interaction unitary U_SE'one can furnish an entangled correlated state |Y'>_SE such that the action of the latter unitary generates CP reduced dynamics on S. We study the general conditions under which this is possible.

Temporal self-similarity of quantum dynamical maps as a concept of memorylessness: The problem of defining quantum non-Markovianity has proven elusive, with various in-equivalent criteria put forth to address it. The concept of CP-indivisibility and the hierarchy of stronger divisibility criteria going up to P-indivisibility, capture a fundamental aspect of memory in quantum non-Markovianity. In practice, however, there can be a memory-like influence associated with divisible channels in the form of weakening, if not reversing, the effects of

decoherence. Arguably, such a facet of memory relates to CP-indivisibility as quantum discord relates to entanglement. We concretize this weaker notion of non-Markovianity by identifying it with deviation from ``temporal self-similarity'', the property of a system dynamics whereby the propagator between two intermediate states is independent of the initial time t_0. We illustrate this idea through examples, and propose a geometric quantification of temporal self-similarity, and show how our approach complements the divisibility-based criterion of quantum non-Markovianity.

Highlights

1. The previous DRDO project on the feasibility of semi-counterfactual quantum key distribution is being followed up with DRDO for a theoretical study of the finite key analysis as well as an experimental work on setting up a prototype of the above key distribution system.
2. A patent filing is underway to design an inexpensive quantum randm number generator by exploiting machine learning techniques, along with Prof K. Sateesh and Mr Karthik Joshi.
3. PPISR web site has been fully revamped in coordination with the newly appointed webmaster Mr. Pushpak.
4. Efforts were undertaken so that Prof. Paniveni Udayashankar has been inducted as an Honorary Professor in the Theoretical Sciences, whilst Prof Sisir Roy, Prof Debajyoti Gangopadhyay and Prof K. Sateesh have been indicated as Adjunct Professors in the Center for Foundational Study.
5. Initiated activities of the “Center for Applicable Mathematics and Sciences” (CAMS), a PPISR forum for trans-disciplinary research, under which Prof K Sateesh presented a talk on machine learning and artificial intelligence (ML / AI).

15. PPISR PATENTS/PUBLICATIONS (2019-20)

PATENTS (2019-20)

US and Indian Patents Granted
a) US 10519387 B2 (granted) "Catalyst composition for converting light naphtha to aromatic compounds and a process thereof" Assignee: HPCL R&D Centre, Bengaluru invented by Ravishankar Raman, Peddy Venkat Chalapathi Rao, Nettem Venkateswarlu Choudary, Shanbhag Ganapati, Janardhan Hodala, Halgeri Anand &GandhamSriganesh Grant date: December 31, 2019.

b) Indian Patent No. 329546(Granted) "Catalyst composition for converting light naphtha to aromatic compounds and a process thereof" Assignee: HPCL R&D Centre, Bengaluru invented by Ravishankar Raman, Peddy Venkat Chalapathi Rao, NettemVenkateswarluChoudary, Shanbhag Ganapati, Janardhan Hodala, Halgeri Anand &Gandham Sriganesh Grant date: January 16, 2020

PUBLICATIONS: (2019-20)

1. Mugaranja, Kirana.P., Kulal, Ananda. Alpha glucosidase inhibition activity of phenolic fraction from Simarouba glauca: An in-vitro, in-silico and kinetic study (2020) Heliyon, 6(7), e04392. doi:10.1016/j.heliyon.2020.e04392.

2. Naik, N.N., Padaki, M., Déon, S., Murthy, D. H. K. Novel poly (ionic liquid)-based anion exchange membranes for efficient and rapid acid recovery from industrial waste (2020) Chemical Engineering Journal, vol. 401, art. No 126148

3. RevanthBadveli, Vinayak Jagadish, R. Srikanth and Francesco Petruccione. Compressed-sensing tomography for qudits in Hilbert spaces of non-power-of-two dimensions. (2020) Phys. Rev. A 101, 062328 (2020); On arXiv: arXiv:2006.01803

4. Vinayak Jagadish, R. Srikanth and Francesco Petruccione. Convex combinations of Pauli semigroups: Geometry, measure, and an application (2020) Phys. Rev. A 101, 062304; On arXiv: arXiv:1910.04114

5. Nagendra Kulal, Crowny John, Ganapati V. Shanbhag Rational design of bifunctional catalyst from KF and ZnO combination on alumina for cyclic urea synthesis from CO2 and diamine (2020) Applied Catalysis A, General, 598, 117550

6. Pandian Manjunathan, Ganapati V. Shanbhag (Book Chapter) Application of tin oxide-based materials in catalysis (2020) Tin Oxide materials-Synthesis, properties, and applications (Elsevier), pp. 519-553

7. Sathyapal R Churipard, Kempanna S Kanakikodi, Dheer A Rambhia, Ch Siva Kesava Raju, AB Halgeri, Nettem V Choudary, Gandham Sri Ganesh, Raman Ravishankar, Sanjeev P Maradur Porous polydivinylbenzene (PDVB) as an efficient adsorbent for hydrocarbons: Effect of porogens on adsorption capacity (2020) Chemical Engineering Journal, 380, 122481

8. Sathyapal R. Churipard, Kempanna S. Kanakikodi, Nileena Jose and Sanjeev P. Maradur Tuning Acidity in Sulfonated Mesoporous Polymer (MP-SO3H) for Efficient Tetrahydropyranylation of Alcohols at Room Temperature (2020) Chemistry Select 5, 293

9. Churipard, S.R., Kanakikodi, K.S., Rambhia, D.A., Raju, C.S.K., Halgeri, A.B., Choudary, N.V., Ganesh, G.S., Ravishankar, R., Maradur, S.P. Porous polydivinylbenzene (PDVB) as an efficient adsorbent for hydrocarbons: Effect of porogens on adsorption capacity (2020) Chemical Engineering Journal, 380, art. no. 122481

10. Revanth, B., Vinayak Jagadish, Akshaya S., Srikanth, R., Petruccione, F. Dynamics of quantum correlations in a Qubit-Oscillator system interacting via a dissipative bath (2020) Open Systems & Information Dynamics, 27, 2050004 (2020).

11 Churipard, S.R., Kanakikodi, K.S., Jose, N., Maradur, S.P. Tuning Acidity of Sulfonated Mesoporous Polymers (MP−SO3H) for Efficient Tetrahydropyranylation of Alcohols at Room Temperature (2020) Chemistry Select, 5 (1), pp. 293-299.

12. Munirathnappa, A.K., Maurya, S.K., Kumar, K., Navada, K.K., Kulal, A., Sundaram, N.G. Sheelite like NaTb(WO4)2 nanoparticles: Green fluorescence and in vitro cell imaging applications (2020) Materials Science and Engineering C, 106, art. no. 110182

13. Kundapura, S.V., Ramagopal, U.A. The CC′ loop of IgV domains of the immune checkpoint receptors, plays a key role in receptor: ligand affinity modulation (2019) Scientific Reports, 9 (1), art. no. 19191

14. Munirathnappa, A.K., Neuefeind, J.C., Yanda, P., Sundaresan, A., Kityk, I.V., Ozga, K., Jedryka, J., Poornesh, P., Rao, A., Sundaram, N.G. Average Structure, Local Structure, Photoluminescence, and NLO Properties of Scheelite Type NaCe(WO4)2 (2019) Crystal Growth and Design, 19 (11), pp. 6082-6091.

15. Kulal, N., Vasista, V., Shanbhag, G.V. Identification and tuning of active sites in selected mixed metal oxide catalysts for cyclic carbonate synthesis from epoxides and CO2 (2019) Journal of CO2 Utilization, 33, pp. 434-444.

16. Kanakikodi, K.S., Churipard, S.R., Halgeri, A.B., Maradur, S.P. Catalytic tertiary butylation of phenol over sulfonated mesoporous polymer catalyst (MP-SO3H): Exceptional selectivity towards 2,4-di-t-Butylphenol (2019) Microporous and Mesoporous Materials, 286, pp. 133-140.

17. Gangopadhyay, D., Srikanth, R. Contextuality and nonlocality of indistinguishable particles (2019) PhysicaScripta, 94 (12), art. no. 125101

18. Aravinda, S., Pathak, A., Srikanth, R. Hierarchical axioms for quantum mechanics (2019) European Physical Journal D, 73 (9), art. no. 207

19. Rahul, S., Ranjith Kumar, R., Kartik, Y.R., Banerjee, A., Sarkar, S. An interplay of topology and quantized geometric phase for two different symmetry-class Hamiltonians (2019) PhysicaScripta, 94 (11), art. no. 115803

20. Pereira Dos Santos, L., Flores-Sahagun, T.S., Paredes, R.S.C., Satyanarayana, K.G., BozzFerla, S.M. Study on the deposition of stainless steel on polymeric substrates by arc electric thermal spraying (2019) Materials Research Express, 6 (10), art. no. 105314

21. Jebarathinam, C., Das, D., Kanjilal, S., Srikanth, R., Sarkar, D., Chattopadhyay, I., Majumdar, A.S. Superunsteerability as a quantifiable resource for random access codes assisted by Bell-diagonal states (2019) Physical Review A, 100 (1), art. no. 012344

22. Kalusuraman, G., Siva, I., Aslan, M., Anandkumar, S., Satyanarayana, K.G. Evaluation of surface pre-treatments on the surface characteristics modifications in sponge gourd (Luffa Cylindrica) fibers (2019) Materials Research Express, 6 (9), art. no. 095106

23. Jagadish, V., Srikanth, R., Petruccione, F. Measure of not-completely-positive qubit maps: The general case (2019) Physical Review A, 100 (1), art. no. 012336

24. Rodríguez Anda, R., Koch, G., Richter, H.-G., Fuentes Talavera, F.J., Silva Guzmán, J.A., Satyanarayana, K.G. Formation of heartwood, chemical composition of extractives and natural durability of plantation-grown teak wood from Mexico (2019) Holzforschung, 73 (6), pp. 547-557.

25. Bakuru, V.R., DMello, M.E., Kalidindi, S.B. Metal-Organic Frameworks for Hydrogen Energy Applications: Advances and Challenges (2019) ChemPhysChem, 20 (10), pp. 1177-1215.

26. Jalageri, M.D., MalgarPuttaiahgowda, Y., Parambil, A.M., Kulal, A. Design of multifunctionalized piperazine polymer and its activity toward pathogenic microorganisms (2019) Journal of Applied Polymer Science, 136 (19), art. no. 47521

27. Shanbogh, P.P., Petwal, V.C., Dwivedi, J., Rao, A., Sundaram, N.G. High-Energy Electron-Beam-Induced Evolution of Secondary Phase and Enhanced Photocatalytic Activity in Monoclinic BiEuWO6 Nanoparticles (2019) Journal of Physical Chemistry C, 123 (17), pp. 10881-10892.

28. Saha, S.K., Dey, D., Roy, M.S., Sarkar, S., Kumar, M. Characterization of Majorana-Ising phase transition in a helical liquid system (2019) Journal of Magnetism and Magnetic Materials, 475, pp. 257-263.

29. Navada, K.K., Kulal, A. Enzymatic degradation of chloramphenicol by laccase from Trameteshirsuta and comparison among mediators (2019) International Biodeterioration and Biodegradation, 138, pp. 63-69.

30. Nagaraja, A., Puttaiahgowda, Y.M., Kulal, A., Parambil, A.M., Varadavenkatesan, T. Synthesis, Characterization, and Fabrication of Hydrophilic Antimicrobial Polymer Thin Film Coatings (2019) Macromolecular Research, 27 (3), pp. 301-309.

31. Kolangare, I.M., Isloor, A.M., Karim, Z.A., Kulal, A., Ismail, A.F., Inamuddin, Asiri, A.M. Antibiofouling hollow-fiber membranes for dye rejection by embedding

chitosan and silver-loaded chitosan nanoparticles (2019) Environmental Chemistry Letters, 17 (1), pp. 581-587.

32. Jagadish, V., Srikanth, R., Petruccione, F. Measure of positive and not completely positive single-qubit Pauli maps (2019) Physical Review A, 99 (2), art. no. 022321

33. Shenoy, A.H., Srikanth, R. Maximally nonlocal subspaces (2019) Journal of Physics A: Mathematical and Theoretical, 52 (9), art. no. 095302

34. Munirathnappa, A.K., Dwibedi, D., Hester, J., Barpanda, P., Swain, D., Narayana, C., Sundaram, N.G. In Situ Neutron Diffraction Studies of LiCe(WO 4) 2 Polymorphs: Phase Transition and Structure-Property Correlation (2019) Journal of Physical Chemistry C, 123 (2), pp. 1041-1049.

35. Navada, K.K., Kulal, A. Enhanced production of laccase from gamma irradiated endophytic fungus: A study on biotransformation kinetics of aniline blue and textile effluent decolourisation (2019) Journal of Environmental Chemical Engineering, .

36. Bakuru, V.R., Churipard, S.R., Maradur, S.P., Kalidindi, S.B. Exploring the Brønsted acidity of UiO-66 (Zr, Ce, Hf) metal-organic frameworks for efficient solketal synthesis from glycerol acetalization (2019) Dalton Transactions, 48 (3), pp. 843-847.

37. Bakuru, V.R., Davis, D., Kalidindi, S.B. Cooperative catalysis at the metal-MOF interface: Hydrodeoxygenation of vanillin over Pd nanoparticles covered with a UiO-66(Hf) MOF (2019) Dalton Transactions, 48 (24), pp. 8573-8577.

38. Casillas, R.R., López, M.C.L., Aguilar, B.B., Olivares, F.D., Satyanarayana, K.G. Preparation and characterization of cellulose nanocrystals using soluble grade cellulose from acid hydrolysis of Huizache (Acacia farnesiana L. Willd.) (2019) BioResources, 14 (2), pp. 3319-3338.

39. Casillas, R.R., López, M.C.L., Aguilar, B.B., Olivares, F.D., Satyanarayana, K.G. Obtaining dissolving grade cellulose from the huizache (Acacia farnesiana L. Willd.) plant (2019) BioResources, 14 (2), pp. 3301-3318.

40. DMello, M.E., Sundaram, N.G., Singh, A., Singh, A.K., Kalidindi, S.B. An amine functionalized zirconium metal-organic framework as an effective chemiresistive sensor for acidic gases (2019) Chemical Communications, 55 (3), pp. 349-352.

41. Shanbogh, P.P., Petwal, V.C., Dwivedi, J., Rao, A., Sundaram, N.G. High-Energy Electron-Beam-Induced Evolution of Secondary Phase and Enhanced Photocatalytic Activity in Monoclinic BiEuWO 6 Nanoparticles (2019) Journal of Physical Chemistry C.

42. Lengowski, E.C., Bonfatti Júnior, E.A., NishidateKumode, M.M., Carneiro, M.E., Satyanarayana, K.G. (Book Chapter) Nanocellulose-reinforced adhesives for wood-based panels (2019) Sustainable Polymer Composites and Nanocomposites, pp. 1001-1025.

43. Lengowski, E.C., Bonfatti Júnior, E.A., NishidateKumode, M.M., Carneiro, M.E., Satyanarayana, K.G. (Book Chapter) Nanocellulose in the paper making (2019) Sustainable Polymer Composites and Nanocomposites, pp. 1027-1066.

44. Sunil Kumar, A., Kudva, J., Bharath, B.R., Ananda, K., Sadashiva, R., Madan Kumar, S., Revanasiddappa, B.C., Kumar, V., Rekha, P.D., Naral, D. Synthesis, structural, biological and in silico studies of new 5-arylidene-4-thiazolidinone derivatives as possible anticancer, antimicrobial and antitubercular agents (2019) New Journal of Chemistry, 43 (3), pp. 1597-1610.

Book Chapter

Manjunathan, P., Shanbhag G. V. (Book Chapter) "Application of tin oxide based materials in catalysis (2020) *Tin Oxide Materials--Synthesis, Properties, and Applications*, (Elsevier) pp. 519-553

E-Book Contribution

Dr. Ganapati Shanbhag was invited by C & EN Brand Lab, A subsidiary of ACS to contribute for an E-Book "The Case for Colloidal Silica-How its versatile chemistry can improve diverse products and processes". It is Sponsored by W R Grace & Co a leading manufacturer of especially chemicals and Catalyst technologies. The e-book is published in January 2020.

16. New Recruitments

Faculty: Dr. D. H. K. Murthy joined PPISR as an Assistant Professor to work in the division of Materials Sciences and Catalysis.

Students

1) Ms. Chaitra Mallannavar, joined Dr. Shanbhag's group as a Research Fellow under HPCL sponsored project
2) Ms. Bhavana Kulkarni has joined Dr. Maradur's group as a Research Fellow
3) Mr. Puneeth Kumar joined Dr. Maradur's group as a Project Fellow
4) Mr. Akshaya Bhat has joined Dr. Ramgopal's group as a Junior Research Fellow
5) Ms. Salima Parvin has joined Dr. Ramgopal's group as a Junior Research Fellow
6) Ms. Shrinidhi Patil, BE (Chemical Engineering) joined PPISR as Research Engineer in to work under the guidance of Dr. Ganapati Shanbhag in a project sponsored by HP Green R & D Centre.

17. HIGHLIGHTS OF RESEARCH ACTIVITIES & ACHIEVEMENTS

Ms. Kavitha K N, who was pursuing research work under the guidance of Dr. Ananda K, submitted her Ph.D. thesis titled "Studies on effect of radiation on laccase producing on endophytic fungi and applications of fungal laccase" to MAHE, Manipal and has been awarded PhD degree.

Mrs Pavithra G C who carried out research work under the guidance of Dr. Ramagopal submitted her thesis titled "Structural Studies of Purine Phosphoribosyl transferases From Pathogenic Bacteria" and was awarded doctoral degree by MAHE, Manipal.

Mr. Pradeep P Shanbogh, who carried out research work under the guidance of Dr, Nalini G Sundaram submitted his thesis titled "Semiconducting Oxide Nanoparticles: Band Gap Engineering, Photocatalysis And Photoluminescence Studies" and has been awarded doctoral degree by MAHE, Manipal.

Mr. Bakuru Vasudeva Rao who was pursuing his research work under the guidance of Dr. Suresh Babu Kalidindi submitted his thesis tilted "Metal-Organic Frameworks MOFs) and their Nanohybrids for Synergetic Heterogeneous Catalysis" to Manipal Academy of higher Education (MAHE) and has been awarded PhD degree.

Mr. Nagendra Kulal, Mrs. Vaishnavi B. J. and Ms. Marilyn DMello, have been awarded the prestigious CSIR Senior Research Fellowships.

Mr. Shankar V Kundapura has been awarded with DST-PhD Fellowships by Karnataka Science and Technology Promotion Society (KSTePS)

Ms. Marilyn E. DMello won Best Poster Presentation award for the poster titled, "Design and Development of Metal-Organic Framework based Materials for Gas Sensing Applications"at Nano India- Biennial National Conference 2019, held at Mahatma Gandhi University, Kottayam, Kerala. (26th -27th April 2019).

Ms. Vaishnavi B. J. received 1st prize for Best ORAL presentation at 3-days International conference on "Emerging Trends in Catalysis" at Vellore Institute of Technology – Vellore campus, held during January 6-8, 2020, where Nobel laureate Robert Grubbs was the Chief Guest. on January 6-8 2020. This conference was organized in association with Royal Society of Chemistry (RSC), UK. She also **received e-Book voucher of EURO 100 from Springer** for winning this award.

Mr. Nagendra Kulal and Ms. Vaishnavi BJ won Best ORAL presentation awards separately at National Conference on "Frontiers of Catalysis Science & Technology and its applications" held at St. Joseph's College, Bengaluru on January 10-11, 2020.

Ms. Chethana A. won Best ORAL Presentation awardfor the topic titled "*Selective gas sensing of low concentration SO2 gas using perovskite oxides*"at "International Conference on Advances in Chemistry (ICACSEM-2020) organized by University of Madras, Chennai held during the 9th and 10th of January 2020.

Ms. Archana received the Best ORAL presentation award for the topic tilted *"LiLa(WO$_4$)$_2$ Polymorphs for Nonlinear Applications: In-situ Neutron Diffraction Study"*at ICMAT-2020 (2nd International conference on Advanced Materials & Technology) at JSS Science & Technology University, Mysore from January 16-18, 2020.

Mr. Nagendra Kulal has won Best POSTER presentationawardat11th Bengaluru India Nano, A prestigious International Conference on theme New Dimensions in Nano Science & Technology for his presentation on "*Transition metal doped CeO$_2$*

nanorod as efficient catalyst for the direct carbonylation of glycerol with CO_2" Nagendra Kulal & Ganapati Shanbhag. held during March 2-3, 2020.

Mrs. Vaishnavi B. J. won Best Seminar award for 2018-2019 for her presentation on "Hydrogen production from Biomass" on June 14, 2019 evaluated among the research scholars for **PPISR weekly semiar Series 2018-2019**. She received the award during Founder's Day programme on July 5, 2019.

Ms. Chethana A. research scholar, visited ElettraSincrotrone Facility, Trieste, Italy to carry out experiments from 13th to 22nd December 2019.

Mr. Shankar Kundapura visited Trieste, Italy, for conducting the experiment during first week of October 2019.

Karnataka Bank Limited has provided the financial support of Rs. 25 lakhs for installation of Solar Power Plant at PPISR under the Bank's CSR initiative scheme.

18. CONFERENCES/SEMINARS/WORKSHOPS

1. Ms. Shrilakshmi S presented a poster titled "Chemical modification and bioconjugation of insulin for therapeutic applications" in the Manipal research colloquium held from April 1st-3rd organized MAHE, Manipal.

2. Mr. Kirana M. P. presented a poster titled " Studies on alpha glucosidase inhibitors isolated from medicinal plants and their endophytic fungi " in the Manipal research colloquium held from April 1st-3rd organized MAHE, Manipal.

3. Mr. Nagendra Kulal presented a poster titled "Chemical fixation of CO_2 by converting into value-added chemicals using heterogeneous catalysts" in "Manipal Research colloquium-2019" 1-3rdApril 2019 in Manipal.

4. Dr. A B Halgeri gave a talk on "Nanocatalytic materials for Chemical industry application from Concept to commercialization" at Webminar on Nanotechnology organized by KSTePS in association with Austrian Trade Commission & IISc.

5. Dr Maradur gave an invited talk on ""Beyond Silica: Mesoporous Polymers, A New Class of Advanced Structured Materials for Catalytic Applications" during One Day Symposium on Advances in Chemical Sciences conducted by PPISR in collaboration with Reva University on 9th April 2019.

6. Dr. Halgeri was invited as the Guest of Honour for the Inauguration of International Conference on Advances in Materials Research, 25 to 27th July 2019 in Ramaiah University of Applied Sciences, Bengaluru

7. Dr. Sujit and his group attended the Discussions Meeting on " Edge Dynamics of Quantum Matter" at ICTS, Bangalore from 10th to 14th June'19.

8. Dr. Sujit and his group attended the "Bangalore Statistical Physics School" at ICTS, Bangalore from 17th to 28th June'19

9. Dr. Halgeri presided over the valedictory function and also acted as moderator for a panel discussion for International Conference on Advances in Materials Research on 27th July 2019 in Ramaiah University of Applied Sciences, Bengaluru

10. Nagendra Kulal gaveOralpresentationtitled "Utilization of CO_2 by converting into dialkylurea via carbonylation reaction using Ni-Sn mixed oxide catalyst" in International Conference on Advances in Materials Research, 25 to 27th July 2019 in Ramaiah University of Applied Sciences, Bengaluru

11. Dr Maradur Delivered a talk in FDP Program on "Scope and Significance of Materials Science for Industry-Academia Collaboration" at Ramaiah Institute of Technology Bengaluru on 29th July 2019

12. Dr. Halgeri gave an inaugural lecture on "Application of Advanced Catalytic Materials in Chemical Industry" at the Faculty Development Programme organized by Ramaiah Institute of Technology, Bangalore.on August 5, 2019

13. Dr. A B Halgeri gave a talk on " Biorefinery : Current Status or research strengths" at KSTA on September 7, 2019

14. Archana K. M. gave Poster presentationon"Upconversion Fluorescence in $NaLa(WO_4)_2:Yb^{3+}/Er^{3+}$ Nanoprobes: Synthesis and Computational studies for *in vitro*Bio-imaging Applications" and Participatedin hands on training in*Bangalore Microscopy Course* (BMC-2019) jointly conducted by C-CAMP, inStem and NCBS during 15th -22nd September, 2019 in NCBS, Bengaluru.

15. Dr. A B Halgeri gave a talk on "Novel Catalytic Material and its application to Chemical Manufacturing Process" at RV College of Engineering on September 26, 2019

16. Dr. A B Halgeri gave a lecture on "Relevance of Catalytic Chemistry in Chemical Industry" at Bangalore University on October 17, 2019

17. Dr. A B Halgeri gave a lecture on Recent Advances in Catalysis on Sustainable Chemistry at Vijaya College on October 18, 2019.

18. Dr. Maradur Delivered an invited talk in one day work shop on "Heterogeneous catalysis in organic synthesis: Concepts and Industrial applications" organized by Vijaya college, Bangalore on 18th October 2019.

19. Mrs. Swetha has attended a two-day workshop on “Indo-Italian Elettra beamline user meeting and workshop” at AIIMS, NewDelhi on November-11th and 12th, 2019.

20. Dr. A B Halgeri gave a lecture on “Recent Developments & Commercialization in Petroleum and Petrochemical catalysts – An Indian Scene” National Training Course on “Prerequisites to Recent Advances in Catalysis”. Held at Kasrgode on December 16, 2019.

21. Dr A B Halgeri gave a talk on Mesoporous materials for clean energy technology at Central University of Kerala on December 17, 2019.

22. Dr. Ganapati Shanbhag was invited to present a lecture on “Biomass – Role of catalysts for its conversion into energy and chemicals” at Central University of Kerala, Kasargod during “National Training Course” on “Prerequisites to Resent Advances in Catalysis” held from December 16 to 20, 2019.

23. Dr. Maradur Delivered an invited talk in one day Lecture Workshop on “Heterogeneous Catalysis in Organic Synthesis: Concepts and Industrial Applications” Vijaya College Bengaluru 18th October 2019.

24. Dr. Maradur delivered an invited talk in biannual lectures on Advanced Materials conducted by CMR Institute of Technology Bengaluru on 14th November 2019

25. Dr. Maradur delivered an invited talk in Research Orientation Workshop for PP College Students Udupi Physics, Chemistry and Biology conducted at PPISR Bengapuru on December 2-7, 2019.

26. Dr. Ganapati Shanbhag gave a lecture on “"Concept and importance of heterogeneous catalysis in modern day research" in Research Orientation Workshop 2019 organized by PPISR for undergraduate students during 2-7, December 2019.

27. Mr. Nagendra Kulal gavea talktitled “Instrumental techniques for materials characterization” in Research Orientation Workshop 2019 for undergraduate students during 2-7, December 2019.

28. Ms. Archana K. M. gave a lecture on title “Overview of Nanomaterials: Significance and Applications” to undergraduate students during Research Orientation Workshop (ROW) 2-7 December-2019.

29. A talk on "Two dimensional materials: An overview" was given by Ms. Marilyn D Mello during Research Orientation Workshop (ROW) 2-7 December-2019 to undergraduate students.

30. Mrs. Swetha delivered a talk on Introduction To Recombinant DNA Technology And Molecular Biology Techniques in Research orientation workshop- 2019 at PPISR

31. Mrs. Swetha was invited as a judge to evaluate science exhibition at Vihan public school

32. Dr. Sujit Sarkar and his group attended International Workshop/Meeting at ICTS . "Thermalization, Many Body Localization and Hydrodynamics" in November 2019.

33. Dr Sujit and his group attended the "Novel Phases of Quantum Matter"InternationalWorkshop/Meetingat ICTS, December 2019.

34. Mr. Sujith S. gave an oral presentation on "*Aromatization of C_5 -rich light naphtha from refinery over non-zeolitic solid acid catalysts*" at National Conference on Frontiers of Catalysis Science & Technology and its applications held at St. Joseph's College, Bengaluru on January 10-11, 2020. This work was conducted in collaboration with HP Green R & D Centre, Bengaluru.

35. Mr. Sathyapal gave an oral presentation at "National conference on frontiers of catalysis science and technology and its applications. Hosted by the department of chemistry, St. joseph's college in association with catalysis society of India, Bangalore Chapter.

36. Dr. Ganapati Shanbhag delivered the prestigious "Late krishna T. Bhagwat Memorial Endowment Lecture Series" on 10-2-2020 at Dr. A. V. Baliga College of Arts & Science, Kumta.

37. Dr. A B Halgeri was invited as the Chief Guest for"ANALYST-2K20" a one-day National Level Intercollegiate Chemistry Fest which was organized by the Department of Postgraduate Studies and Research in Chemistry of St Aloysius College, Mangaluru on 20th of February, 2020.

38. Dr. A B Halgeri gave a talk on "Development of Novel Mesoporous Catalysts for Biomass Conversion to Clean Energy and Chemicals"at the One Day National Conference on "Advances in Chemical Sciences and Technology for Environment and Sustainability" (ACSTES-2020) which was held at SV National Institute of Technology Surat on 27th February, 2020.

39. Dr. Murthy gave a talk on "Large-area photocatalyst panels for solar H_2 production using aluminum-doped $SrTiO_3$: Insights from spectroscopy on material design" charge carrier dynamics in nanomaterials studied using time-resolved laser spectroscopy" at Jain University, global campus near Kanakapura on 27th February, 2020.

40. Dr. Murthy gave a talk on “Ultrafast charge carrier dynamics in nanomaterials revealed using time-resolved laser spectroscopy” at Raman Research Institute (RRI), Bangalore on 10th March, 2020.

41. Dr. Murthy gave an Oral presentation at VTU campus, near Chikkaballapura on 12th March, 2020. The title of the talk was “Large-area photocatalyst panels for solar H_2 production using aluminum-doped $SrTiO_3$”

42. Mr. Kempanna attended the International Conference on Advances in Chemistry with specific reference to Catalysis, Sensors, Drug Delivery and Energy Materials (ICACSEM) attended – 9th – 10th January 2020 was hosted by physical chemistry department, University of Madras and he has given a oral presentation.

43. Dr. Ananda K, conducted one day workshop on “Culturing of microorganisms and antimicrobial activity” for the PUC students of Govt. Pre University College, Hiriyadka, Udupi on February 29, 2020. It was covered in daily news Udayavani: - http://epaper.udayavani.com/ArticlePage/APpage.php?edn=sudina(Udupi)&articleid=UVANI_SUDP_20200307_5_13

44. Dr. Ananda K actively participated in 3 days conference on “New Dimensions in Nanoscience and Nanotechnology for industry 4.0” at “11thBengaluru INDIA NANO 2020” on March 4-6, 2020.

45. Dr. Sujit gave a talk on “Physics of Interacting Quantum BKT "atTheoretical Physics Department of IMSc.

46. Dr. Sujit gave a talk on " Physics of Interacting Quantum BKT " atPhysics Department of IIT Madras (Chennai).

19. INVITED LECTURES

1. Ms. Anushka Durg, CFRCE gave a talk on “Physics of Black Holes” on April 15, 2019

2. Prof K R Krishnamurthy, IIT-Madras, Chennai gave an invited lecture on “Conversion of Ethanol to Higher Carbon Number Alcohols” May 2, 2019

3. Prof. Tabish Qureishi, Professor, JMI, Delhi, delivered a lecture on "Momentum Kicks in Double-Slit Interference" on June 26, 2019.

4. Mr. Vasudevan gave a lecture, demo and interaction “Health, Fitness and the Benefits of Exercises & Nutrition” on September 20, 2019

20. IN-HOUSE SEMINARS

1. Title: "Safety at PPISR: Good Laboratory and Housekeeping for Safe working environment"
   Speaker: Dr. Sanjeev P. Maradur Date: April 5, 2019

2. Title: Chemiresistive Hydrogen Gas Sensors
   Speaker: Ms. Marilyn DMello Date: May 24, 2019

3. Title: : Homogeneous Catalysis: New Paradigms and Importance in Present Day Research
   Speaker: Dr. Ganapati Shanbhag Date: May 31, 2019

4. Title: Hydrogen Production From Biomass
   Speaker: Mrs. Vaishnavi B. J. Date: June 14, 2019

5. Title Factals and Chaos Theory: Repetitive but never boring!
   Speaker: Mr. Rahul Shrma, Date: June 21, 2019

6. Title: Am I Missing The Point?
   Speaker: Dr. R Vetrivel Date: July 19, 2019

7. Title: Topological Quantum Systems and Majorana Zero Modes
   Speaker: Mr. Rahul Sharma Date: July 23, 2019

8. Title: A Mathematical approach to Majorana fermion understanding: Based on Advanced Quantum Mechanics
   Speaker: Dr. Sujit Sarkar Date: August 16, 2019

9. Title: The blocks & chains of P2P systems
   Speaker: Mr Vinod Rao Date: September 6, 2019

10. Title: Metal induced crystallization of proteins
    Speaker: Dr. Pavithra G C Date: September 13, 2019

11. Title: Evolution of solar cells, emerging trends and future directions
    Speaker: Ms. Chethana Date: September 24, 2019

12. “Title: The RAFT hypothesis that neither sails nor sinks: Can crystallography shed new lights?”
    Speaker: Ms. Swetha Lankipalli Date: October 11, 2019

13. Title: Organic Synthesis in Unconventional Solvents: Exploring the Potential of Water as a Greenest Solvent"
    Speaker: Mr. Sathyapal R., Date: November 8, 2019

14. Title: Metabolic engineering of plant natural products in microbial cells
    Speaker: Mr. Kirana M P Date: November 13, 2019

15. Title: Revisiting Darwinism: Examples of environmental adaptations across organisms
    Speaker: Ms. Shrilakshmi S. Date: November 29, 2019

16. Title: Towards Enhancing Solar Fuel Production Through Overall Water Splitting
    Speaker: Dr D. H. K. Murthy Date: Jan 03 2020

17. Title" "Topological Photonics: The Platform For Light and Matter Interaction"
    Speaker: Mr. Y R karthik Date: Jan 24, 2020

18. Title: Indefinite Causal Order in Quantum Theory
    Speaker: Mr. U Shrikant Date: February 4, 2020

19. Title: Topological States Of Condensed Matter
    Speaker: Mr, Ranjith Kumar Date: Feb 28 2020

20. Title: "Selective Hydrogenation Over Supported Metal Catalysts: From Nanoparticles to Single Atoms"
    Speaker: Ms. Vaishnavi B J Date: March 13, 2020

21. EVENTS AND MEETINGS

Inaguration of H. H. Sri Vibudhesha Theertha Swamiji's Kuteera:

The newly constructed "H. H. Sri Vibudhesha Theertha Kuteera" was inaugurated by our present Chairman, H. H. Sri VishwapriyaTheertha Swamiji on 14th June 2019 at the Bidalur Campus**.**

Founder's Day Celebrations:

As a mark of tribute to this great visionary H. H. Sri Vibudhesha Theertha Swamiji, PPISR celebrated Founder's Day Celebration from **July 4-5, 2019**. On the first day, i.e. July 4, 2019, **Prof Navakanta Bhat, Professor, Indian Institute of Science,** Bangalore and Chairperson, Centre for Nano Science and Engineering, IISc, who is a recipient of **Infosys Prize 2018** in Engineering and Computer Science was invited as the **Chief Guest,** who also inaugurated the Technical programme. This was then followed by series of Guest lectures from various renowned academic Institutions as well as lectures by Faculty members of PPISR in the area of Theoretical Physics, Biological and Materials sciences. Speakers included eminent scientists, Dr. Mary Hyacinth Bastian, Shell Technology Centre, Bangalore; Dr. Dinesh Rangappa, Professor at VTU-Moddenahalli campus; Prof. Chandan Dasgupta, International Centre for Theoretical Physics, Tata Institute of Fundamental Research, Bengaluru; Dr. Anindita Banerjee, Quantum Security Specialist, QuNu Labs, Bangalore; Dr. Ravi Manjithaya. Associate Professor, MBGU, JNCASR; and Prof Vinoth kumar K.R. Asst. Professor, National Centre for Biological Sciences-TIFR.

On the second day, i.e. **July 5, 2019** evening, we had organized Valedictory Function and **Dr. Surendra Kulkarni,** Former Dean, Christ University, Head of GE/ SABIC R&D Centre, was invited as the **Chief Guest** and **Dr. Ramesh, Chief Executive Office,** Karnataka Science and Technology Academy (KSTA) was the **Guest of Honour** for this occasion. The programme began with an invocation followed by a welcome address by the Director and inspiring talks by the guests.

The programme ended with the distribution of medals and certificates to the winners of Annual sports and games for the year 2019 held at Bidalur campus.

Visit of delegates from Indo-Korea Science & Technology Center

Mr Sung-Jin Park along with Dr Seung Cheol Lee and Dr Satadeep Bhattacharjee of the Indo-Korea Science and Technology Center, Bengaluru visited PPISR on July 23rd 2019. Dr.Halgeri gave an overview of research activities of PPISR which was then followed by the presentation on I-KIST research activities by Prof Lee. This was then followed by discussions with the faculty members who are working in the area of Material Science in order to explore the possibility of collaborative research work of mutually interesting areas in the near future.

One-Day Symposium on "Advances in Chemical Sciences"

PPISR in association with Reva University organized a one-day Symposium on Advances in Chemical Sciences. Dr G. V. Shanbhag, Dr. Nalini Sundaram, Dr. Sanjeev Maradur and Dr Suresh Babu delivered lectures on the research activities carried out by them at PPISR.

Annual review meeting:

The annual review meeting was held on 23.10.2019 at Sadashivnagar office to review all the research projects carried out by the faculty of PPISR. The meeting was chaired by Prof. Nagaraja, IISc, Bengaluru. Prof. A. B. Halgeri (Director, PPISR) and Prof. K. Srihari, Hon. Secretary AMEF represented the PPISR in the committee.

The meeting started with a welcome address by Prof. A. B. Halgeri. This was followed by a brief presentation about PPISR activities by Prof. A. B. Halgeri. This was then followed by presentations of all faculty members in all three divisions. Prof. Nagaraja appreciated the overall progress made during the last one year gave suggestions and provided advice in each and every presentation. Finally, at the end, he summarized his overall view about the performances by the PPISR Scientists. Dr. Srihari also briefed that he is aware of all the progress made by the faculty of PPISR with regular interactions with Director and his visits to the Institute. Dr. Srihari said, he also brought this to the notice of H. H. Sri Vishwapriya Theertha Swamiji.

Dr. Nagaraja finally appreciated many of the projects going on in the Institute. He was of the opinion that each Scientists are handling too many projects and suggested to take enough researchers to work on this. Also, suggested to work quickly with some important projects and try to give a big jump for its success. Further, he said that even though the Institute is doing good, it needs more and more financial support to sustain the progress in the long run and to achieve greater success in future.

Memorandum of Association between Indo-Korea Science and Technology and Poornaprajna Institute of Scientific Research:

Dr. Lee, Director of Indo-Korean Science and Technology (IKST), Bengaluru along with two of Korean Delegates Ms. Sang Kyung Kim & Ms. Bora Seo visited PPISR on January 30, 2020. After identifying the mutually interesting areas of collaborative research programmes, an MOU has been signed by both the Directors, Dr. A. B.

Halgeri (PPISR) and Dr. Seung Cheol Lee (IKST) on behalf of their respective organizations. Both the institutes have agreed to work together on joint research projects, exchange of researchers, joint events etc. This MOU would help in establishing a close cooperative relationship between the two institutes with an aim of further growth of both organizations. Dr. R. Vetrivel and Dr. Ganapati Shanbhag from PPISR, and Dr. Satadeep Bhattacharjee Head-R&D, IKST and Mr. Mithun Suresh, Executive Operations, IKST were present on this occasion.

Outreach Programme for Poornaprajna School Students:

For the seventh consecutive year, the outreach programme for all Poornaprajna (PP) schools of Bangalore jurisdiction was organised at PPISRfrom December 16-20, 2019. All the class IX students from the five PP schools participated in the programme. This program has been designed to give high school students an opportunity to gain some experience on the research activities undertaken by the doctoral students for their PhD programme. The objective was to inspire high school students to pursue higher studies motivate further to take up research in fundamental and applied sciences. The students were also given a glimpse of the various sophisticated equipments in the Materials as well as the Biology laboratories.

Research orientation Workshop

Over the last several years, we have been arranging many Workshops for college and school children to popularize basic science and for this current year, we had organized aweek-long Research Orientation Workshop for Undergraduate students of Poornaprajna College, Udupi from December 2-7, 2019.

On December 2, 2019, Dr Pandurangappa, Registrar, Bangalore Central University was invited as the Chief Guest and also inaugurated the programme. Morning session includes series of lectures on the current areas of research that were being carried out by of PPISR faculty members as well as students and in the noon session, hands-on experiments using various sophisticated instruments were conducted on all five days.

On December 6, 2019, after lunch all students had career guidance discussions with faculty members of PPISR. After the discussions, we had organized Valedictory function and Dr. Harish P was invited as the Chief Guest, who also gave a Valedictory address. Nearly 22 students as well as faculty members attended this Workshop. On December 7, 2019, all of them were taken to Nehru Planetarium and Visveswaraiah Industrial and Technological Museum. Overall, the Workshop was a grand success.

National Conference organized by CSI-BC

For the current year, CSI – BC, organized a National Conference On “Frontiers of Catalysis Science & Technology and Its Applications (Focsta-2020)” from 10-11, January 2020 in association with the Chemistry Department of St. Joseph's College for the benefit of academia as well as industry people in and around Bangalore. Many distinguished scientists from both industry and academia delivered

Plenary/Invited lectures, which were well attended by both academic as well as industrial researchers. Overall the conference was a grand success.

Two-days training course on DFT for Computational Catalysis

As a part of ongoing HPCL sponsored project, work, Dr. R. Vetrivel, Co-PI of the project gave a two-day training course on the use of DFT for Computational Catalysis at PPISR from March 11-12, 2020

Visit of Faculty Members from BMS College of Engineering

Few faculty members of Chemistry Division from BMS College of Engineering, Bengaluru visited our campus on July 1, 2019. Dr Sanjeev Maradur presented an overview of PPISR research activities and they visited all the laboratories to have a glimpse of the instruments used in research activities at our laboratories in Bidalur campus.

Visit of Dr. V. K. Gupta, VP, Reliance Industries Ltd

Dr. V K Gupta, Senior Vice President and Head-Polymer, Reliance Research and Development Centre, Reliance Industries Limited, Navi Mumbai visited the Bidalur Campus on July 25, 2019 and he is impressed with the interest and creativity of faculty members and students doing high impact research for the societal benefits. He wishes good luck to all members of strongly disciplined and cultured team with creativity which will go a long way in continuous flow of futuristic scientific leaders for many years.

Visit of Lecturers from Ramaiah Institute of Technology

A team of forty members from Ramaiah Institute of Technology visited the campus in collaboration of Faculty Development Programme with PPISR on January 16, 2020. An overview of PPISR alogwith a brief note on the work carried out in PPISR was presented by the faculty members and in reciprocate, the visiting team members also presented their work. The members also visited the laboratories to have the glimpse of the instruments available in the labs.

Visit of representative from Karnataka Bank Ltd

The Karnataka Bank, the close Banking Associate of AMEF have come forward to provide support for the installation of solar power plant at our Bidalur Campus under the Bank's CSR initiative. One of the representatives from Karnataka Bank Sri. Srinivasa Deshapande, Head, CSR, Karnataka Bank, Registered and Head Office Mangaluru visited PPISR on January 23, 2020, went through all the labs, and discussed about the proposed solar photovoltaic plant to be set up at PPISR.

Visit of Lecturers from Maharani College

A group of lecturers from Maharani College, Bengaluru, headed by Dr Nagesh Babu visited PPISR on February 20, 2020. They were quite impressed by the research activities carried out at PPISR.

Board of trustees meeting of Admar Mutt Education Foundation (AMEF)

The meeting was held at Sadashivnagar campus on November 2, 2019 in the presence of Chairman, H. H. Sri VishwapriyaTheertha Swamiji along with trustee members and invited members. Dr. Anand B. Halgeri made a presentation on overall progress of the institution. Both Chairman as well as Trustee members of AMEF highly appreciated the progress of research activities of PPISR. The Annual Report of the institution for the year 2019-20 was released by the Chairman on this occssion.

Other Events

- **Release of News Letter:** H. H. Sri VishwapriyaTheerthaSwamij released the News Letter for the year 2019 on November 6, 2019. This was then followed with benediction by Paramapooja Sri Sri Swamiji.

- **Felicitation of the Ph.D student**: Dr. Pradeep Shanbhag's parents (on behalf of Dr. Pradeep Shanbhag) and Dr. Pavithra GC were felicitated by H. H. Sri VishwapriyaTheertha Swamiji for receiving Ph.D. award from MAHE, Manipal during the year 2019. They were presented with a "Certificate of Appreciation" for their achievements.

- **Independence day celebrations:** The 72nd Independence Day was celebrated at Bidalur Campus on August 15, 2019. The director of the institute Dr. Anand B Halgeri hoisted the flag and addressed the gathering. Later on saplings were planted in the campus to mark the celebration of Independence Day and to enrich further the greener gardens of the campus.

- **Republic Day Celebrations**: The 71st year of Republic Day was celebrated with enthusiasm at the Bidalur Campus on January 26, 2020. Dr. Ganapati V Shanbhag, one of our faculties hoisted the flag and addressed the gathering by mentioning the importance of having the world's largest constitution and its beneficiaries to the world's largest democratic nation and its nationals. Similarly, he spoke about the internal constitution of PPISR and its importance for prolific and smooth running of the institution and the internal and external safety of its members.

22. Poornaprajna Analytical Centre (PAC)

In order to strengthen technological infrastructure to carry out advanced research in various science disciplines under one roof and make their services available for the faculty and students to carry out globally competitive R & D in basic and applied sciences, PPISR has procured several analytical instruments namely Powder X-ray Diffractometer, Fourier Transform Infrared Spectroscopy (FTIR) Ultra Violet–Visible Spectroscopy (UV-VIS), Atomic Absorption Spectroscopy (AAS), Fluorescence Spectrophotometer, Temperature Program desorption (TPD) Analyzer and Surface Area Analyzer etc., that are necessary for general analysis. The aforementioned instruments are available for use mainly by the Scientists and the Research students at PPISR and our collaborators. This facility is also extended to all researchers from academic institutions and industries, to characterize their samples at nominal charges under the guidance of highly qualified PPISR staff. The following instruments are available for external users.

1	**Powder X-ray Diffractometer (PXRD)** The D2 PHASER – table top X-ray Powder Diffractometer from Bruker is ideal for qualitative, quantitative and structure analysis of polycrystalline samples.	
2	**Fourier Transform Infrared Spectroscopy (FTIR)** The Bruker-alpha FTIR spectrophotometer is a compact instrument and measures the infrared spectrum, which represents the molecular absorption and transmission of a sample.	
3	**Fluorescence Spectrophotometer** The Varian Cary Eclipse Fluorescence Spectrophotometer is a compact instrument and measures the fluorescence, phosphorescence, chemi/bio-luminescence, and time resolved phosphorescence.	
4	**Ultraviolet – Visible Spectroscopy** The UV-Visible spectrophotometer from Perkin Elemer can be routinely used in analytical chemistry for the quantitative determination of different analytes such as transition metal ions, highly conjugated organic compounds, and biological macromolecules.	

5	**Atomic Absorption Spectroscopy** This instrument from Perkin-Elmer is used for the qualitative and quantitative determination of chemical elements employing the absorption of optical radiation (light) by free atoms in the gaseous state. In analytical chemistry, the technique is used for determining the concentration of a particular element (the analyte) in a sample to be analyzed.	
6	**Temperature Program desorption (TPD) Analyzer** BEL's new fully-automated catalyst analyzer, enables comprehensive catalyst study by using the techniques; 1) Temperature programmed desorption (TPD) 2) Temperature programmed reduction (TPR) BELCAT II will be the strong tool for the catalyst evaluation.	
7	**Surface Area Analyzer** BELSORP-miniII is a compact, volumetric adsorption measurement instrument used for specific surface area and pore distribution measurement. Up to 3 samples can be measured simultaneously and independently with dedicated software, which makes operation of the instrument straightforward.	
8.	**Thermo Gravimmetric Analyzer (TGDTA/DSC)** STA6000 (Perkin Elmer) is Simultaneous Thermal Analyzer for simultaneous measurement and analysis of weight change and heat flow	

23. VISITORS' VIEWS

- **Dr. SEUNG CHEOL LEE, Director, Korea Institute of Science and Technology**: As a theoretical materials scientist, this visit was very fruitful and productive. Strong collaboration between Indo Korea Science and Technology Centre (IKST) and PPISR should show another good example of materials science, especially catalyst relevant research topics. I appreciate the hospitality showed to us.

- **Prof. MUKUNDA N. Retd. Professor, Center for Theoretical Studies, IASc.** It is a pleasure to come here again after about a decade, Fine campus, Calm atmosphere and good place to work academically. All my best wishes.

- **SRI SWAPNIL YERANDE AND SRI ANIL KHATRI, Deepak Group of Companies, Baroda.**
  We had a great impression about the facilities built in institute. It is great to see the academic facility who understand industry requirement. We are happy to work with you and looking forward to fruitful and long-term collaboration with you. Best of luck. PPISR has great potential to become Catalyst Excellent Centre in India. We are looking forward to work together.

- **Prof. TABISH QURASHI, Centre for Theoretical Pgysics, Jamia Milia Islamia, New Delhi.**
  It was really nice visitingthis wonderful little institute again. The place is very nice with friendly warm people who are enthusiastic about learning. I would love to visit again.

- **Prof. NAVAKANTA BHAT, Professor and Chair, CeNSE, IISc, BANGALORE:** I was very impressed with the quality of research work pursued. In particular, the collaboration with industry was so refreshing and unique. I am sure that the dedicated faculty and students will take this institute to greater heights.

- **Dr. HYACINTH MARY BASTIAN, Shell Technology Centre, Bengaluru**: The research scholars show a lot of energy and enthusiasm. The facilities are good, the labs are well maintained; potential to explore future collaborations. Enjoyed the interactions with students.

- **Dr. ANINDITA BANERJEE, Quantum Security Specialist, QuNu Labs, Bengaluru**.
  Very positive students. Faculties are very enthusiastic. Students can definitely explore this domain and anything we can do jointly will be great.

- **Dr. ANJALI A KARADE, Department of Bio Chemistry, IISc, Bengaluru.** It was very good to visit the institute and deliver a lecture at the symposium. The campus is lovely and the projects and publications from here are of high quality. Hope the institute expands and then will flourish even better.

- **Prof. K R VINOTH KUMAR, Assistant Professor, National Centre for Biological Sciences – TIFR, B'lore.**

  Great Campus. Need to expand, get women faculty and go towards gender neutrality.

- **Dr. B K BISWAL, N I I, New Delhi.**

  I am very impressed with the scientific ambience maintained in the institute. The greenery in the campus even great that motivated me. I wish you best of luck for the progress of the institute.

- **V. K GUPTA, Sr. Vice President and Head Polymer, Reliance Research and Development Centre, Reliance Industries, Navi Mumbai**.

  Congratulations to Prof. Halgeri and his team for creating the ecosystem for creativity and interest in faculty members and research students to do high impact research for societal benefits. A very strong disciplined culture in the team with creativity will go long way in continuous flow of future scientific leaders for many years. Good wishes to all.

- **Prof. PANDURANGAPPA, Registrar, Bengaluru Central University, Bengaluru.**

  Congrats to Dr. Halgeri and his team for maintaining the facilities and the scientific instruments. Mainly focussed on the Catalysis research work. Avery good research team comprising faculty and research students provide a good research atmosphere in the institute.

- **Dr. V. GAYATHRI, Bengaluru Central University, Bengaluru.**

  I congratulate Dr. Halgeri for his excellent work in building of Poornaprajna Institute. The laboratories and infrastructure are excellent.

Annual report release during AMEF meeting

Best presentation award to Nagendra at Bengaluru India Nano conference

RAC Meeting

(12) **United States Patent**
Ravishankar et al.

(10) **Patent No.: US 10,519,387 B2**
(45) **Date of Patent: Dec. 31, 2019**

(54) **CATALYST COMPOSITION FOR CONVERTING LIGHT NAPHTHA TO AROMATIC COMPOUNDS AND A PROCESS THEREOF**

(71) Applicant: **Hindustan Petroleum Corporation Ltd**, Mumbai, Maharashtra (IN)

(72) Inventors: **Raman Ravishankar**, Bangalore (IN); **Peddy Venkat Chalapathi Rao**, Bangalore (IN); **Nettem Venkateswarlu Choudary**, Bangalore (IN); **Ganapati V. Shanbhag**, Bangalore (IN); **Hodala Lakshminarayan Janardhan**, Bangalore (IN); **Anand B. Halgeri**, Bangalore (IN); **Sriganesh Gandham**, Bangalore (IN)

(73) Assignee: **HINDUSTAN PETROLEUM CORPORATION LTD.**, Mumbai (IN)

(51) **Int. Cl.**
C10G 35/095 (2006.01)
B01J 37/28 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***C10G 35/095*** (2013.01); ***B01J 29/061*** (2013.01); ***B01J 29/076*** (2013.01); ***B01J 29/40*** (2013.01);
(Continued)

(58) **Field of Classification Search**
None
See application file for complete search history.

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US Patent granted on December 31, 2019

Faculty visits to PPISR

ರಾಮಯ್ಯ ಆನ್ವಯಿಕ ವಿಜ್ಞಾನಗಳ ವಿಶ್ವವಿದ್ಯಾಲಯವು ಪದಾರ್ಥ ವಿಜ್ಞಾನಗಳ ಕುರಿತು ಆಯೋಜಿಸಿದ್ದ ಅಂತಾರಾಷ್ಟ್ರೀಯ ಸಮ್ಮೇಳನವನ್ನು ಉದ್ಘಾಟಿಸಲಾಯಿತು.

ಸಮಾಜಮುಖಿ ಸಂಶೋಧನೆಗಳಾಗಲಿ

ಸಂ.ಕ.ಸಮಾಚಾರ ಬೆಂಗಳೂರು

ಮನುಷ್ಯನ ಕಾಯಿಲೆಗಳನ್ನು ಗುರುತಿಸುವಂತಹ ನ್ಯಾನೋ ಯಂತ್ರೋಪಕರಣಗಳು ಇಂದು ಅಗತ್ಯವಾಗಿವೆ. ಹಾಗಾಗಿ ಸಂಶೋಧಕರು ತಮ್ಮ ಸಂಶೋಧನೆಗಳನ್ನು ಸಮಾಜಮುಖಿ ಯಾಗಿಸಬೇಕೆಂದು ಪ್ರೊ. ಸದಕಾಂತ ಭಟ್ ಕರೆ ನೀಡಿದರು.

ರಾಮಯ್ಯ ಆನ್ವಯಿಕ ವಿಜ್ಞಾನಗಳ ವಿಶ್ವವಿದ್ಯಾಲಯ ಆಯೋಜಿಸಿದ್ದ ಅಂತಾರಾಷ್ಟ್ರೀಯ ಸಮ್ಮೇಳನದಲ್ಲಿ ಮಾತನಾಡಿದ ಅವರು, ವೇಗವಾಗಿ ಬೆಳೆಯು ತ್ತಿರುವ ಪ್ರಪಂಚದಲ್ಲಿ ಪದಾರ್ಥಗಳ ಕುರಿತ ಸಂಶೋಧನೆ ಅಗತ್ಯವಾದ ಪ್ರಾಮುಖ್ಯತೆ ಪಡೆದಿದೆ. ಆದರಲ್ಲೂ ನ್ಯಾನೋ ವಿಜ್ಞಾನ ತಂತ್ರಜ್ಞಾನ ಕುರಿತ ಸಂಶೋಧನೆಗಳು ಮುಂಚೂಣಿಯಲ್ಲಿವೆ. ಮನುಷ್ಯನ ಕಾಯಿಲೆಗಳನ್ನು ಗುರುತಿಸುವಂತಹ ನ್ಯಾನೋ ಯಂತ್ರೋಪಕರಣಗಳು ಪ್ರಸ್ತುತ ಅಗತ್ಯವಾಗಿವೆ ಎಂದು ತಿಳಿಸಿದರು.

ಕುಲಪತಿ ಡಾ. ಶಿವಕುಮಾರ ಶ್ರೀಧರನ್ ಮಾತನಾಡಿ, ರಾಮಯ್ಯ ವಿ.ವಿ.ಯಲ್ಲಿ ಉನ್ನತ ಮಟ್ಟದ ಶಿಕ್ಷಣ ಹಾಗೂ ಸಂಶೋಧನೆಗೆ ವೇಕಾದ ಸೌಲಭ್ಯಗಳನ್ನು ಕಲ್ಪಿಸಲಾಗಿದ್ದು ಮುಂದಿನ ದಿನಗಳಲ್ಲಿ ಆನ್ವ ಯಿಕ ಸಂಶೋಧನೆಗಳು ಮತ್ತಷ್ಟು ವೇಗ ಪಡೆದುಕೊಳ್ಳಲಿವೆ ಎಂದು ಹೇಳಿದರು.

ಪೂರ್ಣಪ್ರಜ್ಞ ಸಂಶೋಧನ ಸಂಸ್ಥೆಯ ನಿರ್ದೇಶಕ ಡಾ. ಆನಂದ ಹಲಗೇರಿ ಅವರನ್ನು ಪದಾರ್ಥ ವಿಜ್ಞಾನಗಳಲ್ಲಿನ ಜೀವಮಾನ ಸಾಧನೆಗಾಗಿ ಗೌರವಿಸಲಾಯಿತು.

ಪ್ರೊ.ಡಾ. ಗೋವಿಂದ್ ಆರ್ ಕತಂಬಿ, ಡಾ. ಸುಂದರೇಶ್, ರಾಸಾಯನಶಾಸ್ತ್ರ ವಿಭಾಗದ ಮುಖ್ಯಸ್ಥ ಡಾ. ನಿರಂಜನ ಪ್ರಭು ಮತ್ತಿತರರಿದ್ದರು.

The Karnataka Bank, the close Banking Associate of Admar Mutt Group of Institutions have come forward to provide support for the installation of solar power plant at our Bidar Campus under the Bank's CSR initiative. One of the representatives from Karnataka Bank Sri. Srinivasa Deshapande, Head, CSR, Karnataka Bank, Registered and Head Office Managaluru visited the Bidalur Campus.

ಬಾಳಿಗಾ ಕಾಲೇಜಿನಲ್ಲಿ ದತ್ತಿ ಉಪನ್ಯಾಸ

ಗಣ್ಯರು ಕಾರ್ಯಕ್ರಮದ ಉದ್ಘಾಟನೆಯನ್ನು ನೆರವೇರಿಸಿದರು.

ವಿಜ್ಞಾನ ಮತ್ತು ಪ್ರದರ್ಶನ , ಮಳೆ ಕೊಯ್ಲು ಮತ್ತು ನೀರಿನ ಸಂರಕ್ಷಣೆ ಕುರಿತು ಚರ್ಚಾ ಕಾರ್ಯಕ್ರಮ

ಮಕ್ಕಳಲ್ಲಿ ವೈಜ್ಞಾನಿಕ ಮನೋಭಾವ ಬೆಳೆಸಿ:.ಆನಂದ್

The faculty members of PPISR delivering Guest Lecture and inaugurating the Science Exhibition on invitation.

Participation of Faculty and students at the 11th Bengaluru - India Nano Workshop held at Bengaluru on 2nd and 3rd of March, 2020. One of the students of PPISR received the best presentation award on this occasion.

Awarding of Lifetime Achievement for Dr. A.B. Halgeri, Director, PPISR in Advanced Materials Science at the International Conference held at Ramaiah Applied University in July, 2019.

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