



# POORNAPRAJNA INSTITUTE OF SCIENTIFIC RESEARCH

Promoted and Managed by Admar Mutt Education Foundation  
Recognised by DSIR, Govt. of India and Manipal Academy of Higher Education  
#167, Poornaprajnapura, Bidalur Post, Devanahalli, Bengaluru - 562 164



**ANNUAL REPORT 2023 - 24**



## ANNUAL DAY CELEBRATION OF PPISR - 2024

The Annual Day Celebration of PPISR for the year 2024 was organised at the Bidalur Campus on February 13, 2024 in the august presence of the chairman H H Shree Eeshapriya Theertha Swamiji alongwith the Director Dr. Anand B. Halgeri, Financial Advisor Shri P. Sreenivasa Rao and the Dean Dr. Ganapati V. Shanbhag.



## INAUGURATION OF PPISR ACTIVITY FORUM IN NEW DIMENTION - 2024



The PPISR Activity Forum which was formed by former PhD students has been continued with a new dimension from the present students under the name: "DHRISHTI -2024" was officially inaugurated by H H Shree Swamiji. As a mark of literature identification, the members of PPISR including the students, faculties and staff members will contribute to the literary intellect apart from the scientific activities and it will be displayed for the benefit of the readers.

## SHREE RAM PRANPRATHISHTA CEREMONY



The Pran Prathishtapan programme of Lord Shree Rama was celebrated at Bidalur Campus on 22.01.2024, the day of Ram Mahotsav at Ayodhya by Students and Staff of PPISR

## PPISR SIGNED MOU WITH QBIT



A MOU was signed between PPISR and Qbit at Sadashivanagar Office premises on June 06, 2024 in the presence of the Director Dr Anand Halgeri, Dr. Srikanth, Dr. Sanjeev from PPISR and Mr. Animesh from QBit.



# Poornaprajna Institute of Scientific Research Bengaluru, India

## Annual Report 2023-2024

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Promoted & managed by Admar Mutt Education Foundation  
Recognized by Dept. of Scientific & Industrial Research, GOI and Manipal Academy of Higher  
Education (MAHE) Deemed to be University

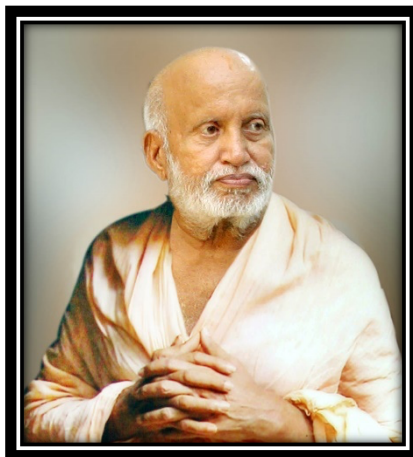
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## Founder's Message

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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 a self-sufficient 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.

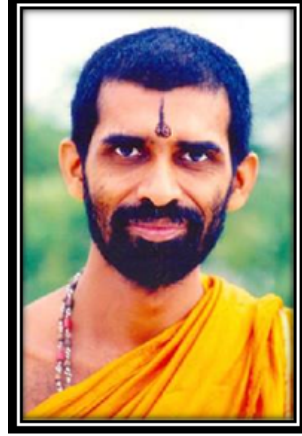
**H H Shree Vibudhesha Theertha Swamiji,  
Founder, PPISR**





## H.H. Shree Vishwapriya Teertha Swamiji's Message

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Founded by my beloved Guruji, an illustrious predecessor, H. H. Shree Vibudhesha Theertha Swamiji, The Poornaprajna Institute of Scientific Research (PPISR), has been described as the crest jewel (*chuDamaNi*) among the Poornaprajna academic family. PPISR is well on track towards fulfilling his dream for it to become a world-class research institute in the areas of Physical, Material, and Biological Sciences. The research work here is carried out with immense curiosity and spirit of service to the Motherland, as in the times of the Vedantic Rishis of yore, who studied deeply the spiritual sciences. The worldwide pandemic, which, by God's Grace has gradually slackened of late, did not weaken the vigor of research activities and progress at PPISR. Perhaps one blessing to come out of this difficult time is that people have now learned to interact online without reducing the quality or volume of research.

The number of students who obtained their Ph.D. at PPISR has now increased to thirty-two. Several new research projects have been initiated. 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. Shree Vibudhesha Theertha Swamiji's vision of India playing a pivotal role in scientific contribution to the scientific world globally. I think we are now in a place where we can have the audacity to hope that one day PPISR will produce a Nobel laureate! May Lord Shree Krishna bless and guide all the members of PPISR!

**H. H. Shree Vishwapriya Theertha Swamiji**  
**Former-Chairman, AMEF**





## Chairman's Message

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Having an academic background both in traditional studies as well as in technology, I am delighted to follow in the footsteps of my beloved Guruji H. H. Shree 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. Shree 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 Materials Sciences and Catalysis and Biological Sciences, where frontier research on industrial-grade catalysts and protein structure analysis are being 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 socially useful issues, such as medicinal applications, green chemistry, solar energy use and cryptography. The Materials Sciences and Catalysis group has made significant progress in the area of specialty chemicals, new energy materials, hydrogen generation, etc. The Institute is ranked 59th position in Chemistry in the India's top 100 institutions by prestigious Nature Index database owned by Nature publishing group.

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. Given the high quality of publications, which has now surpassed 400, about 32 research scholars completed their PhD programmes in the brief span since its expansion, 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. Shree Eeshapriya Theertha Swamiji**  
**Chairman – AMEF**





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## Message from Hon. Secretary, USAMEC & AMEF



Uniquely among the heads of various spiritual organizations of this country, His Holiness Shree Vibudhesha Theertha Swamiji, the then chief Pontiff of Udupi Shree 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. Shree Vibudhesha Theertha Swamiji attained the Lotus Feet of Lord Shree Krishna, the mantle of providing sacred guidance of PPISR has been graciously taken up by H.H. Shree Vishwapriya Theertha Swamiji, the present Pontiff of Shree Admar Mutt, Udupi, the President of USAMEC and Chairman of AMEF.

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 31 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 400 publications in peer-reviewed journals of international repute. In PPISR's journey in pursuit of the sacred, scientific vision set forth by H. H. Shree Vibudhesha Theertha Swamiji and guided by H. H. Shree Vishwapriya Theertha Swamiji and H.H. Shree Eeshapriya Theertha 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, USAMEC & AMEF



## Foreword from the Director



I have great pleasure in presenting the Thirteenth Annual Report on the account of research and academic activities of Poornaprajna Institute of Scientific Research (PPISR) for the year 2023-24. We are steadily making progress in highly competitive scientific research and is coming into limelight on the national and international stage by maintaining the uniqueness in the research field. The Institute has chosen contemporary frontier areas of research in the fields of Materials Science and Catalysis, Biological Science and Theoretical Sciences. PPISR is successfully forging ahead a fruitful academia-industry

partnership by innovating, designing and developing novel multifunctional materials that have wide-ranging applications in catalysis, nanotechnology, etc. Several new research projects have been initiated with sponsorship from industries like Sulzer-GTC Technology Inc, USA, Sravathi Advanced Process technologies Bengaluru, SABIC Agri Nutrients and SABIC Research and Technology, Bengaluru and also Government agencies like VGST, DST, DRDO etc. Currently, 18 doctoral students are actively involved in research activities on many sponsored projects both from Government agencies as well as from industries.

PPISR has been pursuing nearly 29 research projects in different areas which are both fundamental as well as applied sciences. These projects have shown significant progress in terms of publications and patents.

Ms. Shrilakshmi S, who pursued PhD under the guidance of Dr. Ananda K as PI and Dr. Udupi A Ramagopal as Co-PI, Mr Kartik who pursued research under the guidance of Dr. Sujit Sarkar, Mr. Shankar Kundapura who pursued research under the guidance of Dr. Udupi A Ramagopal, Ms. Vaishnavi B. J. who pursued PhD under the guidance of Dr. Ganapati V Shanbhag successfully defended their PhD theses and have been awarded their PhD degrees.

Our doctoral students attended various nation and international conferences and few students namely Dr. Vaishnavi B. J., Ms. Bhavana B. Kulkarni, and Mr. Harsha M won best poster and oral presentation awards. Dr. Ranjith Kumar R. won the prestigious National Dr. K. V. Rao Scientific Society research award and Ms. Asha Devi, who is working under the guidance of Dr. Naresh Nalajala has been awarded DST-Inspire fellowship.

In 2023-24 alone, the Institute has published 26 research papers and 3 Book chapters in all areas of sciences and overall, PPISR has crossed 400 publications in peer-reviewed high impact factor international journals. During this tenure, four patents have been filed in the areas of materials sciences and catalysis as well as biological sciences.

We are happy to inform you that based on the excellent research capabilities and quality of publications by our scientists and research scholars M/s. Galgotias University, Greater Noida, UP has entered an MOU with PPISR.

During this tenure, we had organized Founder's Day, International Conference In Association with The Catalysis Society Of India, Bangalore Chapter and GITAM University, Outreach program with a theme of "**Today's Science for Tomorrow's Scientists**" for Xth standard Students from all five Poornaprajna Schools in Bangalore, A Science exhibition spanning two days, themed "The Significance of Chemistry in Daily Life," was conducted in collaboration with the Royal Society of Chemistry Local Session, the Poornaprajna Institute of Scientific Research, and the Poornaprajna Education Centre, Bengaluru,



Annual Day Celebrations, and National Science Day Celebrations. A couple of years back, students of PPISR initiated 'PPISR Activity Forum' which serves as a platform to nurture and showcase the hidden talents of all the members of PPISR in various fields. Various creative programs are being organized every month which includes paintings, sketches, write-ups, poems etc. H H Shree Eeshpriya Theertha Swamiji inaugurated this programme and appreciated the overall efforts.

On the whole, the entire year 2023-24 was much more productive and successful with the unstinted support and blessings from H. H. Shree Vishwapriya Theertha Swamiji, H. H. Shree 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**

## MEMBERS OF BOARD OF TRUSTEES/ MANAGEMENT

|   |                   |
|---|-------------------|
| <b>H. H. Shree EeshapriyaTheertha Swamiji</b><br>Peetadhipathi, Udupi Shree Adamaru Matha                           | Chairman          |
| <b>H. H. Shree Vishwapriya Theertha Swamiji</b><br>Udupi Shree Adamaru Matha  | Former Chairman   |
| <b>Dr. K. Srihari</b><br>Professor (Rtd), UAS, Bengaluru  | Hon. Secretary    |
| <b>Sri B.R. Prabhakara</b> , IAS (Rtd),<br>Former Chief Secretary Govt. of Karnataka                                | Member            |
| <b>Sri Rajendra J. Hinduja</b> ,<br>Industrialist, Bengaluru  | Member            |
| <b>Sri Laxmisha G. Acharya</b> ,<br>Industrialist, Mumbai   | Member            |
| <b>Dr. U. Shankar Rao</b> ,<br>Medical Director, National Hospital, Chennai.  | Member            |
| <b>Padma Shri Dr. V.R. Prahalada</b> ,<br>Former Vice Chancellor, Defence Institute of<br>Advanced Technology, Pune | Member            |
| <b>Prof. V. Nagaraja</b> , Professor IISc, Bengaluru  | Member            |
| <b>Sri. S. T. Raghavendra Mady</b>  | Member            |
| <b>Dr. Anand B. Halgeri</b> , PPISR   | Director          |
| <b>Sri P. Sreenivasa Rao</b> , PPISR  | Financial Advisor |
| <b>Padma Vibhushan Prof. P. Rama Rao</b> , FASc, FNA,<br>FNASc, Ex. Secretary, Ministry of S &T, GOI                | Special Advisor   |
| <b>Sri K. R. Prasad</b> , Advocate, Bengaluru   | Special Advisor   |

## **RESEARCH ADVISORY COMMITTEE**

1. Padma Shri Dr V R Prahalada, Former Vice Chancellor, Defense Institute of Advanced Technology, Pune
2. Prof C Sivaram, Professor, Indian Institute of Astrophysics, Bengaluru
3. Prof S Natarajan, SSCU, IISc, Bengaluru
4. Prof G U Kulkarni, Director CeNS and Professor, JNCASR, Bengaluru
5. Prof T N Guru Row, Retired Professor, SSCU, IISc, Bengaluru
6. Prof Chandrabhas Narayana, Director, RGCB, Thiruvananthapuram
7. Prof S Ramakumar, Retired Professor, IISc, Bengaluru
8. Prof Uday Kumar Ranga, Professor, MBGU, JNCASR, Bengaluru
9. Prof B Gopal, Professor, MBU, IISc, Bengaluru
10. Prof Jayanth Murthy, Professor, IIA, Bengaluru
11. Prof Sisir Roy, T.V. Raman Chair Visiting Professor, National Institute of Advanced Studies, Bengaluru.
12. Dr Sateesh K S, Professor, The University of Trans-Disciplinary Health Sciences and Technology, Bengaluru.
13. Prof A B Halgeri (Member Secretary), Director, PPISR

## DOCTORAL ADVISORY COMMITTEE

|                            |   |
|----------------------------|---|
| ◆ Dr. C. Sivaram           | Former Professor, Indian Institute of Astrophysics (IIA), Bengaluru     |
| ◆ Dr. C.S. Gopinath        | Deputy Director, CSIR-National Chemical Laboratory (NCL), Pune          |
| ◆ Dr. C. M. Chandrashekhar | Adj. Faculty, Indian Institute of Science (IISc), Bengaluru             |
| ◆ Dr. Dinesh Nagegowda     | Sr. Principal Scientist, CSIR-CIMAP, Bengaluru                          |
| ◆ Dr. K. R. Krishnamurthy  | Former Professor, Indian Institute of Technology (IIT) Madras, Chennai  |
| ◆ Dr. Arun Basrur          | Former Head R&D, Sud Chemie Ltd., Vadodara                              |
| ◆ Dr. A. Sakthivel         | Professor, Central University of Kerala                                 |
| ◆ Dr. Shubhangi Umbarkar   | Sr. Principal Scientist, CSIR-National Chemical Laboratory (NCL), Pune  |
| ◆ Prof. Sudarsanam Putla   | Asst. Professor, Indian Institute of Technology (IIT), Hyderabad        |
| ◆ Prof. Naveen V Kulkarni  | Asst. Professor, Amrita Vishwa Vidyapeetham, Kerala                     |
| ◆ Dr. Ankur Bordoloi       | Principal Scientist, CSIR-Indian Institute of Petroleum (IIP), Dehradun |
| ◆ Dr. Vijay Ramdin Singh   | Asst. Professor, GITAM University, Bengaluru                            |
| ◆ Prof Sachin R Rondiya    | Asst. Professor, Indian Institute of Science (IISc), Bengaluru          |
| ◆ Dr. Udupi A. Ramagopal   | Professor, GITAM University, Visakhapatnam                              |
| ◆ Dr. Nalini Sundaram      | Vice. Dean, St. Joseph's University, Bengaluru                          |

## **ORGANIZATION**

**Director:** Dr. Anand B. Halgeri

**Financial Advisor:** Sri P. Sreenivasa Rao

### **Core Faculty:**

Dr. Ganapati V. Shanbhag (Dean-Academics)

Dr. Udipi A. Ramagopal

Dr. Sujit Sarkar

Dr. Srikanth R.

Dr. Ananda K.

Dr. Sanjeev P. Maradur

Dr. Naresh Nalajala

Dr. Nagasuresh Enjamuri

### **Honorary Professor:**

Dr. Rajappan Vetrivel

Prof. Paniveni Udayashankar

### **Administration:**

Senior Administrative Officer: Mr. Kishore L. Gaikwad

Accounts Officer: Mrs. Nandini S.

Sr. Secretary to Director: Mrs. Latha Srinivasan

### **Support staff:**

Mr. Vishwaprakash A.

Mr. Praveen Kadam

Mr. Sriramappa S.

Mr. Nagaraj

Mr. Kesavmurthy



## **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 Udupi Shree Adamaru Matha H H Shree 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 RD 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. Shri. Eeshapriya Theertha Swamiji to make Poornaprajna Institute of Scientific Research a Centre of Excellence to realize the dreams of his Param Guruji H. H. Shree Vibudhesha Theertha Swamiji. H. H. Shree 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. Shree 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 professors and 35 distinguished scientists from various renowned organizations. So far, 31 students from PPISR have obtained their Ph.D. degree from MAHE, Manipal. Presently, 21 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 400 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 Institutes 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 Shree Adamaru Matha Education Council (USAMEC). All these developments would not have been possible without the guidance, support and blessings from H. H. Shree Vishwapriya Theertha Swamiji and H. H. Shree 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. Shree Vibudhesha Theertha Swamiji.

## **MISSION OF THE INSTITUTE**

- \* 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 publish research articles in reputed national/ international journals of high impact.
- \* 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 opportunities for talented young students to carry out short-term research projects
- \* To file patents on research findings of potential commercial applications.
- \* To provide facilities to visiting scholars and faculty from all over India and abroad to work with the institute's faculty
- \* To organize periodic summer and winter schools for the young undergraduate and graduate students.
- \* 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.

## DIVISION STRUCTURE

Faculty

Research Scholars/ Project Students

### MATERIALS SCIENCE AND CATALYSIS

**Dr. A. B. Halgeri**

Professor and Director

**Dr. G. V. Shanbhag**

(Dean (Academics))

Associate Professor and HOD

Ms. Vaishnavi B. J., Mr. Sujith S., Ms. Chaitra Mallannavar Mr. Harsha Murudappa, Ms. Meghana H K, Mr. Rajashekhar Vaibhav, Ms. Chethana A., Ms. Rakshitha C., Mr. Vidwathpriya Karaba, Mr. Srinatha M.S., Mr. Santhosh Kumar, Mr. Nandish S H, Mr. Mukesha, Ms. Priyadarshini, Mr. Magudeshwaran, Mr. Kaviraj, Mr. Ganesh N. S., Mr. Karthikeyan, Ms. Harshitha C.

**Dr. Sanjeev P. Maradur**

Associate Professor

Ms, Bhavana Kulkarni Mr. Ayush H., Mr. Purohith Kumar.

**Dr. Naresh Nalajala**

Assistant Professor

Ms. Asha Devi, Mr. Manjunath Reddy

**Dr. Nagasuresh Enjamuri**

Assistant Professor

-

**Dr. Rajappan Vetrivel**

Honorary Professor

-

### BIOLOGICAL SCIENCES

**Dr. U. A. Ramagopal**

Associate Professor

Mr. Shankar Kundapura, Mr. Gopala Krishna, Mr. Nikhil Gigi

**Dr. K. Ananda**

Associate Professor

Ms. Shrilakshmi S., Mr. Mallikarjun, Ms. Jyotsna, Ms. Akshitha P. S.

### THEORETICAL SCIENCES

**Dr. Sujit Sarkat**

Associate Professor

Mr. Ranjith Kumar R.,

Mr. Kartik Y. R.

**Dr. R. Srikanth**

Associate Professor

Mr. Vinod Rao, Mr. Sanjoy Dutta ,

Mr. Shubhodeep, Dr. Vijay Pathak

## **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 equipment, 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. 15 students have obtained Ph.D. from the department till 2024 and at present, there are several students pursuing research and diligently working towards their Ph.D. degrees. More than 170 publications have been published in reputed national/ international journals in the last nine years with an average impact factor of > 4.0. About 27 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 2024. The division has organized several conferences and workshops.

### **The mission of the Division**

- To innovate, design and develop novel multifunctional materials with wide applications in various fields like heterogeneous catalysis, photocatalysis, nanotechnology, gas sensing, ab- sorbents, photoluminescence, etc., and thus pave the way for fruitful academia-industry partnership.
- The division is committed to training several doctoral students through a research program that promotes excellence and original thinking.
- 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:**

- Heterogeneous catalysis
- Shape selective acid-base catalysis
- Novel materials for green chemical processes
- Biomass conversion to value-added products
- Catalytic CO<sub>2</sub> utilization by converting into useful chemicals
- Mesoporous polymers for catalysis and other applications
- Metal organic frameworks for catalysis and gas sensing
- Gas sensing
- Photocatalytic H<sub>2</sub> generation
- Computational studies (DFT) for 'structure-property' correlations

## Faculty Profile



### **Dr. A. B. Halgeri**

Professor and Director

Email: [abhalgeri@gmail.com](mailto:abhalgeri@gmail.com),

[director@ppisr.res.in](mailto:director@ppisr.res.in)

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, such as 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 Solid Acid Catalyst for Low Temperature Catalytic Applications" sponsored by HPCL (R&D)
- "Development of Novel Catalyst for light naphthavolarisation" 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)
- “Development of adsorbent materials for sulfide compounds removal” Sponsored by: GTC Vorro LLC, USA

#### **INDUSTRIAL PROJECTS:**

1. “Development of Catalyst and Process for Specific CO<sub>2</sub> Transformation” sponsored by: Hindustan Petroleum Corporation Ltd. (HPCL)
2. Structure Based Rational Design of Pd1 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
6. “Rationalization of Yield Prediction Guided by Computational Insights” Sponsored by Sravathi AI Technology Pvt Ltd (SAITPL), Bengaluru
7. “Catalyst and process development for hydrocarbon synthesis via halogen mediation” Sponsored by: Sulzer-GTC Technology Inc, USA

#### **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, 31 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 23rd National Symposium on Catalysis (CATSYMP-23) were successfully conducted.

#### **PUBLICATIONS AND PATENTS**

He has published around 150 research papers in national and international peer reviewed journals and has also obtained 40 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 RD Division of the Public 16 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. Recently, 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
9. Lifetime Achievement Award from the Material Society India for his immense contribution in catalyst design and process development during the ICAMR-2019 conference.



**Dr. RAJAPPAN VETRIVEL**

Honorary Professor

Materials Science and Catalysis Division

Email:Rajappan.vetrivel@ppisr.res.in

**Brief CV:**

2019 Chief Scientist – Sravathi AI Technology Pvt. Ltd., Bangalore

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:**

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

**Accomplishments and Recognitions:**

1. Visiting Associate Professor at Tohoku University, Sendai, Japan from 1993 to 1994 and conducted research under Indo-Japan collaboration program
2. Visited University of Cambridge & University College London, UK to perform research studies in Indo-UK collaborative research program
3. Visited ‘Ecole Nationale Superieure de Chimie’, Montpellier, France in 1988 & 1989 for an Indo-French project
4. Received the Best Young scientist award – Gold medal (1998) of Catalysis Society of India

5. Life Member of the Catalysis Society of India, Elected executive committee member, and Assistant Editor of Bulletin of the Catalysis Society of India.
6. Life Member of the Polymer Society of India
7. Elected Fellow of the Maharashtra Academy of Sciences
8. Supervised 3 research students of NCL, Pune who were awarded a Ph.D. degree by the University of Poona, Pune
9. Research publication actions in peer-reviewed journals
10. I have filed 7 global patents and 4 patent applications
11. I obtained management recognition awards in the form of company shares for leading R&D projects that led to business benefits
12. Currently Co-investigator for two industry-sponsored (by HPCL and Sravathi AI Technology Pvt. Ltd.) projects

### **PUBLICATIONS AND PATENTS**

1. I have published 125 research papers in national and international peer-reviewed journals and have also obtained Indian and International patents. Some of the selected publications are:
2. R. Vetrivel Et Al, J. Mol. Structure (Theochem), 94, 187 (1983).
3. R. Vetrivel and Coworkers J. Mol. Catal., 37, 157 (1986).
4. R. Vetrivel, Et Al, Proc. 9th Int. Cong. Catalysis, Vol. 4, (Eds. M.J. Phillips and M. Ternan), Chemical Institute Of Canada, 1988, P.1766.
5. R. Vetrivel, Et Al, Proc. R. Soc. London, A417, 81 (1988).
6. R. Vetrivel and Coworkers, Guidelines for Mastering the Properties of Molecular Sieves, (Eds. D. Barthomeuf Et Al), Plenum Press, New York, 1990, P.263. [Nato Asi Series B: Physics, Vol. 221].
7. 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.)
8. R. Vetrivel, Zeolites, 12, 424 (1992)
9. R. Vetrivel and Coworkers J. Phys. Chem. 96, 3096 (1992)
10. R. Vetrivel and Coworkers, Macromolecules, 25, 2215 (1992)
11. R. Vetrivel, Appl. Catal., 92(2), N16 (1992)
12. R. Vetrivel and Coworkers, Appl. Surface Sci., 82/83, 516 (1994)
13. R. Vetrivel and Coworkers, J. Am. Chem. Soc., 120, 4752 (1998)
14. R. Vetrivel and Coworkers, J. Am. Chem. Soc., 120, 11426 (1998)
15. R. Vetrivel and Coworkers, J. Catal., 174, 88 (1998)
16. R. Vetrivel and Coworkers, Langmuir, 18, 932 (2002)

- 17.R. Vetrivel and Coworkers, *Combinatorial Chemistry and High Throughput Screening*, 6, 1 (2003)
- 18.R. Vetrivel and Coworkers, *J. Phys. Chem.*, B108, 11541 (2004)
- 19.R. Vetrivel, and Coworkers, *Proc. 10th International Conference on Advanced Materials (Iumrs-Icam 2007) Held in Bangalore, India, Oct. 2007*
- 20.R. Vetrivel, 'Gtl Experience' *Proc. 4th R&D Conclave (Organized by Petrotech Society) Held at Goa, India, Jan. 2010*
- 21.R. Vetrivel, Invited Talk at JNCASR Winter School On "Materials and Processes for Applications in Energy and Environment", Bangalore, Jan. 2015
- 22.R. Vetrivel and Coworkers, 'How Supercomputers Help to Overcome the Technical Challenge of Keeping Satellites Working Smoothly Hundreds of Kilometers Above Earth?', *Shell Business Innovations*; 2016. <https://www.shell.com/inside-energy/smooth-moves-in-space.html>
- 23.R. Vetrivel and Coworkers, 'Computational Catalysis' *Proc. New Trends in Computational Chemistry for Industrial Applications, Expoquimia, Barcelona, Oct. 2017*
- 24.N. Kulal, R. Vetrivel, N.S.G. Krishna and G.V. Shanbhag, *ACS, Applied Nano Materials*, 4, 4388 (2021)
- 25.N. Kulal, R. Vetrivel, C.S. Gopinath, R.K. Ravindran, V.N. Rao, M. Shetty, R. Shrikanth D. Rangappa and G.V. Shanbhag, *Chem. Engg. J.*, 419, 129439 (2021)





**Dr. Ganapati V. Shanbhag**  
**Dean (Academics)**  
**Associate Professor and HOD**  
Materials Science and Catalysis Division  
E-mail: shanbhag@ppisr.res.in

#### **BRIEF CV:**

- ❖ January 2023-till date Dean (Academics), PPISR
- ❖ April 2019-till date HOD, Materials Science and Catalysis Division
- ❖ January 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:**

##### ➤ **Designing catalysts for biofuel synthesis and biomass transformation**

Glycerol is obtained as a by-product during transesterification of vegetable oil which accounts for one tenth of every gallon of biodiesel produced. Another chemicals like furfural and terpenes are biomass derivatives. These chemicals can be converted into value added products by catalytic processes namely, acetalization, oxidation, hydrogenation, hydrogenolysis, alcoholysis esterification, transesterification etc. Hence, there is a great commercial interest to design green and chemoselective catalysts for these processes. Our group has reported KF/alumina, metal hydroxystannate, modified zeolite beta, mesoporous tin oxide, mesoporous tin phosphate, catalysts for transesterification, carbonylation, acetalization, alcoholysis, esterification reactions which published in reputed international journals *viz.* Catalysis Letters, RSC Advances, Journal of Molecular Catalysis A, Catalysis Science and Technology Journals.

##### ➤ **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. Post synthesis modification has been carried out for zeolites by silanation, selective coking and metal/non-metal oxide impregnation. Phosphate modification was studied extensively 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. A few papers are published in RSC Advances, Applied Catalysis A journal and Chemical Engineering Science journals.

##### ➤ **Chemical fixation of CO<sub>2</sub> by converting into valuable chemicals.**

CO<sub>2</sub> activation and valorization into value-added products is an emerging area of research considering the increasing environmental concerns caused by the emission of CO<sub>2</sub> into atmosphere by various modes resulting in the greenhouse effect and health hazards. Designing catalysts for CO<sub>2</sub> fixation to produce important products like cyclic carbonate, substituted urea, cyclic urea, glycerol carbonate is challenging as the catalyst should activate CO<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> transformation into value added chemicals has been conducted since last few years. Several research works have been published by this group in internationally reputed journals like Chemical Engineering Journal, ACS Applied Nano Materials, Journal of CO<sub>2</sub> Utilization, Applied Catalysis A and a book chapter with Springer Nature publishers.

#### **RECOGNITIONS/ACHIEVEMENTS/AWARDS/MEMBERSHIP:**

- 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.
- 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, USA.
- Chemical Today magazine published an interview of Dr. Shanbhag in June 2016 issue.
- 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.
- Dr. Shanbhag is the co-inventor in the two US patents (granted) filed by HPCL in the collaborative project.
- 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.
- 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.
- 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.
- Dr. Shanbhag has delivered several invited talks at prestigious national/ international conferences such as 1) 3<sup>rd</sup> 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) 5<sup>th</sup> 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) 23<sup>rd</sup> 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
- Dr. Shanbhag received International Travel Grant from SERB, DST, Govt. of India to travel to Australia to attend ICEAN conference in 2018.

- Dr. Shanbhag was invited as PhD thesis Examiner by a reputed CSIR institutes and prestigious universities.
- Dr. Shanbhag worked as Member of the Syllabus revision committee/ Board of Studies for Chemistry for Siddaganga Institute of Technology (SIT), Tumkur 2013-2018 and RV College of Engineering, Bengaluru (Since 2022).
- Dr. Shanbhag has been the reviewer for prestigious international journals like Nature Communications, Chemical Communications, Chemical Engineering Journal, RSC Advances, Catalysis Science and Technology, Applied Catalysis A, Catalysis Communications, Journal of Chemical Sciences, ChemCatChem, New Journal of Chemistry, ACS Sustainable Chemistry and Engineering etc since the last 12 years.
- 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.
- Life member of International Zeolite Association (IZA) and Catalysis Society of India (CSI) and member of American Chemical Society.

#### STUDENTS (2023-2024):

|    | PhD students            |    | Project Fellows         |
|----|-------------------------|----|-------------------------|
| 1  | Ms. Vaishnavi B. J.     | 12 | Mr. Manjunath Reddy     |
| 2  | Mr. Sujith S.           | 13 | Mr. Vidwathpriya Karaba |
| 3  | Ms. Chaitra Mallannavar | 14 | Mr. Srinatha M.S.       |
| 4  | Mr. Harsha Murudappa    | 15 | Mr. Santhosh Kumar      |
| 5  | Ms. Meghana H K         | 16 | Mr. Nandish S H         |
| 6  | Mr. Rajashekhar Vaibhav | 17 | Ms. Priyadarshini       |
|    | <b>Project Fellows</b>  | 18 | Ms. Rakshitha C.        |
| 7  | Mr. Magudeshwaran       | 19 | Mr. Mukesha N           |
| 8  | Mr. Kaviraj             |    |                         |
| 9  | Ms. Harshitha C         |    |                         |
| 10 | Mr. Kartikeyan          |    |                         |
| 11 | Mr. Ganesh N.           |    |                         |

#### GROUP ALUMNI:

##### A) PhDs

1. **Dr. Vijaykumar Marakatti:** PhD topic: Design of solid acid catalysts for Prins reaction and toluene methylation PhD from: Manipal University Date of PhD Award: 28<sup>th</sup> April 2015 Number of Publications: 08 Number of Patents: 01 Present Position: Research Scientist, King Abdullah University of Science and Technology (KAUST), Saudi Arabia.
2. **Dr. Janardhan H L:** PhD topic: Studies on pore modified zeolite catalysts for aromatization and aromatic substitution reactions Date of PhD Award: 10<sup>th</sup> June, 2015 Number of Publications: 05 Number of Patents: 01 Present Position: Team Lead, Materials Research, Dhio Research and Engineering Pvt. Ltd, Bengaluru.
3. **Dr. Manjunathan P.** PhD Title: "Designing Heterogeneous Catalysts for the Conversion of Glycerol & Furfuryl Alcohol into Value-Added Chemicals" Date of PhD Award: 21<sup>st</sup> August, 2018 Number of Publications: 10 Award: Senior Research Fellowship 2016 (CSIR, Govt. of India) Present Position: Research Officer, Indian Oil Corporation Ltd (IOCL), Govt. of India since June 2021.
4. **Dr (Mrs). Swetha Sandesh**  
PhD topic: Novel eco-friendly catalysts for biodiesel synthesis and conversion of by-product glycerol into value-added products Date of PhD Award: 09<sup>th</sup> May 2015 Number of Publications: 06 Award: Senior Research Fellowship 2012 (CSIR, Govt. of India) Present Position: CEO, Niranthara Scientific Solutions Pvt Ltd

5. **Dr. Nagendra Kulal:** PhD topic: “Metal oxide based acid-base bifunctional catalysts for chemical fixation of CO<sub>2</sub> via carbonylation reactions” Date of PhD Award: December 22, 2021 Present Position: Post Doctoral researcher, Catalysis Division, Refining and Advanced Chemicals, King Fahd University of Petroleum and Minerals (KFUPM), Dhahran, Saudi Arabia.
6. **Dr. Marilyn Dmello:** PhD topic: Design and Development of Metal-Organic Frameworks based Materials for Gas Sensing Applications, Date of PhD Award: September 30, 2022 Present Position: SERB-National Postdoctoral Fellow, Centre for Nano and Soft Matter Sciences, Bangalore
7. **Ms. Chethana A.:** PhD topic: Design of Semiconductor Oxide Nanomaterials for Efficient Gas Sensors, Date of PhD Award: 6<sup>th</sup> March 2023 Present Position: Post Doctoral Fellow, Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru

#### **B) M. Tech Thesis Guided:**

- 1) **Mr. Satish Burla** 2011-2012. Currently, he is Scientist in SABIC Research Centre, Bengaluru
- 2) **Mr. Prashant Kumar K.** 2012-2013. Currently, he is Scientist in SABIC Research Centre, Bengaluru
- 3) **Mr. Girish Kamath** 2015-2016. Currently, he is pursuing his PhD at Univ. of Saskatchewan, Canada

#### **C) Post-Doctoral Fellows:**

- 1) **Dr. Ramesh S.** 2012-2013: He worked in a project sponsored by Shell Technology Centre, Bengaluru and GTC, USA for the period of 1 year.
- 2) **Dr. Prakash Chandra** 2015-2016: He worked in the project sponsored by PW Technology Inc, USA for the period of 1 year.
- 3) **Dr. Subba Reddy Marri** 2016-2017: He conducted research in industry project sponsored by HP Green R & D Centre Bengaluru and worked during 2016-2017.

#### **NATIONAL AND INTERNATIONAL COLLABORATORS:**

1. Dr. Nikolay Nesterenko, Head, Global Solutions, Sulzer-Chemtech, Switzerland
2. Prof. Ajayan Vinu, University of Newcastle, Australia
3. Dr. Ding ZhongYi, Sulzer-GTC Technology Inc, USA
4. Dr. C. S. Gopinath, HOD, Catalysis Division, CSIR-NCL, Pune
5. Dr. G. Valavarasu, DGM, HP Green R & D Centre, Bengaluru
6. Dr. Raman Ravishankar, DGM, HP Green R & D Centre, Bengaluru
7. Prof. Shubhangi Umbarkar, Principal Scientist, CSIR-NCL, Pune.
8. Prof. Rajendra Srivastava, Associate Professor, IIT-Ropar, Punjab
9. Prof. A. Sakthivel, Central University of Kerala, Kasargod.
10. Dr. Ankur Bordoloi, Sr. Scientist, CSIR-IIP, Dehradun

#### **RESEARCH 2023-2024:**

##### **CURRENT PROJECTS:**

##### **1) Catalyst and process development for hydrocarbon synthesis via halogen mediation**

Sponsored by: **Sulzer-GTC Technology Inc, USA** Duration: 3 years 2021- 2023

Principal Investigator: **Dr. Ganapati V Shanbhag**

Research fellows: Mr. Harsha M., Ms. Aishwarya, Mr. Vidwathpriya, Ms. Rakshitha, Mr. Mukesha, Mr. Srinatha, Mr. Manjunath, Mr. Santhosh Kumar, Mr. Nandish, Ms. Priyadarshini

The project was extended for initially for 10 months from February to December 2023 after completion of two successful projects in 2021 and 2022. The project work continued with vapor phase dehydrohalogenation experiments. The reactions were conducted in high pressure catalyst testing unit to convert LPG into propylene via halogen mediation. The catalyst was designed to achieve high conversion and selectivity for the desired product. They were conducted in in house designed glass reactor under low pressure with PPISR developed catalyst

to obtain performance under various conditions. Later, we conducted carbonization experiments to synthesize new carbon materials. The third phase of the project was successfully completed on December, 2023.

Status: 3<sup>rd</sup> year project was successfully completed

## **2) Synthesis of fertilizers using CO<sub>2</sub> mineralization technique**

Sponsored by: SABIC Research and Technology Pvt. Ltd, Bengaluru 2023-2024

Duration: 1 Year and 3 months

Principal Investigator: **Dr. Ganapati V Shanbhag**

Co-investigator: Dr. Naresh Nalajala

Research fellows: Mr. Kaviraj, Ms. Harshitha

The project proposal by Dr. Shanbhag was accepted by SABIC on CO<sub>2</sub> mineralization research and the project was initiated in October 2023. There was initial set up of the experiments and hiring of the project fellows. Initial synthesis work was started and the reaction conditions were optimized for two important fertilizer chemicals. Later, 1 KG bulk synthesis was conducted and high yields of the products were obtained. The products were characterized by various techniques to know the purity, moisture, particle size etc. These products were sent to SABIC for further evaluation and the report was submitted.

Status: Under progress

## **3) Next Generation Cellulose Based NP Fertilizers**

Sponsored by: SABIC Research and Technology Pvt. Ltd, Bengaluru , 2024

Duration: 3 months,

Principal Investigator: **Dr. Ganapati V Shanbhag**

Research fellows: Mr. Kaviraj, Ms. Harshitha, Mr. Magudeshwaran, Mr. Ganesh and Mr. Karthikeyan

A new agreement was signed with SABIC in March 2024 to initiate a project to make cellulose based NP Fertilizers. The project was initiated by procurement of chemicals and the work is going on successfully. A few project review meetings are conducted and it is on the verge of completion.

Status: Ongoing.

## **4) Enhancing activity of HAP catalyst by hydrothermal in-situ Zn incorporation for transformation of CO<sub>2</sub> to produce cyclic urea from diamine**

(Sponsored by **Vision Group on Science & Technology**, CESEM, Govt. of Karnataka, 3<sup>rd</sup> year)

Research fellow: Ms. Chaitra N. Mallannavar

PhD Guide: Dr. Ganapati V Shanbhag

The synthesis of 2-imidazolidinone using a nontoxic CO<sub>2</sub> as carbonyl source has drawn greater attention as carbon dioxide is abundant, which can be used as C1 feedstock for chemical synthesis. During this period, different concentration of zinc oxide loaded Hydroxyapatite (HAP) catalysts have been screened and 13% Zn-HAP showed 60% conversion for ethylene diamine and 96% selectivity for 2-imidazolidinone. Different catalyst characterizations such as XRD, N<sub>2</sub>-sorption, CO<sub>2</sub> and NH<sub>3</sub>-TPD has done to study about the active species. So further catalyst characterization such as SEM, TEM and XPS has to be done to understand its active sites, morphology and metal-support interaction. Design of experiments will be employed using response surface methodology to optimize reaction conditions.

Status of the work: Work under progress

## **5) Cycloaddition of propylene glycol to propylene carbonate via CO<sub>2</sub>**

(Sponsored by Vision Group on Science & Technology, CESEM, Govt. of Karnataka, 3<sup>rd</sup> year)

Research Guide: Dr. Ganapati V Shanbhag

Research fellow: Mr. Sujith S.

Cyclic carbonates are attractive and promising chemical for its wide applications in batteries, inert solvent, and raw materials for polycarbonate resin. The proposed method is greener

mainly because water is only byproduct whereas epoxide route high reactivity or toxicity and requires careful handling. Initial screening of various mixed metal oxide catalysts for propylene glycol to propylene carbonate via CO<sub>2</sub> was performed. Interestingly, The Copper Molybates catalyst has shown equivalent yield compared with the reported catalyst (CeO<sub>2</sub>). Additionally, The Cu<sub>3</sub>Mo<sub>2</sub>O<sub>9</sub> catalyst was synthesized by varying capping agent and the catalyst activity showed better results for the PEG-400. The work is completed and manus.

Status: In progress.

### **6) Selective synthesis of furfuryl acetate from furfuryl alcohol over solid acid catalysts and active site exploration using Density Functional Theory”**

Research Guide: Dr. Ganapati V Shanbhag

Research fellow: Ms. Vaishnavi B.J.

Furfuryl acetate is obtained from the esterification of biomass derivative furfuryl alcohol which has potential applications as a biofuel additive, fragrance, and flavoring agent. Herein, various catalysts such as zeolites, mesoporous materials, ion-exchanged macro reticular resin, silicoalumino phosphates with diverse physicochemical properties such as porosity, strength and amount of acidity, topology, and material stability were investigated for this transformation. Catalysts were characterized by various techniques. Sulfated zirconia was the best performing catalyst which exhibited the highest furfuryl acetate yield of 95% at a low catalyst loading and reactants mole ratio with a good recyclability. The excellent catalytic activity of three top-performing catalysts (sulfated zirconia, SAPO-11 and Al-SBA-15) was explained using adsorption energies of various species on the catalyst by Density Functional Theory (DFT) studies. Importantly, a new method of correlation was developed with respect to hydrogen removal energy of the catalysts obtained from DFT which correlated well with the catalytic performances of distinctly different solid catalysts.

Status: The work is published in prestigious Catalysis Science and Technology Journal (RSC) with impact factor of 6.1

### **7) Hydrolysis of furfuryl alcohol to yield Levulinic acid using Sulfonic acid-functionalized flexible SO<sub>3</sub>H-Metal Organic Framework**

Research Guide: Dr. Ganapati V Shanbhag

Research fellow: Ms. Vaishnavi B.J.

Sulfonic acid-functionalized flexible MOF with one-dimensional channels with wide range of chemical stability was studied to efficiently convert Furfuryl alcohol to Levulinic acid via hydrolysis. It can be concluded that sulfonic acid moieties are the active site that helped to obtain the highest LA yield so far. Importantly densely populated acidic sites present throughout the channel contributed to the excellent catalytic activity (FA Conversion >99% and LA Selectivity- 98%) at the optimized reaction conditions. There was no leaching of the actives species and the material showed very good recyclability up to 4 cycles. SO<sub>3</sub>H-MOF, owing to its high density of -SO<sub>3</sub>H sites in its pores, accessible channels, and good thermal and chemical stability, this MOF presents excellent catalytic performance for any Brønsted acid-driven catalytic reaction.

Status: Manuscript under preparation

### **8) Alcoholysis and esterification of biomass-derived feedstocks to yield alkyl levulinate using metal-organic framework**

Research Guide: Dr. Ganapati V Shanbhag

Research fellow: Ms. Vaishnavi B.J.

SO<sub>3</sub>H-MOF proved to be the potential catalyst for the two-pathway transformation. The high-density sulfonic acid functionalized metal-organic framework, SO<sub>3</sub>H-MOF, has shown the highest yield towards ethyl levulinate of 99 and 97% respectively for both the pathways viz. alcoholysis and esterification at lower reactant mole ratio, catalyst loading, and temperature. It can be concluded that sulfonic acid moieties are the active site that helped to obtain the highest alkyl levulinate yield for both the transformations. There was no leaching of the active species observed and the material showed very good recyclability up to 4 cycles. The catalytic application for the SO<sub>3</sub>H-MOF, has not been explored well as it is new material. Due to its

densely arranged Brønsted acidic sites in the channels of the MOF, this new MOF can be used for various organic transformations for fine chemical synthesis in the future.

Status: Published

### **9) Tuning of zinc oxide with basic metal oxide for heterogeneous catalysis and their application in organic carbonate synthesis using sequestered CO<sub>2</sub> source**

Research fellow: Mr. Harsha M

PhD Guide: Dr. Ganapati V Shanbhag

Ethylene carbonate (EC) is an important five-membered alkylene carbonate. It has found many applications as an inert solvent and reactive intermediate. Since EC has high boiling and flash points, low toxicity, and high solvency, it has been considered an attractive solvent. As a reactive intermediate, EC can be used to synthesize polyurethane, dialkyl carbonates, urea and many more. In addition, EC can be used as an electrolyte in lithium-ion batteries. Thus, much attention has been paid to synthesizing EC. Several chemical routes have been reported for the production of EC. The phosgene route, reaction using diols and alkyl trichloro acetate, carbon dioxide insertion into oxirane, the reaction between carbon dioxide and glycol, and the reaction of ketal with carbon dioxide. The major drawback of these routes is the use of toxic compounds and the low yield of EC. Therefore, using ethylene glycol and urea is a better route for the synthesis of EC. In this work, zinc oxide on basic metal oxide was studied as a catalyst. The different catalysts were screened and metal composition was optimized.

Status: Under progress

### **10) One-pot synthesis of $\gamma$ -Valerolactone from furfural/furfuryl alcohol via transfer hydrogenation using modified clay based catalyst**

Research fellow: Meghana H K

PhD Guide: Dr. Ganapati V Shanbhag

Gamma Valerolactone (GVL) is a first choice as a “green solvent” as it possesses excellent

physical and chemical properties such as high boiling point, low melting point, high dielectric constant and low viscosity. The cascade reactions take place with a combination of both Lewis and Bronsted acid sites. The Lewis acid sites catalyse the transfer hydrogenation steps and the Bronsted acid sites catalyse the alcoholysis of furfuryl alcohol to alkyl levulinate step. Zirconium ion exchanged with montmorillonite clay although gave promising conversion and selectivity towards GVL. This could however be improved by multiple ion exchanges. A Zn-MMT nanohybrid was also prepared and screened for the reaction. It failed to display good conversion or selectivity towards GVL.

**Status-** Under progress

### **11) Treatment of Van Der Waals dispersion forces for layered MXenes in the framework of DFT**

Research fellow: Mr. K M Rajashekhar Vaibhava

PhD Guide: Dr. Ganapati V Shanbhag

First-principles calculations are performed within the context of density functional theory using the generalized gradient approximation with the Perdue–Burke–Ernzerhof (PBE) exchange–correlation functional and the projected augmented wave (PAW) approach with plane wave cutoff energy of 50 Ry, as implemented in the Quantum Espresso code.  $14 \times 14 \times 1$  k-points mesh in the Brillouin zone of the unit cell is employed. In this work we have calculated Binding energy values between two layers. This done to quantify the energetic differences between different VdW methods employed. The inter layer distance was set to  $7 \text{ \AA}$ . Also, we have calculated electronic properties of the materials such fermi energy and conduction band level, valence band level if applicable for both mono and bi-layered systems. For bi-layered systems the inter layer distance calculated in the previous studies are used. To avoid the



interaction in c direction we have extended the c axis to 35 Å and kept the original unit cell dimension in a and b. These calculations are performed for Sc<sub>4</sub>C, Ti<sub>4</sub>C, V<sub>4</sub>C, Cr<sub>4</sub>C, Zr<sub>4</sub>C, Nb<sub>4</sub>C, Mo<sub>4</sub>C, Hf<sub>4</sub>C, Ta<sub>4</sub>C and W<sub>4</sub>C MXenes with Fluorine and Oxygen terminations. This study is performed to understand the ability of different VdW methods to account the VdW binding force. The different VdW methods employed are D2, D3, XDM and VdW-DF2.

Status: Under progress

## **B) Events and Achievements (2022-2023):**

### **Publications:**

1. Vaishnavi B.J., Vaibhava K.M.R., Sujith S., Harsha M., Meghana A., Vetrivel R., Shanbhag G.V.\* The influence of catalyst structure on acidic strength of –SO<sub>3</sub>H groups for alkyl levulinate synthesis from biomass-derived feedstocks using sulfonic acid functionalized flexible MOF catalyst Author links open overlay panel (2024) **Chemical Engineering Journal**, 491, 151724 DOI: 10.1016/j.cej.2024.151724
2. Manal, A.K., Shanbhag, G.V., Srivastava, R. Design of a bifunctional catalyst by alloying Ni with Ru-supported H-beta for selective hydrodeoxygenation of bisphenol A and polycarbonate plastic waste (2023) **Applied Catalysis B: Environmental**, 338, art. no. 123021, DOI: 10.1016/j.apcatb.2023.123021
3. Sujith, S., Vaishnavi, B.J., Kamath, G., Kumar, R.R., Reddy, R.S., Valavarasu, G., Ravishankar, R., Maradur, S.P., Bennet, C., Shanbhag, G.V., Highly selective aromatization of light naphtha using mesoporous aluminosilicate catalysts and theoretical model for predicting activity (2023) **Journal of Porous Materials** 30, 1069–1083
4. Kulal, N., Bhat, S.S., Hugar, V., Mallannavar, C.N., Lee, S.-C., Bhattacharjee, S., Vetrivel, R., Shanbhag, G.V. Integrated DFT and experimental study on Co<sub>3</sub>O<sub>4</sub>/CeO<sub>2</sub> catalyst for direct synthesis of dimethyl carbonate from CO<sub>2</sub> (2023) **Journal of CO<sub>2</sub> Utilization**, 67, art. no. 102323
5. Dmello, M.E., Vishwanathan, S., Bakuru, V.R., Shanbhag, G.V., Kalidindi, S.B. Metal-Organic Framework-Derived Co-Doped ZnO Nanostructures Anchored on N-Doped Carbon as a Room-Temperature Chemiresistive Hydrogen Sensor (2023) **ACS Applied Nano Materials**, 6, 1, 238–247
6. R. K. Jha, M. Manikandan, M. Prabu, N. R. Vineeth, P. Dharmalingam, R. Archana, **M. Harsha**, S. R. Shankar, K. Bhatte, T. Raja Temperature-Controlled Hydrothermal Synthesis of α-MnO<sub>2</sub> Nanorods for Catalytic Oxidation of Cyclohexanone, **ChemPlusChem**, 2024, e202300589 in press. (**Collaboration work with CSIR-NCL, Pune**).

### **Patents:**

Catalyst for carbon dioxide hydrogenation to methanol and method of preparation thereof, (2023) **Indian Application number:** 202341022626, Inventors: S. Kotni, G. Valavarasu, G. V. Shanbhag, R. Vetrivel, A. B. Halgeri, S. Sujith, C. N. Mallannavar and K.M.R Vaibhava (filed by HPCL; outcome of collaborative project).

### **Book Chapter:**

**B J Vaishnavi and Ganapati V. Shanbhag** Chapter 24: **Catalytic hydrogen generation from biomass and its derivatives** in the book: Handbook of Emerging Materials for Sustainable Energy, Jan 2024, Elsevier, USA.

### **Successful completion of the industry sponsored project:**

A project sponsored by Sulzer-GTC Technology Inc, USA was successfully completed its 3<sup>rd</sup> term in December 2023. The novel solid catalysts were designed for the transformation of natural gas and LPG via halogen mediation to make value added products like alkenes, ethers,

alkylated amines, carbon etc in batch and continuous mode. Dr Nikolay Nesterenko, Head, Technology Commercialization Gas Solutions CFCL of Suzer Chemtech, Zurich visited PPISR from 21<sup>st</sup> to 24<sup>th</sup> June, 2023. During these 4 days, there were series of review meetings on the sponsored project that was conducted since two and half years at PPISR sponsored by Sulzer GTC. He appreciated the overall progress made in this project by Dr. Shanbhag and his team.

#### **Agreement and initiation of a new sponsored project:**

Dr. Shanbhag wrote a proposal on CO<sub>2</sub> mineralization related work for SABIC and it was accepted for a 1 year and 3 months project. An agreement was signed for the first time with SABIC for a sponsored project and the project was initiated in October 2023.

#### **Keynote/ Invited as speaker for international conferences/workshops:**

1. Dr. Ganapati Shanbhag was nominated as **speaker at an International Conference** on "Catalysis Engineering and Technology" (CET-2023) which was scheduled on June 14-16, 2023 **in Dubai, UAE**. This conference was conducted in collaboration with Catalysis Society of India.
2. Dr. Ganapati Shanbhag gave a **Key note address** and also **chaired the technical session** at a three days **International Conference** on, "Green Chemistry Solutions for Sustainable Future (ICGCSF-2023)" organized by **GITAM university**, Bengaluru Campus in association with Catalysis Society of India (CSI), Bengaluru Chapter, from 20<sup>th</sup> to 22<sup>nd</sup> September, 2023.
3. **Dr. Ganapati V. Shanbhag** was invited as a speaker for National Workshop on Futuristic Catalysts and Catalytic Processes (NWFCCP-2024)" during February 15–16, 2024 organized by **Central University of Kerala, Kasargod**, Kerala. He gave a talk on "Chemical fixation of CO<sub>2</sub> by converting into value added chemicals using heterogeneous catalysts."
4. **Dr. Ganapati V. Shanbhag** delivered an invited lecture for the MSc Chemistry students of **The Oxford College of Science**, Bengaluru on 26<sup>th</sup> February 2024 on "Catalysis and its role in the eco-friendly synthesis of fuels and chemicals."
5. Dr. Shanbhag gave an **invited talk** on "Catalysis and its role in the green synthesis of fuels and chemicals" in a programme sponsored by **Royal Society of Chemistry** in association with **PPEC**, at Sadashivnagar campus on November 21, 2023 as a part of Science Exhibition by high school students and invited talks related to Chemistry.

#### **Best Presentation award**

1. **Dr. Vaishnavi B. J.** student of Dr. Shanbhag won **best ORAL presentation** award for her research on "Combinational approach of experimental and DFT for alkyl levulinate synthesis from biomass-derived feedstocks using sulfonic acid functionalized flexible MOF catalyst" at three days International Conference on, "Green Chemistry Solutions for Sustainable Future (ICGCSF-2023)" organized by Department of Chemistry, GITAM University from 20<sup>th</sup> to 22<sup>nd</sup> September, 2023.
2. Mr. Harsha M., student of Dr. Shanbhag won a "**First prize**" in **\*Best Poster presentation award\*** during National workshop on "Futuristic Catalysts and Catalytic Processes" organized by Central University of Kerala, Kasargod during February 15–16, 2024.
3. **Presentations at conference/workshop**
4. **Mr. Harsha M.** delivered an ORAL presentation on "Design of bimetallic oxide solid catalysts for cycloaddition of polyols by CO insertion to obtain cyclic carbonate" at ICGCSSF-2023 international conference organised by GITAM University from 20<sup>th</sup> to 22<sup>nd</sup> September, 2023.
5. **Ms. Chaitra N. Mallannavar**, gave an ORAL presentation on her research work titled "Cycloaddition of CO<sub>2</sub> into styrene oxide to yield styrene carbonate using mixed metal oxide dispersed silanol rich mesoporous SBA-15 catalyst" at the International Conference ICGCSF-2023 Organized by GITAM University from 20<sup>th</sup> to 22<sup>nd</sup> September, 2023.

6. **Ms Meghana H.K.** gave an ORAL presentation titled “Transesterification of glycerol with DMC to produce glycerol carbonate using a Zn-Sn bifunctional catalyst” at the International conference ICGCSF-2023, held at GITAM University, from 20<sup>th</sup> to 22<sup>nd</sup> September, 2023.
7. **Ms. Sujith S.** delivered an ORAL presentation titled “Carbonylation of propylene glycol with CO<sub>2</sub> to produce propylene carbonate over bimetallic Cu-Mo oxide catalyst” at the International conference ICGCSF-2023, held at GITAM University, from 20<sup>th</sup> to 22<sup>nd</sup> September, 2023.
8. **Ms. Chaitra N. M.** participated and gave Oral presentation on “Catalytic fixation of CO<sub>2</sub> by cycloaddition with styrene oxide for the synthesis of styrene carbonate using mixed metal oxide dispersed silanol rich mesoporous SBA-15 catalyst” at International Winter School and Conference, themed "Recent Advances in Materials (RAM-90)" from December 04-09, 2023 at JNCASR, Bengaluru.
9. **Mr. Sujith S., Mr. Harsha M. and Ms. Meghana H.K.** presented their respective research works at REVA University is organized the 3<sup>rd</sup> International Conference on Global Trends in Sustainable Technology and its Applications in Applied Sciences (GTSTAAS-2023) during 30-31, October, 2023 at REVA University, Bengaluru.
10. **Mr. Sujith S. and Mr. Rajashekhara Vaibhava** attended and presented their work at DFT workshop (Computational Design of Electrocatalyst) and 3<sup>rd</sup> international conference on Materials Genome organized by SRM University, Guntur, Andhra Pradesh with the National Supercomputing Mission, from 18-24 February 2024.

#### **MSc Internship projects:**

1. **Ms. Swathi Shetty**, from St Aloysius College, Mangaluru conducted her 2 months MSc internship project from June 5 to August 4, 2023 with Dr. Ganapati Shanbhag on the topic titled “Synthesis of cyclic urea from CO<sub>2</sub> and diamines using Zn -based solid acid-base catalyst”
2. **Ms. Vaishnavi Pai**, from St Aloysius College, Mangaluru conducted her 2 months MSc internship project June 5 to August 4, 2023 with Dr. Ganapati Shanbhag on the topic titled “Synthesis of methyl N-phenylcarbamate via aromatic amine carbonylation with dimethylcarbamate using supported iron oxide catalyst”
3. **Mr. Shashank B.**, from Mangalore University, Dept. of Chemistry, Mangaluru conducted his MSc internship project from 1<sup>st</sup> September to 13<sup>th</sup> October 2023. with Dr. Ganapati Shanbhag on the topic titled “Synthesis of methylphenyl carbamate from aniline and dimethyl carbonate using metal supported on g-C<sub>3</sub>N<sub>4</sub> catalyst.”
4. **Mr. Ajith K. G**, from Jnana Kaveri PG Centre, Chikka Aluvara, Kushalanagar conducted his MSc project September 12 to November 4, 2023 with Dr. Ganapati Shanbhag on the topic titled “Synthesis of amino alcohols from styrene oxide and aniline using cobalt loaded on g-C<sub>3</sub>N<sub>4</sub> catalyst.”
5. **Ms. Ria Majumdar.**, from Mount Carmel College, Dept. of Chemistry, Bengaluru conducted her MSc internship project from 16<sup>th</sup> November 2023 to 7<sup>th</sup> January, 2024 with Dr. Ganapati Shanbhag on the topic titled “Synthesis of Flavanone and Chalcone via Claisen Schimdt Reaction using Metaloxyhydroxide as Catalyst.”
6. **Ms. Dia Sajan**, from Mount Carmel College, Dept. of Chemistry, Bengaluru conducted her MSc project 16<sup>th</sup> November 2023 to 7<sup>th</sup> January, 2024 with Dr. Ganapati Shanbhag on the topic titled “Synthesis of Flavanones and Chalcones through Claisen-Schmidt Condensation using Zeolitic Imidazole Frameworks (ZIFs) as Catalysts.”

#### **PhD thesis Examiner for a CSIR institute:**

Dr. Ganapati Shanbhag was invited by The Academy of Scientific and Innovative Research (AcSIR), Govt of India as PhD thesis examiner of a PhD student from one of the CSIR institutes in August 2023.

### **DAC Member for MIT, Manipal PhD student**

Dr. Ganapati Shanbhag invited to be the DAC member as subject expert for PhD student of Dept. of Mechanical and Manufacturing Engineering, Manipal Institute of Technology, Manipal in April 2023.

### **Invitation from a prestigious Journal to submit research work:**

Dr. Shanbhag received an invitation to submit his research from prestigious Green Chemistry (RSC) Journal.

### **Sulzer GTC project review meeting with Dr. Nikolay Nesterenko, Head, Global Solutions, Sulzer**

Dr Nikolay Nesterenko, Head, Technology Commercialization Gas Solutions CFCL of Suzer Chemtech, Zurich visited PPISR from 21<sup>st</sup> to 24<sup>th</sup> June, 2023. During these 4 days, there were series of review meetings on the sponsored project that was conducted since two and half years at PPISR sponsored by Sulzer GTC. The meetings were attended by Dr. Nikolay, Dr. A. B. Halgeri, Dr. Ganapati Shanbhag, and others involved in the project. Dr. Shanbhag presented the detailed results of all the project work and there were discussions of the progress made in this project and future directions. Dr. Nikolay also visited the labs and inspected all the reactors, experimental details and analytical instruments and methods that were used for the project work. He also gave a talk on the overview of Sulzer company and the specific technical information on the ongoing project work. He expressed his happiness on the overall progress made in this project and appreciated the efforts that is being put by the PPISR team for this project.

### **Online Project review meetings:**

Sulzer GTC, USA has been conducting **weekly review meetings** for its sponsored project online attended by their respective teams and Dr. A. B. Halgeri (Project Coordinator, Sulzer GTC) Dr. Ganapati Shanbhag (Principal Investigator, Sulzer GTC) presented the results of the whole week and the teams discuss the next strategy to move further in the project.

### **New project proposal meetings with industry executives**

1. Dr. Raman Ravishankar, Deputy General Manager, HPCL, Govt. of India visited PPISR on June 30, 2023 and discussed with Dr. Ganapati Shanbhag on the new project proposal on a topic of mutual interest. Subsequently, Dr. Shanbhag wrote a proposal and submitted to HPCL.
2. Dr. Ravi Hegde, Lead Scientist, SABIC R & D Centre, Bengaluru visited PPISR on August 3, 2023 and discussed with Dr. Ganapati Shanbhag about a new project proposal from SABIC.

### **Ph.D. open defence viva and award:**

Ph.D. open defence viva of Ms. Vaishnavi B. J., was held on Friday, July 14, 2023 at Poornaprajna Auditorium, Devanahalli Campus. The title of her thesis is "Designing novel catalysts for conversion of biomass derivatives furfuryl alcohol and levulinic acid into value-added chemicals" External examiner: Dr. Shubhangi Umbarkar, Senior Principal Scientist and Chair, Inorganic Chemistry & Catalysis Division, CSIR-National Chemical Laboratory (NCL), Pune and MAHE representative, Dr. D. H. K. Murthy, Associate Professor, Dept. of Chemistry, MIT, Manipal were present during the Viva. Internal Examiner and PhD Guide Dr. Ganapati V. Shanbhag (Guide), Ph.D. Coordinator: Dr. Ananda K., PPISR, Director Dr. A. B. Halgeri, other faculty and students of PPISR were also present. Ms. Vaishnavi successfully defended her thesis and answered all the questions posed by the examiners and audience. She was subsequently awarded the Ph.D. degree by MAHE (deemed to be University), Manipal.

### **PhD Protocol meeting conducted by MAHE:**

1. PhD Protocol meeting conducted by MAHE (deemed to be University) for Mr. Rajashekhar Vaibhava on 7<sup>th</sup> August, 2023 in a virtual mode. He presented his synopsis on his PhD topic titled "DFT and Quantum Computing studies of layered MXenes and their applications in catalysis by the inclusion of Van der Waals dispersion forces."
2. PhD Protocol meeting for Ms. Meghana H. K. was conducted virtually by MAHE (deemed to be University) on 14<sup>th</sup> December, 2023 in the presence of her guide Dr. Shanbhag. She presented her synopsis on her PhD topic titled "Transformation of hemicellulose-based xylose sugar and its derivatives into value-added chemicals using solid catalysts."

### **New Recruitments:**

1. **Mr. Magudeshwaran N.** : He completed his BE in Chemical Engineering from SSM College of Engineering, Tamil Nadu. in 2023 and also holds a diploma on Petrochemical Engineering,. He joined as Research Engineer in Dr. Shanbhag's group in Sulzer GTC, USA sponsored project on June 20, 2023.
2. **Mr. Kavi Raj:** He completed his MSc from Madurai Kamaraj University, Tamil Nadu. in 2023 and joined as Research Engineer in Dr. Shanbhag's group in Sulzer GTC, USA sponsored project on July 7, 2023.
3. **Mr. Tejas Madane** secured his BE in Chemical Engineering from Dayanand Sagar College of Engineering, Bengaluru in 2023 and joined in Sulzer GTC, USA sponsored project under the supervision of Dr. Ganapati Shanbhag on July 19, 2023.
4. **Mr. Ganesh N:** He completed his MSc from Tumkur University, Karnataka in 2023 and joined as Research Fellow in Dr. Shanbhag's group in Sulzer GTC, USA sponsored project on November 22, 2023.
5. **Mr. Sree Karthikeyan** secured his B.Tech. in Chemical Technology from Excel College of Engineering and Technology, Tamil nadu in 2023 and joined in Sulzer GTC, USA sponsored project under the supervision of Dr. Ganapati Shanbhag on November 29, 2023.
6. **Ms. Harshitha C:** She completed her BE in Chemical Engineering from Ramaiah Institute of Technology, Bengaluru in 2022. She joined Dr. Shanbhag's research group on December 1, 2023 to work in the project sponsored by SABIC Research and Technology Pvt. Ltd.



**Dr. Sanjeev P. Maradur**

**Associate Professor**

Materials Science & Catalysis Division

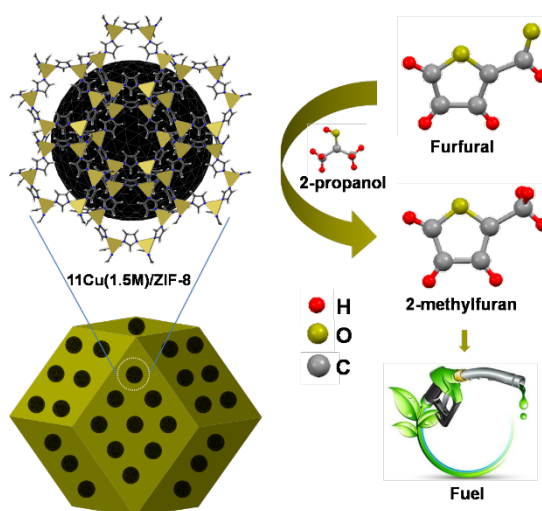
E-mail: [sanjeevpm@ppisr.res.in](mailto:sanjeevpm@ppisr.res.in)

### RESEARCH INTERESTS:

Our group is working on a class of advanced materials, which share the advantages of both mesostructured materials and polymers of organic frameworks. The organic framework can provide numerous opportunities to tailor the chemical properties through the incorporation of a wide variety of useful organic functional groups by grafting or co-condensation. These polymers provide us with good opportunities for designing novel and innocuous support for heterogenization of a homogeneous catalyst as well as catalysts by itself. Also, we are working on conversion of biomass platform chemicals such as glycerol, furfural and bio alcohols to value added products.

Recently we started exploring metal organic frameworks (MOF's) for catalytic applications. Metal-organic frameworks (MOFs) are the emerging porous materials that have acquired staggering attention owing to its unique properties such as high specific surface area (SSA), intrinsic porosity, and tailorable chemistry. Catalysis by MOFs mainly depends on the active sites, both metal centres and organic linkers. "MOFs for heterogeneous catalysis" is particularly an attractive prospect, because the well-defined pore surface chemistry of MOFs allows much desired structure-activity relation to be established which is very difficult to achieve in many of the traditional heterogeneous catalysts. Especially, with the development of MOFs with excellent thermal/chemical stabilities. MOFs have been explored for various catalytic applications in recent times. In couple of our research projects, we have utilized UIO-66 based MOF catalysts for organic transformations and published the results in high impact factor journals. Our group in has published 4 research articles in MOF based catalysis research and 3 articles in collaboration with Andra University Vishakhapatnam.

Our group continued collaboration with MAHE Manipal in the area of photocatalysis, Amritha University on deoxydehydration of polyols to olefins and Christ University Bengaluru on carbon materials for catalytic applications.



### Training of Students:

PhD Awarded : 02  
Guiding as PI/CoPI : 01  
MSc Project completed : 20  
B.Tech/M. Tech. Project completed: 07

## **RECOGNITIONS/ACHIEVEMENTS:**

1. Received “**Award for Best Publication**” in Metallurgical and Materials Science Category, from Vision Group on Science & Technology (VGST, Govt. of Karnataka 2019-2020).
2. Received **Seed Money for Young Scientist Research Program Award** from Vision Group on Science and Technology, Govt of Karnataka in 2014.
3. 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.
4. 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.
5. Life member of Catalysis Society of India (CSI).

## **STUDENTS**

### **Alumni:**

1. Dr Manjunathan P. (Co-guide)
2. Dr Sathyapal R. Churiparad (Guide)
3. Dr. Kempanna S. Kankikodi (Guide)

### **PhD Students**

1. Ms. Bhavana B. Kulkarni
2. Mr. N. S. Huchcheshwarmath

### **Project Fellow**

1. Mr. Purohith Kumar

## **RESEARCH:**

**Industry Sponsored Project: “Rationalization of Yield Prediction Guided by Computational Insights”.** Sponsored by Sravathi AI Technology Pvt Ltd (SAITPL), Bengaluru Jan 2022 to Mar 2024.

Principal Investigator: Dr. Sanjeev P. Maradur Co-PI: Dr Rajappan Vetrivel, Dr. Ganapati V. Shanbhag

Research Student: Mr. Purohith Kumar

The DFT calculations for some of the important reactions which are reported in the literature will be carried out and then the properties will be extracted using the python script, the experimental yield is included along with these DFT properties to create a Dataset. The dataset will be subjected to QSAR analysis to find out the significant properties affecting the yield of the reaction. Tuning those properties while machine learning model building will improve the performance of the machine learning model. A Machine Learning model which can predict the yield of the reaction using multiple DFT properties will be the goal of this study.

**Status:** Completed successfully.

## **ACADEMIC PROJECTS**

1. **Catalytic transfer hydrogenation of biomass-derived furfural to 2-methylfuran over multifunctional Cu NPs@ZIF-8 MOF catalyst**  
**Principal Investigator: Dr. Sanjeev P. Maradur**  
Research Student: Bhavana B. K.



The hydro-deoxygenation of furfural to 2-methylfuran (2-MF) by catalytic transfer hydrogenation (CTH) is a selective route to remove the excess oxygen containing functional groups in the biomass-derived feedstocks. CTH reaction involves the use of alcohols as hydrogen donor source instead of high-pressure exogenous hydrogen, thus making the process highly economic and inexpensive. The 2-methylfuran obtained by the selective hydro-deoxygenation of furfural is an important organic chemical intermediate, as widely used in medicines, pesticides, and fine chemicals. In addition, the oxygenation-containing 2-MF has good combustion performance, high energy density, and high octane number, is a very competitive biomass-derived gasoline alternative fuel. The reaction scheme involves hydrogenation of furfural to furfuryl alcohol which on subsequent hydrogenolysis produces 2-MF. Even though numerous studies have been reported on the conversion of furfural to 2-MF, very few catalysts have been developed for the CTH of furfural. To the best of our knowledge, there are no reports available on the MOF catalysed CTH of furfural. Herein, Cu NPs@ZIF-8 material has been synthesized and used in the CTH of furfural.

**Status:** Ongoing

## 2. **Deoxydehydration of polyols to olefins catalysed by Organometallic di-oxo molybdenum complexes**

**Students:** Bhavana. B. K, and Nakul (Amritha University)

**Collaborators:** Dr Sanjeev P. Maradur, Dr. Naveen Kulkarni (Amritha University)

Research Student: Bhavana B. K.(PPISR), Mr. Nakul (Amritha University)

Biomass deoxygenation and up-conversion have gained popularity as methods to produce commodity chemicals currently produced by the petrochemical industry. Deoxydehydration (DODH) is a promising route for converting biomass-derived diols and polyols into alkenes and dienes. The reaction converts vicinal diols into alkenes, typically using high oxidation state metal-oxo complexes as catalysts and PPh<sub>3</sub> or secondary alcohols as reductants. DODH was first reported by Cook and Andrews. Cp\*ReO<sub>3</sub> was used as a precatalyst to convert 1-phenyl-1,2-ethanediol to styrene with PPh<sub>3</sub> as an oxo-acceptor and reductant. Toste and co-workers have demonstrated that MeReO<sub>3</sub> is an excellent catalyst using secondary alcohols as reductants. Other studies in the literature have shown that a wide variety of reductants can be used. Mechanistic studies of MeReO<sub>3</sub> by Abu-Omar and co-workers show that a reduced dioxo species is the active form of the catalyst. Recently, a handful of molybdenum complexes have been shown to be active for DODH at high temperatures and pressures. In this collaborative project, a series of 6 di-oxo molybdenum complexes were synthesized by Dr. Kulkarni's group and initial catalytic screening has been carried out at PPISR. Initial catalyst screening for the DODH reaction of 1,2-octane diol are promising with good selectivity for the olefin product. The NSMo<sub>3</sub> and NSMo<sub>7</sub> catalyst are found to be more active compared to other complexes in a series. Further optimization studies and substrate scope studies are planned and will be carried out.

**Status:** Ongoing

## 3. **Base-free oxidative esterification of 5-Hydroxymethylfurfural (HMF) to furan-2,5-dimethylcarboxylate (FDMC) using novel MOF-based Fe<sub>3</sub>O<sub>4</sub> NPs/Mn<sub>2</sub>O<sub>3</sub> catalyst**

**Principal Investigator:** Dr. Sanjeev P. Maradur

Research Student: Bhavana B. K.

Oxidative conversion of aldehydes to esters is an important transformation for the synthesis of fine and specialty chemicals. In this concern, the catalytic conversion of 5-**Hydroxymethylfurfural (HMF)** into **2,5-dimethylcarboxylate (FDMC)** involves the initial oxidation of the alcohol group into aldehyde group in methanol, and followed by oxidative esterification of the two aldehydes into esters in one-pot. Looking at the literature, the



oxidative esterification of HMF into FDMC has been rarely studied. Generally, noble metal catalysts demonstrated higher catalytic activity than the non-noble metal catalysts for the oxidative esterification reactions. The high cost of noble metal catalysts as well as the use of the base as the additives makes these processes less economic and environmentally friendly. For the sustainable manufacturing of chemicals from biomass, exploring high-performance non-noble metal catalysts is an important emerging goal, owing to their low cost, abundance in nature and favorableness for industrial application. Due to the intrinsic low activity of the non-noble metal catalysts, it is a great challenge to develop effective non-noble metal catalytic systems for the oxidative esterification of HMF into FDMC. Herein, a novel MOF-based Fe<sub>3</sub>O<sub>4</sub> NPs/Mn<sub>2</sub>O<sub>3</sub> material has been synthesized and applied for the oxidative esterification of HMF to FDMC under base-free conditions.

**Status:** Ongoing

4. **Mil-101 (Cr)-catalysed carboxymethylation of biomass-derived alcohols to organic carbonates**

**Principal Investigator: Dr. Sanjeev P. Maradur**

Research Student: **Bhavana B. K. and Sai Krishna**

Organic carbonates are significant intermediates in the chemical industry. They have been drawing increasing interest for various applications, as monomers for poly-carbonates and phosgene-free polyurethanes, as organic solvents, and manufacture of lithium batteries. The traditional processes for the synthesis of organic carbonates endure from limitations and still need the use of toxic reagents, like phosgene, dimethyl sulfate, carbon monoxide, and pyridine. On the other hand, Dimethyl carbonate (DMC) is an organic compound of concern owing to its extensive green credentials. It is biodegradable, non-toxic, and considered to be a green solvent. Thus, DMC is a green alternative to highly toxic and hazardous chemicals like halohydrocarbons and dimethyl sulfate in methylation reactions and phosgene in carboxymethylation reactions. DMC undergoes carboxymethylation with various alcohols to yield alkyl methyl carbonates or dialkyl carbonates without generating inorganic salts as the by-product.

**Status:** Ongoing

5. **Metal Functionalized Porous Hybrid Materials (M@MOF) for reduction of 4-nitrophenol to 4-aminophenol**

**Principal Investigator: Dr. Sanjeev P. Maradur**

Research Student: **N S Huchcheshwarmath.**

Nitroaromatic compounds are the important intermediates for several industries including pharmaceuticals, production of paper, petrochemical, fungicides, pesticides, insecticides, preservatives, explosives, dyes, leather, and wood. Nitrophenol derivatives such as 4-nitrophenol (4-NP) have been considered as non-biodegradable pollutants according to the U.S. Environmental Protection Agency (EPA). Hence, it is important to find an effective method to remove or modify these pollutants before they can be released into the environment. Para-nitrophenol (p-NP) is one of the hazardous and toxic pollutants, which is known to cause adverse health effects in living organisms. It is known to be anthropogenic, toxic and inhibitory in nature. The reduction of Nitrophenol. The catalytic reduction of p-NP is effective in many useful applications such as analgesic and antipyretic drugs, photo-graphic developer, corrosion inhibitor, anticorrosion lubricant, etc. for this catalytic reaction many noble metal-alloy nanoparticles has been reported, but reports on applications of precious-metal nanoparticles are quite limited. We focusing on the Precious-metal nanoparticles because of their significant properties of high activity. Here The material has been explored for the transformation of 4-Nitro phenol (4-NP) to 4-Amino phenol (4-AP) using NaBH<sub>4</sub> as hydrogenation agent with the help of UV-Vis spectrometer.

**Status:** Ongoing

## **RESEARCH HIGHLIGHTS: (only 2022-23)**

### **A. Publications**

1. “Highly selective aromatization of light naphtha using mesoporous aluminosilicate catalysts and theoretical model for predicting activity” S Sujith, BJ Vaishnavi, Girish Kamath, Ranjith R Kumar, R Sudarshan Reddy, G Valavarasu, Raman Ravishankar, Sanjeev P Maradur, C Bennet, Ganapati V Shanbhag, *Journal of Porous Materials*, 30 (2023) 1069-1083.
2. **Book Chapter:** “Mesoporous polymers for the catalytic conversion of biomass platform molecules to value-added chemicals” Bhavana B. Kulkarni, Kempanna S. Kankikodi, Sathyapal. R. Churipard and Sanjeev P. Maradur, Chapter 22, *Handbook of Emerging Materials for Sustainable Energy*, 493-526, Elsevier Publishing, 2024.
3. “Effect of morphology and their oxygen vacancies of nanostructured CeO<sub>2</sub> catalyst for carboxymethylation of biomass-derived alcohols” Kempanna S Kanakikodi, Nagendra Kulal, KS Subramanya, MS Puneethkumar, Bhavana B Kulkarni, Ganapati V Shanbhag, Sanjeev P Maradur\*. *Molecular Catalysis* 552 (2024) 113667.

### **B. Resource person/papers presented in conferences:**

1. Dr. Maradur gave an invited talk at Faculty Development Program on "Polymer Composites for Engineering Applications" (PCEA-2023) conducted by Department of Chemistry, B. M. S. College of Engineering, Bengaluru 23<sup>rd</sup> May 2023.
2. Dr. Maradur gave an invited talk to MSc students at BVV Science College Bagalkot on 5<sup>th</sup> August 2023.
3. Dr. Maradur delivered a keynote talk at the “International Conference on Nanotechnology Addressing the Convergence of Materials Science, Biotechnology and Medical Science” (IC-NACMBM-2024) to 12<sup>th</sup> February -2024 at Centre for Interdisciplinary Research (CIR), D. Y. Patil Education Society (Deemed to be university), Kolhapur, India.
4. Dr. Maradur delivered a talk on “Metal-Organic Frameworks (MOFs) Catalysis for Valorization of Biomass-Derived Chemicals" at Faculty Development Program on 'Innovations in Material Science and Analytical Techniques' BMS Institute of Technology & Management, Yelahanka, Bengaluru on 14<sup>th</sup> March 2024.

### **Other Scientific Activities**

1. Dr. Maradur in collaboration with Modelicon Infotech LLP, Bengaluru and Anukoolan Solutions Pune has submitted a proposal on “Pilot studies on direct air capture (DAC) for the removal of carbon dioxide” to Capture 6, California, USA. April 2023.
2. Dr. Maradur submitted a major research grant proposal on “Biorefining in a Circular Economy: Valorization of Agricultural Waste Rice Husk Derived Furfural to High Value Chemicals” for possible funding from Vision Group on Science and Technology (VGST), Govt of Karnataka (Ref No: VRN/001785/22-23 May 2023).
3. Scientists from High Performance Plastic India Pvt Ltd, A Unit of SABIC, Bengaluru visited PPISR on 6<sup>th</sup> June 2023 to discuss about possible research collaboration. Dr

Gaurav Mediratta, P, Sivakumar, Konda, Shivakumar, Dr. Satish Pandey, R K, Prashant from SABIC and Dr. Maradur, Dr Shanbhag, Dr. Naresh N, Dr A. B. Halgeri from PPISR attended the meeting. Dr Maradur made a presentation about the expertise and research capabilities at PPISR. Further discussions to work on a collaborative program is under process.

4. Scientists from Yokogawa, Bengaluru visited PPISR on 14th September 2023 to discuss about possible research collaboration. Mr. Ravikumar Ramamurthy, Mr. Prasenjit Das, Dr. Maharnob Sarkar and Mr. Rakesh Ramachandran from Yokogawa and Dr. Maradur, Dr Shanbhag, Dr. Ananda, Dr. Naresh N, Dr A. B. Halgeri from PPISR attended the meeting. Dr Maradur, Dr Naresh and Dr. Ananda made a presentation about the expertise and research capabilities at PPISR. Further discussions to work on a collaborative program is under process.
5. Ms. Bhavana Kulkarni delivered an oral presentation entitled “Cascade upgrading of bio-based furfural to 2-methylfuran by selective hydrodeoxygenation over a multifunctional metallic Cu NPs supported MOF material” at 3rd International Conference on “Global Trends in Sustainable Technology and its Applications in Applied Sciences (GTSTAAS – 2023)” from 30<sup>th</sup> to 31<sup>st</sup> October 2023, organized by ‘School of Applied Sciences’ REVA University in collaboration with ‘Indian Association of Applied Microbiologists’ and won 2<sup>nd</sup> prize in this oral presentation.
6. Bhavana B. Kulkarni has been awarded a poster prize from Nanoscale Horizons (RSC) at International Winter School on Frontiers in Materials Science and International Conference on Recent Advances in Materials (RAM-90), Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru, Dec 4-9, 2023.
7. Ms. Rainie Cherian, MSc student of Mount Carmel College Bengaluru joined Dr Maradur’s group for Student Research Internship from 16th November to 7<sup>th</sup> January 2024.
8. Ms. Bhavana Kulkarni completed 3 years after PhD registration on 29th October 2023. She presented her thesis colloquium on 29<sup>th</sup> December 2023. She has completed the minimum criteria for PhD thesis submission with 4 research articles published as author/coauthor and DAC members recommended her to go ahead with thesis writing.
9. Mr. Bharath B., MSc student of Department of Chemistry, Gitam University Bengaluru joined Dr Maradur’s group for Student Research Internship from February to April 2024.



**Dr. Naresh Nalajala**

**Assistant Professor**

Materials Science & Catalysis Division

E-mail: [naresh@ppisr.res.in](mailto:naresh@ppisr.res.in)

#### **BRIEF CV:**

- Assistant Professor, Department of Materials Science and Catalysis, PPISR Bangalore, India (01/07/2022 –To date).
- Pool Scientist, Catalysis division, CSIR-National Chemical Laboratory Pune, India (01/09/2020– 17/06/2022).
- Project Scientist, Catalysis division, CSIR-National Chemical Laboratory Pune, India (28/01/2019 – 31/03/2020).
- National Postdoctoral Fellow (NPDF) at Catalysis division, CSIR-National Chemical Laboratory Pune, India (23/01/2017 – 22/01/2019).
- Research Associate (RA) at Catalysis division, CSIR-National Chemical Laboratory Pune, India (25/05/2016 – 24/11/2016).
- Research Associate (RA) at Department of Energy Science and Engineering, IIT Bombay, India (18/09/2015 – 17/03/2016).
- Ph. D. in Nanomaterials for energy-conversion applications from IIT Bombay – Monash Research Academy, during 2010-2016.
- M-Tech in Materials Science and Engineering from NIT Tiruchirapalli, Tamilnadu, during 2008-2010.
- MSc in Physics from Andhra University affiliated PG college, Andhrapradesh, during 2004-2006.

#### **RESEARCH INTERESTS:**

##### **Exploring structural properties of metal oxide/metal hybrids for sensor and energy-conversion applications**

In general, well-defined single crystal surfaces are model systems which known to exhibit surface sensitive catalytic, electrocatalytic and photocatalytic properties and efforts are therefore made to translate the findings to bulk nanomaterials of practical importance. SHAPECAT is aiming at design and synthesis aspects of nanocrystals of different shapes of various metals (Pd, Pt, Ag, Au, Cu) and semiconductors ( $\text{TiO}_2$ ,  $\text{BiVO}_4$ ) of high selectivity in size, shape and composition. Further, the reagents used for the synthesis of size- and shape-controlled nanoparticles adsorb strongly on the surface and they adversely impact the surface properties. In this regard, surfactant removal from the shape-controlled nanoparticles is inevitable to study catalytic and electrocatalytic reactions. SHAPECAT is addressing on how to clean the nanoparticle surfaces by employing various methods such as solution phase methods, physical methods etc. In addition, SHAPECAT is interested in exploring the facet-engineered and well-integrated hybrid nanocrystals (Semiconductor (oxide based)/Metal) for sensor, catalytic, electro/ photocatalytic applications.

### **Rooftop photocatalyst panels for solar fuels and chemicals synthesis**

For instance, H<sub>2</sub> production from the particulate form of photocatalyst is hindered by several limitations; (a) decrease the efficiency to half when increase the loading to double due to inadequate material exposure to light, (b) prevalent light scattering rather than light absorption and therefore decrease in charge generation, (c) material disintegration due to mechanical forces which are persistent from the stirring, and (d) heavy material and infrastructure requirements which further increase the cost of hydrogen production. These issues can be successfully circumvented by taking the powder form of catalyst into thin film over a ordinary substrate. This approach is the inspiration from a leaf where all the components interconnected towards never ending photosynthesis process. In contrast to solar cell where electrons are needed to travel several microns distance to reach the contact, thin film photocatalysis provide the charge carriers locally and instantaneously utilize the charge carriers and complete the reaction that led to efficient hydrogen production. Not only aiming at the design of novel materials, SHAPECAT will be exploring on the design possibilities of photocatalyst panels with features of efficient and cost viable manner for synthesis of valuable chemicals (methanol, ammonia, ethanol) and fuels (H<sub>2</sub>) using inexhaustible resources (Water, CO<sub>2</sub>, N<sub>2</sub>, CH<sub>4</sub> and sunlight).

### **RECOGNITIONS/ACHIEVEMENTS/AWARDS/MEMBERSHIP:**

- Dr. Palle Ramarao Award-2020 from AP Science city, Andhrapradesh (AP), India.
- CSIR-Pool Scientist's Scheme fellowship (08/01/2020-07/01/2023)
- Associate fellow of Andhra Pradesh Academy of Sciences (APAS), 2018.
- National postdoctoral fellowship (23/01/2017 – 22/01/2019)
- DST RA fellowship under the grant no. GAP304026 (05/2016 – 11/2016)
- IIT Bombay research associate (RA) fellowship (09/2015 – 03/2016)
- Department of Science and Technology (DST) doctoral fellowship (07/2010 –08/2015)
- IITB-Monash Research Academy visiting fellowship (04/2014 – 06/2014)
- Ministry of Human Resource Development (MHRD) master's fellowship (06/2008–06/2010)
- Recognized as a Ph. D. guide with Manipal University, Udupi, Karnataka.
- Serving as a institute warden at PPISR, Bangalore.
- Serving as a mentor: Ph. D. thesis (2, ongoing), Master thesis (10, completed).
- Serving as a review editor for Frontiers in Physics (IF:3.54)
- Serving as a RSC Advances Reviewer Panel member
- Serving as a potential reviewer for various journals from prestigious publishers: Angew Chem International Edition (10) , ACS Industrial &Engineering Chemistry Research (1), Chemical Engineering Journal (2), iScience (1), Catalysis Communications (1), Chemistry Select (1), ACS Applied Materials and Interfaces (3), Langmuir (2), Reviews on Advanced Materials Science (1), Small methods (1), Journal of Industrial and Engineering Chemistry (1), Frontiers in Chemistry (2), Bulletin of Materials Science (2).

**STUDENTS (2023-2024):**

|   | <b>PhD students</b>   |
|---|-----------------------|
| 1 | Ms. Asha Devi K S     |
| 2 | Mr. Manjunath Reddy G |

**NATIONAL AND INTERNATIONAL COLLABORATORS:**

1. Dr. K Prabhakar Reddy, Brookhaven National Laboratory, USA
2. Prof. Gurumurthy, Department of Physics, MAHE, Manipal.
3. Prof. K. Suresh K, Associate Professor, Department of Chemistry, Central Tribal University of AP.
4. Dr. Sachin Rondiya, Assistant Professor, Department of Materials Engineering, IISc Bangalore.

**A. RESEARCH 2023-2024:****CURRENT FUNDING:**

1. Design and development of UV-visible light active rooftop photocatalyst panels for green H<sub>2</sub> generation and value added chemicals from sunlight harvesting (Role: Principle investigator; budget: INR 29 Laks duration: 24 months; status: Ongoing). (Startup Research Grant (SRG-SERB), 2023-25)
2. Shape-engineered nanocrystals for solar H<sub>2</sub> and valuable chemicals from sunlight harvesting (Role: Mentor, DST-Inspire Doctoral Fellowship for Ms. Asha Devi, duration: 2023-2028). Status: Ongoing
3. Semiconductor Oxide-Crystalline Framework Hybrid Gas Sensors: Advancing Hydrogen Detection Across a Wide Dynamic Range (Role: Co-Principle investigator; budget: INR 35 Laks duration: 36 months; status: Ongoing). (BRNS, 2024-2027)

**CURRENT PROJECTS:****1. Unraveling the phase engineering of TiO<sub>2</sub> for H<sub>2</sub> gas sensing applications****Research Student: Ms. Asha Devi****Principle Investigator: Dr. Naresh Nalajala**

Hydrogen is becoming increasingly important in light of the world's growing energy needs due to its efficiency and environmental friendliness. However, because of its flammability, there are safety concerns, and necessitates early detection at various ppm levels (from ppb to 10%) at ambient temperatures. The present study investigated the phase engineering of TiO<sub>2</sub> for H<sub>2</sub> gas sensing behavior; to establish this, TiO<sub>2</sub> sensors with different phases (pure anatase, pure rutile, bi-phase (anatase and rutile), and tri-phase (anatase, rutile, and brokite)) and their Pd-modified counterparts opted. It is interesting to observe that, at room temperature (25°C), the TiO<sub>2</sub> sensor with pure anatase phase (A=100) is more active (better response time and % response) compared to the sensor with the dominant rutile phase (A=0). On the other hand, at 25°C, the A=0 sensor exhibited the best performance (response time and % response) among the others after Pd sensitization, emphasizing the importance of synergy between crystalline phases of support (TiO<sub>2</sub>) with metal (Pd) and thus

underscores the strong metal support interaction (SMSI). The present investigation on phase engineering of TiO<sub>2</sub> sensors unveils new scientific knowledge to design and develop efficient and stable sensors that work under ambient (preferably 25-100°C) temperatures and a wide range of analyte concentration conditions.

**Status: Manuscript under communication**

## **2. Shape-engineered nanohybrids for solar H<sub>2</sub> and value added Chemicals**

**Research Student: Ms. Asha Devi**

**Principle Investigator: Dr. Naresh Nalajala**

This work investigate the synergistic effect between the semiconductor and metal facets for generation of H<sub>2</sub> and valuable chemicals synthesis. To establish, study employed water/glycerol as reactant mixture and TiO<sub>2</sub> (different shapes) and Pd (different shapes) as catalyst system. Glycerol known to be waste from biodiesel industry (10 % of biodiesel) and therefore it is imperative to generate value addition to waste. The aforementioned shape-engineered Pd/TiO<sub>2</sub> nanohybrids expect the efficient H<sub>2</sub> generation and value added chemicals (glycerolaldehyde, dihydroxyacetone etc) with high selectivity and stability. The unique features of proposed nanohybrids including unsaturated surfaces, defects, O<sub>2</sub> vacancies and active sites may pave the way for better performance.

**Status: Initiated**

## **3. Designing photocatalyst panel reactor for small scale generation of H<sub>2</sub> under in-house solar simulator**

**Research Student: Mr. Manjunath Reddy**

**Principle Investigator: Dr. Naresh Nalajala**

In order to translate the lab scale discoveries to commercial scale, it is important to use thinfilm based catalyst materials for optimization. We have developed a portable cell of size 5x5 cm<sup>2</sup> reactor with two acrylic substrates coated with catalyst and used silicon gasket to provide a gap between the plates. Different thickness of silicon gasket provide the thickness of reactant (for instance, water/methanol mixture) and its effect on yield of H<sub>2</sub>. Similarly, flow rate of reactant, thickness of catalyst coating over substrate, amount of Pd over TiO<sub>2</sub>, intensity of simulated sunlight (50, 75, 100 mWcm<sup>-2</sup>) will be studied. The optimized performance conditions will be a guideline for our 1 m<sup>2</sup> pilot scale plant to generate efficient, stable and large scale H<sub>2</sub> production.

**Status: Initiated**

## **4. Design and development of single atom copper on TiO<sub>2</sub> for photo-catalytic hydrogen production.**

**Research Student: Mr. Manjunath Reddy**

**Principle Investigator: Dr. Naresh Nalajala**

Hydrogen is seen as a significant energy source for the future because of its high energy content and lack of harmful or greenhouse gas emissions during combustion. Although the technology for producing hydrogen from fossil fuels is now well-established, the usage of these raw materials is unattractive for the future since they are non-renewable and release greenhouse gasses (carbon dioxide, carbon monoxide) when used to provide the energy needed for the processes involved in producing hydrogen. Titanium dioxide is the most prominent material for the photo catalytic water splitting since it has unique properties

such as strong oxidising ability, long term stability, nontoxicity, high refractive index, high dielectric constant, cost effective and easy to prepare. Although titanium is good catalyst for production hydrogen to enhance its efficiency single atom copper is doped on its surface which effectively separate the electron-hole pairs, lowers the probability of a recombination process and increase light absorption to the visible portion of the solar spectrum.

**Status: Initiated**

**B) Events and Achievements (2023-2024):**

- As a seminar coordinator, more than 20 talks being conducted by in-house and external expert speakers.
- As a sports coordinator, successfully organized sports activity at PPISR, Bidalur campus and honoured the sports winners by His Holiness Shree Eeshapriya Theertha Swamiji on founder's day celebration.

**Publications:**

NA

**Patents:**

NA

**Book Chapter:**

1. **N. Naresh**, Shape-controlled Bi-metallic Nanostructures for Electrochemical Oxidation of Liquid fuels”, Chapter 1, 2024, Nova Science Publishers.(Book Chapter)

**Keynote/ Invited as speaker for international conferences/workshops:**

1. Invited as speaker for one day symposium on “Catalysis and Renewable Energy for Sustainable Development Goals (SDGs)” in honour of Dr. C. S. Gopinath superannuation by CSIR-NCL Pune. Delivered a lecture on “Hydrogen: A buzz molecule for sustainable future” on 27/06/2024.
2. Invited as resource person for national conference on “Trends in Multidisciplinary Research: Applications and Challenges” organized by Department of Science, M S Ramaiah College of Arts, Science and Commerce from 15/05/2024-16/05/2024. Delivered lecture on “Shape Can Serve the Survival: A Journey Through Catalytic, Electrocatalytic and Photocatalytic Applications” on 16/05/2024.
3. Invited as resource person for Faculty Development Program on “Recent Innovations on Green and Sustainable Energy” organized by Dayanand Sagar College of Engineering from 23/02/2024-29/02/2024. Delivered lecture on “Hydrogen: A buzz molecule for sustainable future” on 24/02/2024.
4. Invited as speaker for Two Day (29/01/2024-30/01/2024) National Seminar on “Recent Advances in Material Science Research” (RAMSR-2024) by Government Degree College for Women, Khammam, Telangana. Delivered a lecture on “Shape-engineered metal nanocrystals and their applications in catalysis” on 30/01/2024.



## **Presentations at conference/workshop**

NA

### **MSc Internship projects:**

1) Name of the students and institution

Prajna Mayya and Mount Carmel College, Bangalore

2) Project title and summary /Abstract of the project

Photocatalysis for solar hydrogen production Using in-house synthesized TiO<sub>2</sub> as semiconductor with Pd as co-catalyst was used for solar H<sub>2</sub> generation. TiO<sub>2</sub> nanoparticles have been synthesized by sol gel method and used as catalyst. Pd/ TiO<sub>2</sub> catalyst was subjected to photocatalytic reaction conditions for solar hydrogen generation from water- methanol mixture and the efficiency was analyzed using gas chromatography.

2)

1) Name of the students and institution

Mahima Kaja and Mount Carmel College, Bangalore

2) Project title and summary /Abstract of the project

Synthesis of palladium modified zinc oxide nanoparticles for photocatalytic hydrogen production

In this study, Zinc oxide (ZnO) photocatalyst was synthesized by sol-gel and hydrothermal technique using zinc acetate as precursor and exposed to sunlight to know photocatalytic activity. The prepared sample was characterized by different techniques such as XRD, FT-IR. Effect of palladium on the shape of ZnO was studied in detail and the catalytic activity of catalyst was studied on photocatalytic splitting of water. The obtained hydrogen was tested by gas chromatography.

3)

1) Name of the students and institution

Chaitra V R and Sri Dharmasthala Manjunatheshwara College (Autonomous), Ujire

2) Project title and summary /Abstract of the project

Shape-engineered hybrid (ZnO/Pd) nanoparticles for dye degradation applications

Different shapes of ZnO nanoparticles (nanorods, nanoflower, nanosheets) were synthesized and modified with different shapes of Pd (nanocube and octahedra). Among these combinations, it was found that ZnO nanorod modified with Pd nanocube exhibited the best degradation ability towards methylene blue under direct sunlight.

4)

1) Name of the students and institution

Thanisha Rai K and Mangalore University

2) Project title and summary /Abstract of the project

Shape engineered hybrid (Zno/Pd) nanoparticles for dye degradation application and hydrogen generation

Similar results as that of above mentioned in (3) were achieved and therefore confirmed the reproducibility of data. Along with dye degradation, solar H<sub>2</sub> generation was attempted

5)

1) Name of the students and institution

Mavin Jason Pinto and St. Aloysius college, Mangalore

2) Project title and summary /Abstract of the project

Palladium modified tin-oxide nanoparticles for hydrogen gas sensing application

During this study, for the first time, SnO<sub>2</sub> nanoparticles modified with shape-engineered Pd nanoparticles are tested for sensor properties. The effect of Various gases at different ppm, temperature and voltage are understood with prepared materials.

6)

1) Name of the students and institution

Ms. Joshna Plavita Nazareth and St. Aloysius college, Mangalore

2) Project title and summary /Abstract of the project

Photocatalytic Activity Of Cu Doped ZnO Nanoparticles

In this study, Cu modified Zinc oxide (ZnO) photocatalyst was synthesized and exposed to sunlight to know photocatalytic activity. The prepared sample was characterized by different techniques such as XRD, FT-IR. Effect of palladium on the shape of ZnO was studied in detail and the catalytic activity of catalyst was studied on photocatalytic splitting of water. The obtained hydrogen was analyzed using gas chromatography.

7)

1) Name of the students and institution

Ms. Deepti M and GITAM, Bangalore

2) Project title and summary /Abstract of the project

Synthesis of TiO<sub>2</sub>/SnO<sub>2</sub> based hybrid nanoparticles for photocatalytic hydrogen generation

In this study, TiO<sub>2</sub>/SnO<sub>2</sub> photocatalyst was synthesized and exposed to sunlight to know photocatalytic activity. The prepared sample was characterized by different techniques such as XRD, FT-IR. Effect of palladium on the shape of ZnO was studied in detail and the catalytic activity of catalyst was studied on photocatalytic splitting of water. The obtained hydrogen was analyzed using gas chromatography.

8)

1) Name of the students and institution

Ms. Niveditha and Mount Carmel College, Bangalore

2) Project title and summary /Abstract of the project

Investigation of structural deformation of TiO<sub>2</sub> for solar H<sub>2</sub> generation

In this study, TiO<sub>2</sub> structure (size and phase) was modified using acid washing and subjected to solar H<sub>2</sub> generation studies. The obtained deformed TiO<sub>2</sub> nanoparticles were further modified with Pd in order to achieve efficient H<sub>2</sub> generation materials. The prepared sample was characterized by different techniques such as XRD, FT-IR. Effect of palladium on the shape of ZnO was studied in detail and the catalytic activity of catalyst was studied on photocatalytic splitting of water. The obtained hydrogen was analyzed using gas chromatography.

9)

1) Name of the student and institution

Ms. Aswini M and GITAM University, Bangalore

2) Project title and summary /Abstract of the project

Investigation of structural deformation of TiO<sub>2</sub> for solar H<sub>2</sub> generation In this study, TiO<sub>2</sub> structure (size and phase) was modified using acid washing and subjected to solar H<sub>2</sub> generation studies. The obtained deformed TiO<sub>2</sub> nanoparticles were further modified with Pd in order to achieve efficient H<sub>2</sub> generation materials. The prepared sample was characterized by different techniques such as XRD, FT-IR. Effect of palladium on the shape of ZnO was

studied in detail and the catalytic activity of catalyst was studied on photocatalytic splitting of water. The obtained hydrogen was analyzed using gas chromatography.

#### **7. New project proposals**

1. Submitted one research proposal to DST under Advanced Materials of the cost ~66 laks.

#### **PhD Protocol meeting conducted by MAHE:**

3. PhD Protocol meeting conducted by MAHE (deemed to be University) for Ms. AshaDevi K S on 29<sup>th</sup> February, 2024 in a virtual mode. She presented her synopsis on PhD topic titled " Exploring Structural properties of Metal/Metal oxide hybrid materials for Gas Sensor Applications"

#### **New Recruitments:**

- 7. Mr. Manjunath Reddy** : He completed his masters in Industrial Chemistry from MS Ramiah University, 2022. He worked as Research Engineer in Sulzer GTC, USA sponsored project at PPISR followed by project associate at IICT Hyderabad. He recruited as a Ph. D. fellow on Feb 12, 2024 under the project of startup research grant (SRG).



**Dr. NAGA SURESH ENJAMURI**

**Assistant Professor**

Materials Science and Catalysis Division

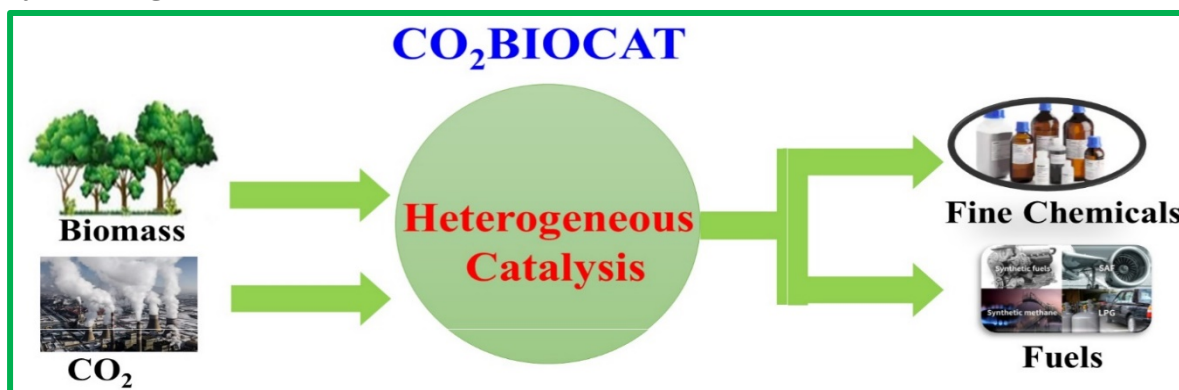
E-mail: nagasuresh@ppisr.res.in

**BRIEF CV:**

- ❖ January 2024 – till date, Assistant Professor, Materials Science and Catalysis Division, PPISR, Bengaluru, India.
- ❖ 2022 – 2023: Postdoctoral Research Fellow, Laboratory of Chemical System & Engineering, Hokkaido University, Sapporo, Japan.
- ❖ 2019-2022: Research Associate, Catalysis and Inorganic Chemistry Division, CSIR-National Chemical Laboratory Pune, Maharashtra, India.
- ❖ 2018-2019: Research Associate, Inorganic & Physical Chemistry Division, CSIR-Indian Institute of Chemical Technology, Tarnaka, Hyderabad, India.
- ❖ 2013-2018: Ph.D. IIT (ISM) Dhanbad, Jharkhand, India.
- ❖ 2013: M.Sc. Chemistry, IIT Guwahati, Assam, India.

**RESEARCH INTERESTS:**

The main focus of Dr. Naga Suresh's group i.e., "CO<sub>2</sub>BIOCAT" is involved an innovative and sustainable research approach focused on catalytic processes for the conversion of CO<sub>2</sub>, biogas, and biomass-derived compounds into value-added fuels and chemicals using a variety of heterogeneous catalysts (It includes mixed metal oxides, metal nanoparticle supported metal oxides, bifunctional solid catalysts and mesoporous materials). Our research work aligns with the broader goal of achieving green and sustainable development by utilizing CO<sub>2</sub> and biomass as carbon sources.



➤ **Tandem catalysts for one step CO<sub>2</sub> hydrogenation to Bio-LPG**

Our research focus on developing tandem catalysts for the one-step CO<sub>2</sub> hydrogenation to Bio-LPG is a commendable approach towards addressing the challenge of CO<sub>2</sub> fixation into valuable fuels. The tandem catalyst strategy, combining multiple reactions over a single

catalyst, is particularly interesting for the synthesis of Liquefied Petroleum Gas (LPG) from CO<sub>2</sub> and hydrogen.

➤ **Biogas upgradation via CO<sub>2</sub> methanation**

Our research focus on biogas upgradation through CO<sub>2</sub> methanation is indeed of great significance for both CO<sub>2</sub> utilization and addressing energy shortages. The utilization of surplus renewable energy for water electrolysis to produce hydrogen, which is then used in CO<sub>2</sub> methanation to convert CO<sub>2</sub> to CH<sub>4</sub>, represents a sustainable and environmentally friendly approach. In summary, our research is focused on a holistic approach that combines renewable energy, CO<sub>2</sub> utilization, and biogas upgradation to produce CH<sub>4</sub>-rich gases. This aligns with the broader goals of sustainability, reducing greenhouse gas emissions, and providing an alternative energy source.

➤ **Catalytic conversion of lignocellulosic biomass to ethylene glycol (EG)**

Our research focus on the catalytic conversion of lignocellulosic biomass to ethylene glycol (EG) is crucial for advancing sustainable and environmentally friendly processes in the chemical industry. Ethylene glycol has widespread applications, and the transition from fossil feedstock to renewable sources like lignocellulosic biomass aligns with the goals of carbon neutrality and environmental sustainability.

➤ **C–O Hydrogenolysis of C<sub>3</sub>–C<sub>4</sub> Polyols Selectively to Terminal Diols**

Our emphasis on glycerol as a biomass-derived platform chemical and its conversion to value-added products is in line with the principles of a circular economy, emphasizing the sustainable use of resources. Glycerol, a by-product in oleochemical industries, holds significant potential for the production of valuable chemicals, particularly propanediols (PDOs). In particular, diols with terminal hydroxyl groups are of great interest because of their vast applications. 1,3-Propanediol (1,3-PDO) is used in the production of poly(trimethylene terephthalate) (PTT). On the other hand, erythritol is a C<sub>4</sub> sugar molecule found in fruits, fermented foods, etc., and is widely used in cosmetics, artificial sweeteners and pharmaceuticals. 1,4-BDO is an important diol because of its extensive use in the synthesis of poly(butylene terephthalate) (PBT) polymer. A bifunctional, bimetallic catalyst can have synergistic interactions between the two metals which work in tandem to perform the surface-catalyzed reactions. Generally, a typical hydrogenolysis bifunctional catalyst consists of a noble metal and an acidic transition metal oxide.

➤ **Solid catalysts for conversion of furfural and its derivatives to alkanediols**

Our focus on the production of alkanediols with five and six carbon atoms, specifically 1,2- and 1,5-pentanediols, as well as 1,2- and 1,6-hexanediols, from lignocellulosic biomass-derived furfural and its derivatives is a commendable effort toward sustainable and green chemistry. The use of solid catalysts adds to the environmentally friendly approach. Several bifunctional catalysts with metal (for hydrogenation/hydrogenolysis) and acid/base (for ring opening) functionalities have been reported. Effective and selective conversion of furfurals to a desired diol is still a challenge.

## RECOGNITIONS/ACHIEVEMENTS/AWARDS/MEMBERSHIP:

- New Energy and Industrial Technology Development Organization (NEDO) Postdoctoral research fellowship (2022-2023), Hokkaido University, Japan.
- CSIR- Bhatnagar Research Associate (RA) fellowship (2019-2022), CSIR-NCL Pune, Maharashtra, India.
- Department of Science and Technology (DST) doctoral fellowship (2013-2017), IIT(ISM) Dhanbad, Jharkhand, India.
- Recipient of Karma Jyoti-2017 award given for their commendable service for the indigent section of the society on occasion of 3rd International Day of Yoga, 21st June-2017, CSM, Indian Institute of Technology (Indian School of Mines), Dhanbad, Jharkhand, India.
- Hyderabad Central University (HCU)-2011, M.Sc. admission, Hyderabad, India (**All India 19<sup>th</sup> Rank**).
- Joint Admission Test (JAM)-2011, M.Sc. admission, Indian Institute of Technology (IIT), India (**All India 575<sup>th</sup> Rank**).
- National Cadet Corps (NCC) certificate 'C' examination in B grade held in 2009 under the authority of ministry of Defence, Government of India.
- Dr. Naga Suresh has been the reviewer for Journal of Chemical Sciences

## Publications:

1. N. Enjamuri, S. Nishikawa, M. Nishijima, S. Tada and R. Kikuchi. Highly Active and stable Ru Promoted Ni/CeO<sub>2</sub> Catalysts for CO<sub>2</sub> Methanation Reaction. **Canadian Journal of Chemical Engineering**, 2024 (**Under review**)
2. S. Bhowmik, N. Enjamuri, G. Sethia, V. Akula, B. Marimuthu, and S. Darbha. Insights into active tungsten species on Pt/W/SBA-15 catalysts for selective hydrodeoxygenation of glycerol to 1, 3-propanediol. **Molecular Catalysis**, 2022, 531, 112704.
3. N. Enjamuri and S. Darbha. Advances in catalytic conversion of lignocellulosic biomass to ethylene glycol. **Catalysis Reviews**, 2022, 1-71.
4. S. Bhowmik, N. Enjamuri, B. Marimuthu, and S. Darbha. C–O Hydrogenolysis of C<sub>3</sub>–C<sub>4</sub> Polyols Selectively to Terminal Diols over Pt/W/SBA-15 Catalysts. **Catalysts**, 2022, 12(9),1070.
5. S. Bhowmik, N. Enjamuri and S. Darbha. Hydrogenolysis of glycerol in an aqueous medium over Pt/WO<sub>3</sub>/zirconium phosphate catalysts studied by <sup>1</sup>H NMR spectroscopy. **New Journal of Chemistry**, 2021, 45, 5013-5022.
6. N. Enjamuri and S. Darbha. Solid catalysts for conversion of furfural and its derivatives to alkanediols. **Catalysis Reviews**, 2020, 1-41.
7. N. Enjamuri, S. Sarkar, B. M. Reddy and J. Mondal. Design and catalytic application of functional porous organic polymers: Opportunities and challenges. **The Chemical Record**, 2019, 19, 1782-1792.
8. R. Kumar, N. Enjamuri, S. Shah, A. S. Al-Fatesh, J. J. B. Suarez and B. Chowdhury. Ketonization of oxygenated hydrocarbons on metal oxide-based catalysts. **Catalysis Today**, 2018, 302, 16-49.
9. N. Enjamuri, S. Hassan, A. Auroux, J. K. Pandey and B. Chowdhury. Nobel metal free, oxidant free, solvent free catalytic transformation of alcohol to aldehyde over ZnO-CeO<sub>2</sub> mixed oxide catalyst. **Applied Catalysis A: General**, 2016, 523, 21- 30.

- 10.** R. Kumar, S. Ponnada, N. Enjamuri, J.K. Pandey and B. Chowdhury. Synthesis, characterization and correlation with the catalytic activity of efficient mesoporous niobia and mesoporous niobia–zirconia mixed oxide catalyst system. **Catalysis Communications**, 2016, 77, 42-46.
- 11.** R. Kumar, N. Enjamuri, J. K. Pandey, D. Sen, S. Mazumder, A. Bhaumik and B. Chowdhury. Bismuth supported SBA-15 catalyst for vapour phase Beckmann rearrangement reaction of cyclohexanone oxime to  $\epsilon$ -caprolactam. **Applied Catalysis A: General**, 2015, 497, 51-57.
- 12.** S. Rahman, N. Enjamuri, R. Gomes, A. Bhaumik, D. Sen, S. Mazumder and B. Chowdhury. Aerobic Baeyer–Villiger oxidation of cyclic ketones over periodic mesoporous silica Cu/Fe/Ni/Co-HMS-X. **Applied Catalysis A: General**, 2015, 505, 515-523.
- 13.** A. A. Dar, N. Enjamuri, Md. Shadab, N. Ali and A. T. Khan. Synthesis of unsymmetrical sulfides and their oxidation to sulfones to discover potent antileishmanial agents. **ACS Combinatorial Science**, 2015, 17(11), 671-681.

**Keynote/ Invited as speaker for international conferences/workshops:**

- Delivered an oral presentation at the **7th Asian Conference on Innovative Energy and Environmental Chemical Engineering (ASCON-IEEChE) 2023 Korea**, Skybay Gyeongpo Hotel, Gangneung, Republic of Korea, 4-7 December 2023.
- Attended “**42<sup>nd</sup> HESS conference**” organized by Hydrogen Energy Association of Japan, Tokyo, Japan, 27<sup>th</sup> -28<sup>th</sup> November 2022.
- Completed certificate course on “Foundations of Chemical Safety and Risk Management for Chemistry Students” by **ACS Center for Lab Safety**, 4th Jan-2022.
- Attended “**One Day International Webinar on Catalytic Materials**” organized by The Catalysis Society of India, IIT(ISM)Dhanbad, India in 2021.
- Attended **1<sup>st</sup> Annual Meeting cum Workshop of India-Netherland bi-lateral project** on Functional Material and Catalysis organized by Department of Applied Chemistry, Indian Institute of Technology (ISM) Dhanbad, India in 2017.
- Attended **6<sup>th</sup> National Symposium for Materials Research** one day workshop on Advance Characterization Techniques-2014 organized by Department of Metallurgical Engineering and Material Science, IIT Bombay, India.
- Attended **Recent Developments in Chemical Science & Technology: Young Scientist’s Meet-2014** organized by Department of Chemistry, NIT Rourkela, India.

**Lab members**

Currently CO<sub>2</sub>BIOCAT is actively looking for motivated postgraduates and Ph. D. students.

## **Biological sciences division**

### **Mission and research progress**

Biological science division works in key areas such as use of active biomolecules from endo- phytic 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 Sci- ence 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 disor- ders 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





## Dr. Udipi A. Ramagopal

Associate Professor , Poornaprajna Institute of Scientific Research, Bengaluru.

Email: [ramagopal.udupi@gmail.com](mailto:ramagopal.udupi@gmail.com), [udupir@alum.iisc.ac.in](mailto:udupir@alum.iisc.ac.in)

Phone: 9900810182

Lab Website: <https://ppisr.res.in/udupi-ramagopal/>

H-Index= 30, I<sub>10</sub> index= 46, Publications =56, Citation/article ~ <60>  
<https://scholar.google.co.in/citations?user=d7t9weUAAAAJ&hl=en>

### Brief CV

- Dean Academics (2018-2022), PPISR, Bangalore, India.
- Associate Professor (2014-current), PPISR, Bangalore, India.
- Assistant Professor 2011 – 2014, (Ramalingaswami Fellow – DBT, 2011-2016), PPISR, Bangalore, India.
- Visiting Faculty, 2011 – Present: Albert Einstein College of Medicine, New York, USA. <https://einsteinmed.edu/faculty/9276/udupi-ramagopal/>
- 2009-2011: Instructor (Faculty), Albert Einstein College of Medicine, New York, USA.
- 2005-2009: Associate of Biochemistry (Faculty), Albert Einstein College of Medicine, New York, USA.
- 2003-2005: Senior Research Associate, Department of Biochemistry, Albert Einstein College of Medicine, New York, USA.
- 2001-2003: Visiting Fellow, National Institute of Health, USA.
- PhD: Department of Physics, Indian Institute of Science, India – 2001

### Awards and Recognitions/Achievements

1. Ramalingswami fellow, DBT, India (2011 - 2016).
2. Best thesis “Kumari L. A. Meera Award and a Gold Medal”, 2001, IISc, India.
3. Visiting Fellow (2001 – 2003, NIH, USA).
4. Visiting Faculty (Albert Einstein College of Medicine, 2011 – current).
5. Coauthored publications with Prof. James Allison, Nobel Laureate in Physiology and Medicine 2018.
6. 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/>).
7. Reviewer: DST (both Extramural and STAR proposals) India, Macromolecular Crystallography beamtime proposal of Argonne National Laboratory, USA, and others. Various Journals such as Nature Scientific Report, Acta-D, Protein Science, BioChem Journal, VirusDes, International Immunopharmacology, ACS OMEGA and so on. Reviewed theses from national institutes such as NII, NIISER, JNCASR. Served as a Doctoral Advisory committee (DAC) member for few students registered under MAHE, Manipal and NIMHANS, Bengaluru.
8. Served in the "User Executive Committee 2002-2003" of National Synchrotron Light Source, Brookhaven National Laboratory, USA.
9. Contributed > 250 protein structures to WorldWide Protein Data Bank (wwPDB).
10. Scientific Advisor “Genelon Life Science Ltd.”, Yelahanka, Bangalore

## **Mentoring:**

PhD Awarded:4 (PI) + 1 (Co-PI)

MS thesis:4

Post-doctoral trainees: 4

Interns and trainees: 15+

Current PhD students (PI/Co-PI): 2

## **Projects**

Currently the lab works on three different themes and all the projects use structural information to derive structure-function relationships and to exploit this knowledge to design effective molecules for therapy. In the following sections brief description of the projects are given.

1.Discovery of inhibitors against NS2B-NS3 protease of Dengue and Japanese Encephalitis virus.

2.Rational Modification of Immune Checkpoint Receptors of PD-1 Pathway for Cancer Immunotherapy.

3.Discovery of inhibitors against main protease (mPro) of SARS-COV-2 and NS2B-NS3 protease of Kyasanoor Forest disease virus.

## **Mentoring Experience**

Mentored/mentoring five PhD students (3 PhD awarded and 1 as Co-PI), 4 MSc/MS thesis and a few postdoctoral fellows at PPISR (other than regular interns).

- Dr. Pavithra G. C. (PhD awarded, currently postdoctoral fellow at University of IOWA, USA).
- Dr. Swetha Lankipalli (PhD awarded, currently working as a Forensic Scientist, Govt. of Andhra Pradesh)
- Mr. Shankar Kundapura (Writing thesis, Registered for PhD under MAHE, Manipal)
- Ms. Shrilakshmi (Presented thesis colloquium, registered under MAHE, Manipal, Co-PI)
- Ms. Salima Parveen (Registered for PhD under MAHE, Manipal)
- Post-Doctoral Fellows and their current affiliations
- Dr. Raghurama Hegde 2012-2018 (PhD. IISc, Bangalore, currently working as a beamline scientist at Elettra Synchrotron, Trieste, Italy, raghurama.hegde@elettra.eu .
- Dr. Debayan Dey (2015-2016, PhD. 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 Regional Ayurveda Research Institute, Itanagar, Arunachal Pradesh, sreubio@gmail.com.

## **Students mentored for their MS Theses**

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

**Grants:**

1. Structure based rational design of PD-1 mutants to create lead molecules for cancer immunotherapy, Bristol Mayers Sqibb, USA (ongoing/extension 2021-2022 approved)
2. X-ray data collection and travel grant to synchrotron sources at XRD2, Trieste, Italy (2 proposal approved).
3. Bhat Biotech, India, Discovery of natural inhibitors of key proteins (2021- ongoing)

**Sponsored projects.**

- Ramalingaswami Fellowship titled “Co-stimulatory molecules: Biology and therapeutic intervention”, 2011-2016, Department of Biotechnology (DBT), New Delhi, India.
- The Establishment of Centers of Excellence in Science, Engineering granted by VGST, Karnataka (2013-2017), Vision Group on Science and Technology (VGST), Karnataka
- Structural and evolutionary investigations on antibiotic resistance conferring rRNA methyltransferases for designing novel strategies of drug development, Department of Science and Technology (DST), 2016-2019, India.
- Bristol Myers Squibb (BMS) scholarship Grant titled “Structure based rational design of PD-1 mutants to create lead molecule for cancer immunotherapy (2018-2019 , one year).
- Bhat Biotech, India, Discovery of natural inhibitors of key proteins (2021- ongoing)
- Bristol Myers Squibb (BMS) scholarship Grant to Udupi A. Ramagopal, titled “Structure based rational design of PD-1 mutants to create lead molecule for cancer immunotherapy (2022-2023)
- X-ray data collection and travel grant to synchrotron sources at (1) SOLEIL, France, ESRF, France (2 proposals approved), XRD2, Trieste, Italy (4 proposals approved) and X29 USA.

**Collaborations:**

**Prof. Steven C. Almo**, Albert Einstein College of Medicine, New York, USA.

**Dr. Dibyendu Samanta**, Indian Institute of Technology, Kharagpur, India.

**Dr. Deepak Kumaran Nair**, Indian Institute of Science, Bengaluru, India.

**Dr. Gaythri Mukharjee**, Indian Institute of Technology, Kharagpur, India

**Prof. Udaykumar Ranga**, Jawaharlal Nehru Center for Advanced Scientific Research, Bengaluru, India.

**Prof. Ramakumar S.**, Indian Institute of Science, Bengaluru, India

(Also, collaborated, and published papers with Prof. Valakunja Nagaraja, IISc (Ex-President, JNCASR), Prof. Suguna, IISc, Prof. Sekar S., IISc and so on).

**Other projects**

- Structural Studies of purine Phosphoribosyltransferase from Pathogenic Bacteria.
- Testing the limits of macromolecular crystallographic phasing.

**RESEARCH INTEREST:**

- (1) Modification of immune checkpoint blockade receptors for cancer immunotherapy.
- (2) Structural and functional characterization of enzymes from pathogenic bacteria.
- (3) De novo structure determination of proteins and methodology development in protein crystallization.
- (4) Discovery of natural inhibitor(s) for a medicinally important enzyme.

## **Publications and patents**

### **Patents**

- (1) BIOLOGICALLY ACTIVE ZINC-FREE HEXAMERIC INSULIN ANALOGUES, (2023), Indian Patent Application No. 202341002384, Inventors: Ramagopal UA, Rao SS, Kundapura S, Ananda K.
- (2) High affinity PD-1 mutant as lead molecules for cancer immunotherapy, (2023), Indian Patent Application No. 202341044329 Inventors: Ramagopal UA, Kundapura S.

### **Publications**

1. Chatterjee S., Kundapura SV, Basak AJ, Das AK, Samanta D, Ramagopal UA\*. High-resolution crystal structure of LpqH, an immunomodulatory surface lipoprotein of Mycobacterium tuberculosis reveals a distinct fold and a conserved cleft on its surface, 2022, International Journal of Biological Macromolecules, 210, PP 494-503. Impact factor **8.05**.



**Dr. Ananda K**

Associate Professor

Biological Sciences Division

E-mail: ananda.at.ppisr.res.in

**RESEARCH INTERESTS:**

In the biological sciences division, we have selected few areas of the research related to health and environments, such as,

- (I) Design of proteins to create lead molecules for the therapeutic purpose
- (II) Bioconjugation of therapeutically important proteins to increase their half-life
- (III) Novel anti-diabetic, anti-bacterial metabolites from plants and microbial sources
- (IV) Proteins secreted by endophytic fungi for degradation of lignin, industrial dyes, and antibiotic molecules
- (v). Mitigation of phytoplasma infection in sandal wood using potential endophytic fungi and
- (VI). Biological activities of synthetic compounds and chemically modified polymers

**Training of Students:**

|  |      |
|--|------|
| PhD Awarded PI                                   | : 05 |
| PhD Awarded Co-PI                                | : 01 |
| PhD Guiding                                      | : 02 |
| MSc Project completed                            | : 08 |
| BSc/BE Project completed                         | : 09 |
| BSc Inspire students                             | : 03 |
| PhD students guided in Collaboration (MIT, MAHE) | : 05 |

**RECOGNITIONS/ACHIEVEMENTS:**

- Recognised as Visiting Professor of Dept. of Biochemistry, Mangalore University, Mangalore during 2020-21. Adjunct Professor of MAHE Manipal Since 2022. Visiting Professor REVA University, Bengaluru since 2021.
- PhD Co-coordinator for Manipal Academy of Higher Education (MAHE), Manipal
- Life Member of Mycological Society of India
- Life member of Association of Microbiologist of India
- Postdoctoral Senate member in Faculty Senate, Quality of Life Committee and of Committee on Committees of Albert Einstein College of Medicine 2007-2009.
- Working experience as Administrative supervisor in KSRTC, Karnataka, India.1998-2003
- President of Mangalore university researcher's forum (MURF) during the period of Ph.D. for a year.
- Member of New York academy of science, NY, USA.2006-2008
- Member of Protein Society, San Diego. USA 2006.

## STUDENTS

### PhD Graduates:

- Dr.Pavithra N
- Dr.Sathish L
- Dr. Kavitha K N
- Dr.Kirana M P
- Dr. Shrilakshmi S
- Dr.Shreya Kanth (Co-PI)

### PhD students (PI/Co-PI) (2023-24)

- Mr.Mallikarjun
- Ms. Jyotsna S

### MSc Project Students (2023-24)

1. Ms. Akshitha P S, MSc student from Mangalore University joined as MSc Project Intern for the period of three months “NUTRITIONAL EVALUATION OF EDIBLE MUSHROOMS” April- August 2023.
2. Ms. Medini Beemappa, MSc student from REVA University, Bengaluru worked on a project titled “Investigation of omega -3 fatty acids and antioxidants from Purslane and its endophytic fungi as a Nutritional Supplements”.during June-September 2023.
3. Ms. Malavika B, MSc student from REVA University, Bengaluru worked as Project student, and completed her MSc project in the month of June 2023 with the project title “Mitigation of phytoplasma using endophytic fungi as a defense for spike decease in sandal wood.”

## RESEARCH:

### SPONSORED PROJECTS (ongoing):

1. “ $\alpha$ -amylase and  $\alpha$ -glucosidase inhibitors from endophytic fungi for treating Type 2 diabetes” funded by VGST-Karnataka for 3 years. (Successfully completed in October-2023)

### ACADEMIC PROJECTS:

1. **Investigation of magic molecules from the selected fungi for the inhibition of starch hydrolysing and aldose reductase enzymes**

PhD Supervisor: **Dr. Ananda K**

Student: **Mallikarjun M**

Fungi and their secondary metabolites are used in health and medicine for a large extent recently. We have selected few filamentous fungi and Mushrooms for the inhibition of starch hydrolyzing enzymes (alpha amylase and alpha glucosidase) and aldose reductase enzyme. There are multiple research groups working on the estimation of inhibitors for these enzymes are found in literature. However, detailed study relating to the purified samples are lacking. Endophytic fungi isolated from *Curcuma longa* which are known to produce compounds like curcumin as per our experimental evidence further studied in detail during this period. The endophytic fungal isolates were cultivated, and secondary metabolites were extracted after 21 days of growth, the extracts were used for estimating antioxidant assay such as DPPH and ABTS assay. Some of the endophytic fungi have shown promising results and they will be studied further in detail. The main goal of this project is to get few natural inhibitors for the targeted enzymes and exploring them to prepare an effective anti-diabetic compound.

**2. Human intestinal glucosidase inhibitors from nutritious edible fungi: A detailed study on finding magic molecules for treating diabetes.**

PhD Supervisor: **Dr. Ananda K**

Student: **S Jyotsna**

The literature survey related to the project were continued and preparation of the protocol for PhD synopsis was prepared. The preliminary analysis on already existing fungal isolates were studied. The same standardised methods will be applied for the edible fungi. For the practice the samples from the other project is given to the student and she amplified DNA of PPCL3 using 3 different primers (ACT, TUB2, CALMADULIN) were amplified and sent it for sequencing, out of which 2 of the samples (ACT, TUB2) qualified the quality control and further sequencing was done. After sequencing BLAST analysis was done. PPLC3 amplified using ACT primer showed 96.18% similarity to *Fusarium oxysporum* and TUB2 amplified PCR product showed 91.51% similarity to *Fusarium veterinerium*. Also, extraction of genomic DNA of the 3 fungal cultures were done in 2 sets and their concentration was also measured [(PPCL1- 943 ng/μl, 1137.9 ng/μl) (PPCL2- 611.8 ng/μl, 121.9 ng/μl) (PPCL3- 995.6 ng/ μl, 975.6 ng/μl)]. ABTS Assay of the two plant extracts was done. Read research articles on the decline in the transfer of glucose into the liver, muscle, and fat cells. Explore the pathophysiology of type 2 diabetes by reading. Read about the DM diagnostic tools that are already in use. Also learn about the pharmaceuticals used to treat DM.

**3. Preparation of conjugated protein as a plasma expander for the transfusion and cell storage stabilizer for the long-term storage of cells.**

PI: Dr. Ananda K, Biological Sciences, PPISR, Bengaluru

Co-PI: Dr.Guruprasad Kalthur , Professor and Head, Department of Reproductive Science, KMC, MAHE, Manipal.

Blood transfusion with a artificially modified protein are gaining importance recently, due to their increased viscosity and retaining balanced colloidal osmotic pressure. There are efforts are being made to achieve this type of molecule using hemoglobin, albumin etc. However, in the market there are no such valuable molecules available which can maintain the plasma concentration stable without much extravasation. In this project we are preparing bio-conjugated albumin as a plasma expander for the application of blood transfusion in emergencies. The similar bioconjugated albumin is also prepared and tested for its ability in enhancing the storage of human cells as well as storage of human sperms being studied recently in collaboration with KMC, Manipal. The initial results indicated that there is an increased activity of sperms in the bio-conjugated media when compared to the existing media. Further detailed studies will b e conducted in future based on the funding opportunity.

**4. Effective management of spike disease in Indian sandal wood by studying endophytes of infected and healthy plants**

**PI: Dr. Ananda K, MSc Project Student: Ms. Malavika**

Studies related to the endophytic fungi isolated from healthy *Santalum album L* (Sandalwood) plants continued. A more detailed study on five endophytic fungi was made. The antimicrobial activity and their MIC studies were very interesting and one of these fungi shown highest activity and more studies on this isolate is needed. The DPPH and ABTS studies, phytochemical analysis of the endophytic fungal isolate's extracts was also completed. The best fungi were grown again, and total DNA was isolated for the molecular sequencing. The manuscript is under communication.

**5. Estimation and extraction of omega-3-fatty acids from Purslane (NELABASALE) and its endophytic fungi**

**PI: Dr.Ananda K, MSc Intern Student: Ms.Medhini**

Omega -3-fatty acid from a plant and fungal source might have higher value as a vegetable source. The plant Purslane, (*Portulaca oleracea*), known for its high alpha linoleic acid (ALA) acid which is an essential fatty acid need to get from external sources in our food. ALA is one of the fatty acids in omega-3-fatty acids. We have estimated the total fatty acids and DHA in the extracted samples from this plant. Three endophytic fungi out of ten shown fatty acid contents and one of them was producing highest amount compared to others is studied in more detail.

#### 6. Plastic degradation by fungal enzymes isolated from the fungi growing on plastics.

PI: Dr. Ananda K, MSc Intern Student: Ms. Akshitha PS

Degradation of plastics in nature usually takes decades of years and complete mineralization is still impossible. However, there are attempts made to degrade plastics using chemicals, radiation and biological routes that were not very successful. The need for plastic degradation is the most essential requirement at present. We have collected plastics which are already disposed to the surroundings and washed them using tap water followed by milli-Q water to remove any debris, using a scissor 10-15 mm dimensions of pieces were made and incubated on agar medium containing antibacterial agents. After few days, the fungi growing on the plastics were isolated and grown on potato agar media. Later, these fungi were grown in a flask containing potato dextrose media and 10 mg of plastic piece. After 21 days of culturing the weight loss in plastic pieces was monitored and there was about 2-4% of weight loss found in one of the incubated isolates. The project will be continued in future.

#### RESEARCH HIGHLIGHTS:

##### Published papers:

Total publications: 59

##### Publications for the year 2023-24: 03

1. Kanth, Shreya, Puttaiahgowda, Yashoda Malgar and **Kulal, Ananda**, Synthesis, characterization, and antimicrobial activities of a starch-based polymer. *Carbohydrate Research* 2023, 532, 108900.
2. Gupta, Sonali, Puttaiahgowda, Yashoda Malgar, Parambil, Ajithkumar Manayan and **Kulal, Ananda**, Fabrication of crosslinked piperazine polymer coating: Synthesis, characterization and its activity towards microorganisms. *Journal of Molecular Structure* 2023, 1274, 134522.
3. Shreya Kanth, Yashoda M. Puttaiahgowda and **Ananda Kulal**. Synthesis and Characterization of Functionalized Starch by Grafting Pyridine for Use in antimicrobial applications. *Starch*. 2024, 2300121. <https://doi.org/10.1002/star.202300121>

##### Patents Filed:

1. Indian Patent (Application No. 202341002384) filed by PPISR in the title " Biologically Active Zinc-Free Hexameric Insulin Analogues" Inventors are Dr.Udupi Ramagopal, Dr.Shrilakshmi S, Dr. Shankar Kundapur and **Dr.Ananda K**,
2. Indian Patent filed (Application No. 202441017114) on the title: Poly(vinyl chloride)-G-1-(2-aminoethyl piperazine) polymer for antimicrobial paint composition and its method of preparation thereof: filed by MAHE Manipal, and inventors are Dr.Yashoda M. Puttaiahgowda (MIT, Manipal) , **Dr.Ananda Kulal (PPISR, Bengaluru)** and Ms.Sonali Gupta (MIT, Manipal).

##### Resource person/papers presented in conferences:

Total presentations: 32

For the year 2023-24: Nil

##### Other Scientific Activities (2023-24)



1. Dr. Ananda K, as Principal Investigator submitted a research proposal to ICMR, Government of India on the title "*In-vitro* and *in-vivo* efficacy of site-specific HSA-Insulin bioconjugates for developing a potential candidate for treating diabetes" on April 28, 2023.
2. Ms. Shrilakshmi S defended her PhD viva on the thesis titled "Rational modification of insulin driven by evolutionary studies and chemistry for therapeutic applications" on May 16, 2023 and PhD was awarded on May 19, 2023. The external Examiner was Dr Rajakumara Eerappa, Associate Professor, HOD of Department of Biotechnology, IIT Hyderabad. She was guided by Dr. Ananda K as PI and Dr. Udupi A Ramagopal as Co-PI, Associate Professors from PPISR.
3. Dr. Ananda under the VGST research grant procured instruments Biosafety cabinet, Digital balance, PCR and fridge required for the cell culture room during April to June 2023.
4. Ms. Malavika B, MSc student from REVA University, Bengaluru completed the MSc project and submitted the thesis titled " 'STUDIES ON POTENTIAL ENDOPHYTIC FUNGI ISOLATED FROM *SANTALUM ALBUM L.* FOR THE MITIGATION OF MICROORGANISMS " to the REVA University for the MSc degree.
5. Ms. Medhini, MSc student from REVA University Joined as Intern in the month of August 2023 and started working on omega-3-fatty acids.
6. Ms. Akshitha, MSc student from Mangalore University joined as Intern in the month of September 2023 and started working on Mushrooms
7. Ms. Shreya Kanth, MAHE Manipal student successfully defended her PhD thesis titled "Synthesis and characterization of anti-microbial polymers and their coating studies" on December 07, 2023, under the guidance of PI: Dr. Yeshoda P, Professor, Department of Chemistry, MIT, Manipal and Co-PI: Dr. Ananda K, Associate Professor, Biological Sciences, PPISR, Bengaluru.
8. Ms. Malavika, from REVA University, Bengaluru completed her intern project and made a presentation on the project "STUDIES ON POTENTIAL ENDOPHYTIC FUNGI ISOLATED FROM *SANTALUM ALBUM L.* FOR THE MITIGATION OF MICROORGANISMS" December 26, 2024 at PPISR seminar hall.
9. Dr. Ananda K, Associate Professor, Biological Sciences, received invitation to become an external subject expert and conducted PhD synopsis Defense of PhD scholar Mr Sreehari Suresh, of CHRIST (Deemed to be University), Bengaluru on November 29, 2023.
10. One Day Seminar on "Science and Technology advancement" was conducted by PPISR on behalf of Science Day celebration 2024. Dr. Ananda, Associate Professor, Chaired the Biological Sciences Session during this one-day Seminar and Mr. Mallikarjun M, Biological Sciences made a presentation on the topic "Cinderella of genetics: A story about Fruit fly" in this seminar.
11. Mallikarjun M, Research Scholar, Biological Sciences registered and attended an online training program on "Revolutionizing Mycology with ChatGPT" organized by MycoAsia international on 15/08/23.
12. Mr. Mallikarjun Research Scholar attended online seminars on "World Fungus Day 2023" organized by Myco India on 1 October 2023.
13. Mr. Mallikarjun M Research Scholar attended Workshop on "Research Methodology, Research and Publication ethics" organized by Karnataka Science and Technology Academy (KSTA) during October 3-7, 2023.
14. Mr. Mallikarjun Research Scholar attended an offline workshop "Genomics and Proteomics" from 27.1.2024 to 28.1.2024 conducted by IISc Bangalore.

#### **RESEARCH COLLABORATION (2023-24)**

1. Department of Chemistry, Manipal Institute of Technology, MAHE, Manipal.
2. Department of Chemistry and Department of Zoology, Mangalore University, Mangalore
3. Department of Biochemistry, St. Aloysius College, Mangalore
4. Forest Protection Division, Institute of Wood Science and Technology, Bengaluru

## EVENTS AND OTHER ACHIEVEMENTS:

1. Dr.Ananda K actively participated and chaired the scientific presentation of biology and summarized the proceedings of the PPISR Founder's day celebration conducted on July 6, 2023.
2. Dr.Ananda taken classes on course work "Research Methodology (PP01)"for the PhD students and completed more than 80% of the syllabus. Also, course work classes for Course "Basics of molecular and biochemical studies (PP31) are taken.
3. Dr.Ananda conducted MSc Biotechnology exams for Mangalore university as external examiner during March 31-April 1, 2023 at Alva's College, Moodabidri.
4. Dr.Ananda K, as Co-PI attended Pre-colloquium DAC meeting of Ms.Shreya Kanth, MAHE Manipal on July 28, 2023. She presented the thesis title "Synthesis and characterization of anti-microbial polymers and their coating studies".
5. Dr. Ananda K, Associate Professor, biological sciences, initiated discussion on a collaboration with Dr. Mustak, Applied Zoology, Mangalore University for conducting animal studies on bio-conjugated protein in the month of August 2023.
6. Dr. Ananda K, Associate Professor, biological sciences have been appointed as an external examiner for Biannual presentations of the PhD scholars held on 12<sup>th</sup> August 2023 at Department of Biotechnology, REVA University, Bengaluru.
7. Dr. Ananda K, Associate Professor, biological sciences have been appointed as an external examiner of Mangalore University for MSc Environmental Sciences and conducted the practical exams on August 21,2023.
8. Dr. Ananda K, Associate Professor, taken classes on course work "Research Methodology (PP01)" and Research Ethics (PP02) for the PhD students and completed the syllabus. Also, course work classes for Course "Basics of molecular and biochemical studies (PP31) are taken.
9. The outreach program for the PPE schools was conducted successfully by doing three experiments in biological sciences Division during September last week.
10. Interview for Junior Research fellow in Biological Sciences conducted on January 9,2024. Out of 200 applications, 18 students were shortlisted and 8 students were interviewed and students selected by the selection committee were communicated for joining as JRF in the biological Sciences division.
11. Mallikarjun M, Research Scholar, Biological Sciences registered and attended an online training program on "International workshop on Bioinformatics" organized by the Department of Human Physiology Holy Cross College, Agartala, in collaboration with MycoAsia on 08/05/23 and successfully received the certificate of completion.
12. Dr. Ananda K, Associate Professor, got nominated as external subject expert for PhD Admission Committee of Yenepoya (Deemed to be University), Mangalore and successfully attended the committee meeting online PhD Admission Committee for selection of candidates for the January 2024 batch on December 21, 2023.
13. Organized outreach program in Biological Sciences for the High School students of two Poornaprajna Schools, Bengaluru during October 9-10, 2023.
14. Mr.Mallikarjun M presented pre-DAC presentation on his PhD synopsis protocol on 6/12/23.
15. Dr. Ananda, Associate Professor, Biological Sciences, reviewed PhD progress of 8 PhD students of REVA university, Bengaluru as an examiner for Biannual presentations of the PhD scholars held on 22<sup>nd</sup> February 2024.
16. Dr. Ananda K, Associate Professor, Biological sciences, actively attended one day online Lecture series on "Startup Fungi" organized by Association of Fungal Biologists (AFB), Mumbai India, MycoAsia Journal of Modern Mycology, MycoIndia Journal of Indian Fungi and Centre for Biodiversity Exploration and Conservation (CBEC) Jabalpur, India. On 03.03.2024 and received a certificate of participation.
17. Dr.Ananda K Associate Professor, Biological Sciences Division prepared and presented future research plans of Biological Sciences Division in the meeting held for the discussion of Vision Documents of PPISR for the next 5-10 years on February 8, 2024 at Sadashivnagar office to the management.

18. Mr.Mallikarjun prepared and presented PhD protocol to the DAC Members and PhD protocol was submitted to MAHE on January 12,2024.
19. Dr. Ananda, Associate Professor, actively participated in organizing and executing the all the programs conducted on “PPISR Annual day celebration” held on 13/2/2024 at PPISR Campus.

## **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) whose areas of expertise span theoretical astrophysics, black hole cosmology, soft condensed matter and crystallographic studies.

### **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 foundational and practical issues pertaining to practical quantum information processing, in particular in the context of quantum open systems and quantum cryptography.
- Temporal & 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 and twin-field quantum digital signatures
- Solitons and spin transport in an antiferromagnetic spin chain
- Relation between non-Markovianity and non-invertibility of Pauli qubit and qudit channels.
- An interplay of topology and quantized geometric phase for two different symmetry-class Hamiltonians
- Fractal dimension, phase and activity level of Solar supergranulation



**Prof. Sujit Sarkar**  
Associate Professor  
Theoretical Science Division  
E-mail: sujit.tifr@gmail.com

## **BRIEF CV:**

- Associate Professor, PPISR: Jan 2018--present
- Assistant Professor, PPISR: 2007 -- 2017
- Faculty Fellow, PPISR: 2005 -- 2007
- IISc Physics Department (year 1997-1998)
- Bar-Ilan University, Physics Department (year 1999-2000)
- Max-Planck Institute, Germany as a Guest Scientist (year 2000-2002)
- The Weizmann Institute of Science (year 2002-2005).
- Associateship position at S. N. Bose National Centre for Basic Sciences (since 2016 and continue)
- Visiting Scientist Positions: Tata Institute of Fundamental Research
- (Mumbai) National Centre for Theoretical Science (NCTS, Taiwan), Karlshruhe Institute of Technology, Germany.

## **RESEARCH INTERESTS:**

- (1). Quantum Many Body Physics and Quantum Field Theoretical Studies of Quantum Condensed Matter System.
- (2). Conformal Field Theory Study for Quantum Spin System.
- (3). Non-Hermitian Quantum Criticality.
- (4). Quantum Phase Transition and Topological Quantum Phase Transition.
- (5). Geometric Structure of Space-Time and Quantum Geometrical Tensor.

## **RECOGNITIONS/ACHIEVEMENTS:**

### **Seminars, Lectures, Workshops and Conferences:**

- (1). Indian Statistical Physics Community Meeting April'2024.**
- (2). Kolkata Statistical Physics Community Meeting (December'2023).**

### Students:

- 1) Mr. Akash Sengupta (Project Student upto September'2023).
- 2) Mr. Ranjan Kumar Tung (Project Student upto February'2024 ).

## **RESEARCH**

### **CURRENT ACADEMIC PROJECTS:**

1). 4th DST PROJECT: Emergence of quantum criticality for hermitian and non-hermitian topological state of quantum matter.

2). Principal Investigator: Sujit Sarkar  
Current Research Projects:

(1). A study of Conformal Field Theory for Quantum Matter System:

We study and present the results of central charge for quantum Ising model with longer range interaction. This model Hamiltonian system has three gapped phase with different topological index and three quantum critical lines also with different topological index. We also present the conformal field theory study for this model Hamiltonian system and present the central charge for the different regimes of the parameter space. We show explicitly non-universal, i.e., for the same value of central charge behaviour of topological states are different. This model Hamiltonian system consists of two multiple quantum critical points, one is topologically trivial and the other is topologically non-trivial. We also present the effect of transverse field on the quantum critical line and also for the evaluation of central charge. We present explicitly difference between the quantum Ising model and the quantum Ising model with longer range interaction. We show explicitly that the minimal model which describe the cft behavior of quantum Ising model is not sufficient to describe the behaviour of quantum Ising model with longer range interaction. Apart from that we show explicitly on the interplay of criticality and topology. This work will provide a new perspective in topological state of conformal field theory.

2). Interplay of Topology, Criticality and Edge Mode Physics for Hermitian and non-Hermitian Quantum Many Body System

The interplay between topology and criticality has been a recent interest of study in condensed matter physics. A unique topological transition between certain critical phases has been observed as a consequence of the edge modes living at criticalities. In this work, we generalize this phenomenon by investigating possible transitions between critical phases which are non-high symmetry (non-HS) in nature. We find the triviality and non-triviality of these critical phases in terms of the decay length of the edge modes and also characterize them using the winding numbers. The distinct non-HS critical phases are separated by multicritical points with linear dispersion at which the winding number exhibits the quantized jump, indicating a change in the topology (number of edge modes) at the critical phases. Moreover, we reframe the scaling theory based on the curvature function, i.e. curvature function renormalization group method to efficiently address the non-HS criticalities and multicriticalities. Using this we identify the conventional topological transition between gapped phases through non-HS critical points, and also the unique topological transition between critical phases through multicritical points. The renormalization group flow, critical exponents and correlation function of Wannier states enable the characterization of non-HS criticalities along with multicriticalities.

**List of Publications:**

**(1). Critical scaling of a two-orbital topological model with extended neighboring couplings**

**Y. R. Kartik, Ranjith R. Kumar & Sujit Sarkar**

Scientific Reports | (2024) 14:4504 <https://doi.org/10.1038/s41598-024-54946-5>

(Nature Publication Group)

**(2). Quantum Field Theoretical Study of Correlated Quantum Ising Model with Next-Nearest-Neighbour Interaction**

**Ranjith R. Kumar & Sujit Sarkar**

**Brazilian Journal of Physics (2024) 54:206 [https://doi.org/10.1007/s13538-024-01584-](https://doi.org/10.1007/s13538-024-01584-x)**

**x**

**(Springer Nature Publication Group)**

**(3). Quantum Berezinskii-Kosterlitz-Thouless (BKT) and reverse quantum BKT in the correlated quantum Ising model**

**Sujit Sarkar**

**Journal of Physical Society of Japan (Under Consideration)**

**(4). Topological Transition on A Conformal Manifold for The Quantum Ising Model with A Longer Range Interaction**

**Sujit Sarkar**

Scientific Reports | (2024) (Under Consideration )

(Nature Publication Group)



**Dr R. Srikanth**  
Associate Professor  
Theoretical Sciences Division  
E-mail: [srik@ppisr.res.in](mailto:srik@ppisr.res.in)

#### **BRIEF CV:**

- ❖ January 2018 – till date, Associate Professor, PPISR, Bengaluru, India
- ❖ 2010 – 2017: Asst. Professor, PPISR, Bengaluru, India
- ❖ 2006 – 2010: Faculty Fellow, PPISR, Bengaluru, India
- ❖ 2003 – 2006: Postdoc, RRI, Bengaluru, India
- ❖ 2000– 2003: Research Associate, CTS, IISc, India
- ❖ 1999 : PhD IIA and IISc, Bengaluru, India

#### **RESEARCH INTERESTS:**

☐ **Quantum cryptography:** Various areas studied include quantum secret sharing, quantum key distribution, key agreement, orthogonal state protocols, bit commitment, counterfactual protocols, twin-field quantum systems, steganography, and quantum information splitting.

☐ **Quantum foundations:** Areas studied include the complementarity of randomness and signaling in simulating quantum nonlocality, understanding the significance of relativity in nonlocality, axiomatic approach to quantum reconstruction, nonlocality and contextuality of indistinguishable particles.

☐ **Quantum information processing and Open quantum systems:** Quantum error correction, its use for characterization of channels, number-phase complementarity in atomic systems, quantum deleters, maximally nonlocal subspaces and their possible applications to self-testing, and the possible applications of noise in quantum information processing. Other areas studied include Markovian and non-Markovian quantum channels, P- and CP-divisibility, combining quantum channels, bath engineering to produce non-markovianity, measure of non-Markovian maps.

☐ **Studies of the Solar atmosphere:** Studied areas include the fractal dimension of the Solar supergranulation as observed in the Ca II K line, its dependence on Solar rotation and activity phase.

#### **RECOGNITIONS (2023 - 2024):**

1. Dr. Srikanth was part of a team put together by Karnataka Science and Technology Association (KSTA) tasked with submitting a report to Karnataka Govt on fostering quantum technologies.



2. Hindu Dharma Acharya Sabha kindly invited me to participate as a speaker and panelist (from a Science perspective) in “ Science and Spirituality Dialogue “ held in Sivananda Ashram, Ahmedabad .
3. Acted as referee for papers submitted to various prestigious international journals, such as Journal of Physics A (Mathematics & General), Physical Review X, Physical Review A (American Physical Society), Quantum Information Processing.
4. Dr R Srikanth facilitated a course by Prof. Kallol Roy, an alumnus of PPISR and current Professor of Data Science at Tartu University, Estonia, wherein Prof Kallol gave a series of ten 2-hour lectures on the subject of machine learning to PPISR students over the period June 28 to Friday July 24, 2024. This should provide an important addition to the regular academic engagements of our students

### **STUDENTS (2023-2024):**

1. Dr Vijay Pathak (postdoc, working in the area of quantum non-Markovianity, information backflow, divisibility of quantum channels)
2. Mr [SANJOY DUTTA](#)(PhD student, working in the area of hybrid quantum systems, entanglement-assisted quantum error correction, quantum steganography)
3. Mr Shubhodeep Gangopathyay (PhD student, working in the area of quantum network nonlocality, quantum secret sharing)

### **GROUP ALUMNI:**

#### **A) PhDs**

1. **Dr. Vinod N Rao:** Area: feasibility studies of practical counterfactual quantum cryptography (July 23, 2023); currently at the quantum technology group, York University, UK.
2. **Dr. Shrikant Utagi:** PhD topic: ASPECTS OF NON-MARKOVIANITY IN OPEN QUANTUM SYSTEM DYNAMICS AND QUANTUM COMMUNICATION (11 Oct, 2021) ; currently postdoc at Physics Dept, IITM.
3. **Dr. Aravinda S.** PhD Title: “Aspects of quantum contextuality” (19 June, 2017); currently Professor of physics at IIT Tirupati.
4. **Dr Amkar S:** PhD topic: "QUANTUM NOISE DUE TO DISSIPATIVE AND NON-DISSIPATIVE INTERACTION WITH A SQUEEZED CODES AND CHARACTERIZING QUANTUM DYNAMICS"; currently, quantum technology officer at Orca Quantum Computing, Canada

#### **C) Post-Doctoral Fellows:**

- 1) **Dr. Rohit Kishan Ray.** 2023-2024: He worked in my DST project CRG/2022/008345.
- 2) **Dr. V Ranjith** 2017-2018: He worked in my DRDO project ““Feasibility Study of a Practical Realization of Protocol for Semi-Counterfactual Quantum Key Distribution (QKD)”

### **NATIONAL AND INTERNATIONAL COLLABORATORS:**

1. Prof Franco Petruccione, Univ. of Stellenbosch, SA
2. Prof. [Subhashish Banerjee](#), IIT Jodhpur
3. Prof Debajyoti Gangopadhyay, Annada College, VBU, Hazaribag
4. Dr. Vinayak Jagadish, CIT Chennai

5. Prof S. Aravinda, IIT Tirupati

## **RESEARCH 2023-2024:**

### **CURRENT PROJECTS:**

- 1) **Entanglement assisted quantum error correction and quantum steganography**  
Principal Investigator: **Dr. R Srikanth**  
Research fellows: Mr. Sanjoy Dutta
- 2) **Quantum error correction, noiseless subsystems or subspaces and quantum secret sharing**  
Principal Investigator: **Dr. R Srikanth**  
Research fellows: Mr. Shubhodeep Gangopadhyay
- 3) **Generalized Breuer-Laine-Piilo measure and information backflow**  
Principal Investigator: **Dr. R Srikanth**  
Research Associate: Dr [Vijay Pathak](#)
- 4) **Causal models of quantum correlations: complementarity and duality**  
Principal Investigator: **Dr. R Srikanth**

### **Publications:**

1. Concatenating quantum error-correcting codes with decoherence-free subspaces and vice versa. Nihar Dash, Sanjoy Dutta, R. Srikanth and Subhashish Banerjee. *Physical Review A* 109(6) 062411 (2024).
2. Experimental realization of quantum non-Markovianity through the convex mixing of Pauli semigroups on an NMR quantum processor. Vaishali Gulati, Vinayak Jagadish, R. Srikanth, Kavita Dorai. *Physical Review A*, 109(4) 042419 (2024).
3. Protocols for counterfactual and twin-field quantum digital signature. Vinod N. Rao, Shrikant Utagi, Anirban, Pathak and R. Srikanth. *Physical Review A*, 109, 032435 (2024).
4. On the eternal non-Markovianity of non-unital quantum channels. Shrikant Utagi, Subhashish Banerjee and R. Srikanth. *International Journal of Quantum Information (IJQI)* 22, 2350039 (2024).
5. Asymmetric one-sided semi-device-independent steerability of quantum discordant states. C. Jebaratnam, D. Das and R. Srikanth. *Phys. Rev. A* 108, 042211 (2023)
6. Sowmya G. M., Rajani G., Paniveni U and R. Srikanth. Dependence of Solar supergranular lifetime on surface magnetic activity and rotation. *Astrophysical Bulletin*, (2023), Vol. 78, No. 4, pp. 606–612.
7. Bifractal behavior of Solar supergranulation and magnetic activity. Gangadhar, R., Bharath, S. Udayashankar, P. and R. Srikanth. Accepted for publication in *Acta Astron.* (2023).
8. Initial correlations and complete positivity of maps. Vinayak J., R. Srikanth, F. Petruccione. *Open Systems & Information Dynamics*, Vol. 30, No. 03, 2350011 (2023).
9. Noninvertibility and non-Markovianity of quantum dynamical maps. Vinayak J., R. Srikanth, F. Petruccione. *Phys. Rev. A* 108, 042202 (2023);
10. Quantum counterfactuality with identical particles. Rao, Vinod N., Anindita Banerjee, and R. Srikanth. *Communications in Theoretical Physics* 75, no. 6 (2023): 065102.

**Sponsored projects (2023 - 2024)**

1. Title: “Qubit and higher dimensional non-unital non-invertible quantum dynamical maps: geometry and the relation to quantum non-Markovianity” Funding: Rs. ~ 26.7 L (DST-SERB project 2023 - 2025)
2. Title: “Designing of Devices and Protocols for Quantum Hacking, Random Number Generation and Secure Communication” Funding: Rs. 20L Interdisciplinary Cyber Physical Systems (ICPS) program of DST, India (with Prof Anirban Pathak) 2020 - 2024
3. Title: “Quantum non-Markovianity: characterization, measure and resources” Funding: Rs. 6.6 L, DST Science and Engineering Research Board (SERB) MATRICS

## Highlights of Research Activities

We are steadily making progress in highly competitive scientific research and is coming into limelight on the national and international stage by maintaining the uniqueness in the research field. The Institute has chosen contemporary frontier areas of research in the fields of Materials Science and Catalysis, Biological Science and Theoretical Sciences. PPISR is successfully forging ahead a fruitful academia-industry partnership by innovating, designing and developing novel multifunctional materials that have wide-ranging applications in catalysis, nanotechnology, etc. Several new research projects have been initiated with sponsorship from industries like Sulzer-GTC Technology Inc, USA, Sravathi Advanced Process technologies Bengaluru, SABIC Agri Nutrients and SABIC Research and Technology, Bengaluru and also Government agencies like Vision Group for Science and Technology, Govt. of Karnataka, Department of Science and Technology, Government of India, Defence Research and Development Organisation , etc. Currently, 18 doctoral students are actively involved in research activities on many sponsored projects both from Government agencies as well as from industries.

PPISR has been pursuing nearly 29 research projects in different areas which are both fundamental as well as applied sciences. These projects have shown significant progress in terms of publications and patents.

### ACHIEVEMENTS

#### Award of PhD degree:

1. Ms. Shrilakshmi S, who pursued PhD under the guidance of Dr. Ananda K as PI and Dr. Udipi A Ramagopal as Co-PI, Associate Professors from PPISR, defended her PhD viva on the thesis titled "Rational modification of insulin driven by evolutionary studies and chemistry for therapeutic applications" on May 16, 2023 and was subsequently awarded the Ph.D. degree by MAHE (deemed to be University), Manipal
2. Mr Kartik who pursued research under the guidance of Dr. Sujit Sarkar has defended his PhD thesis titled "Geometry, Criticality and Topological transitions in Hermitian and non-Hermitian systems" on 29<sup>th</sup> June 2023 and was subsequently awarded the Ph.D. degree by MAHE (deemed to be University), Manipal.
3. Mr. Shankar kundapura who pursued research under the guidance of Dr. Udipi A Ramagopal defended his thesis titled Rational Modification of Immune Checkpoint Receptors of PD-1 Pathway for Cancer Immunotherapy on Jun 26, 2023 and has been awarded PhD degree by MAHE.
4. Ms. Vaishnavi B. J. who pursued PhD under the guidance of Dr. Ganapati V Shanbhag successfully defended her PhD open defence of her thesis titled "Designing novel catalysts for conversion of biomass derivatives furfuryl alcohol and levulinic acid into value-added chemicals" on July 14, 2023 and was subsequently awarded the Ph.D. degree by MAHE (deemed to be University), Manipal.

### **Dr. K. V. Rao Scientific Society research award**

**Dr. Ranjith Kumar R.** won the prestigious National Dr. K. V. Rao Scientific Society research award on 1<sup>st</sup> September 2023 from for his exemplary research work on “Multicritical Phenomenon in Topological States of Matter”.

### **DST INSPIRE Fellowship:**

Ms. Asha Devi, who is working under the guidance of Dr. Naresh Nalajala has been awarded DST-Inspire fellowship. She is the second Inspire student from our institute.

### **Best Presentation award**

**Dr. Vaishnavi B. J.** student of Dr. Shanbhag won **Best Oral presentation** award for her research on “Combinational approach of experimental and DFT for alkyl levulinate synthesis from biomass-derived feedstocks using sulfonic acid functionalized flexible MOF catalyst” at International Conference on “Green Chemistry Solutions for Sustainable Future (ICGCSF-2023)” organized by Department of Chemistry, GITAM University from 20th to 22nd September, 2023.

**Ms. Bhavana B. Kulkarni** won 2nd Place for **Best Oral Presentation** at 3rd international Conference Global trends in sustainable technology and its applications in applied sciences organized by Reva University and Indian association of Applied microbiologist (IAAM) 30-31st October 2023.

**Ms. Bhavana B. Kulkarni** has received the **Best Poster prize award** from Nanoscale Horizons at International winter school and international conference on RAM-90- 2023 by JNCASR) Bengaluru, 4-6th December 2023.

**Mr. Harsha M.**, student of Dr. Shanbhag won a “**First prize**” in **\*Best Poster presentation award\*** during National workshop on "Futuristic Catalysts and Catalytic Processes" organized by Central University of Kerala, Kasargod during February 15–16, 2024.

### **Ongoing Sponsored Projects:**

#### **A. Industry sponsored projects:**

1. Catalyst and process development for hydrocarbon synthesis via halogen mediation  
Sponsored by: Sulzer-GTC Technology Inc, USA Principal Investigator:

Dr. Ganapati V Shanbhag

Duration: 10 months Jan - Dec- 2023

2. “Rationalization of Yield Prediction Guided by Computational Insights”.

Sponsored by Sravathi AI Technology Pvt Ltd (SAITPL), Bengaluru

PI- Dr. Sanjeev P Maradur

Co-PI: Dr. Vetrivel and Dr. Ganapati V. Shanbhag

Duration: February 2023 to January 2024.

3. Synthesis of fertilizers via carbon dioxide mineralization

Sponsored by: SABIC Agri Nutrients and SABIC Research and Technology, Bengaluru

Duration: 1 year

Principal Investigator: Dr. Ganapati V Shanbhag

Co-PI: Dr. Naresh Nalajala

### **Government agencies sponsored projects:**

1. “Designing of devices and protocols for quantum hacking and secure communication sponsored by: Department Of Science And Technology, (DST-SERB), Govt of India)

Principal Investigator: Dr. R. Srikanth

Duration: 2021-2024

2. “Emergence of quantum criticality for hermitian and non-hermitian topological state of quantum matter

Sponsored by: Department of Science and Technology,

Principal Investigator: Dr. Sujit Sarkar

Duration: 2022-2024

3. “Qubit and higher-dimensional nonunitary noninvertible quantum dynamical maps: geometry and the relation to quantum non-Markovianity

Sponsored by: DST SERB for core research grant has been accepted for providing grant money to hire an RA

Principal Investigator: Dr R Srikanth

Duration: 2023-2026

4. “Design and development of rooftop photocatalyst panels for solar H<sub>2</sub> generation and value-added chemicals”

Sponsored by Science and Engineering Research Board (SERB), DST under the startup research grant (SRG)

Principal Investigator: Dr. Naresh Nalajala

### **PUBLICATIONS:**

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7. Utagi S., Banerjee S., Srikanth R. On the eternal non-Markovianity of non-unital quantum channels (2023) *International Journal of Quantum Information*, art. no. 2350039
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11. Jagadish V., Srikanth R., Petruccione F. Noninvertibility and non-Markovianity of quantum dynamical maps (2023) *Physical Review A*, 108 (4), art. no. 042202
12. Kartik Y.R., Sarkar S. Mixed state behavior of Hermitian and non-Hermitian topological models with extended couplings (2023) *Scientific Reports* 13, art. no: 6431
13. Krishnaveni V., Esclance DMello M., Sahoo P., Thokala N., Bakuru V.R., Vankayala K., Basavaiah K., Kalidindi S.B. Palladium-Nanoparticle-Decorated Covalent Organic Framework Nanosheets for Effective Hydrogen Gas Sensors (2023) *ACS Applied Nano Materials*, 6 (13), pp. 10960 – 10966
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19. Swamy A., Kanakikodi K.S., Bakuru V.R., Kulkarni B.B., Maradur S.P., Kalidindi S.B. Continuous Flow Liquid-Phase Semihydrogenation of Phenylacetylene over Pd Nanoparticles Supported on UiO-66(Hf) Metal-Organic Framework (2023) *ChemistrySelect*, 8 (5), art. no. e202203926
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21. Jebarathinam C., Das D., Srikanth R. Asymmetric one-sided semi-device-independent steer ability of quantum discordant states (2023) *Physical Review A*, 108 (4), art. no. 042211
22. Y. R. Kartik, Ranjith R Kumar, and Sujit Sarkar, Critical scaling of a two-orbital topological model with extended neighboring couplings (2024) (*Nature Scientific Report*, 14, 4504).
23. Shreya Kanth, Yashoda M. Puttaiahgowda and Ananda Kulal. Synthesis and Characterization of Functionalized Starch by Grafting Pyridine for Use in Antimicrobial Applications (2024), *Starch*. 2300121.
24. Vinod N. Rao, Shrikant Utagi, Anirban Pathak, R. Srikanth. Protocols for counterfactual and twin-field quantum digital signature, (2024), *Physical Review A Phys. Rev. A*, 109, 032435
25. Shrikant Utagi, Subhashish Banerjee and R. Srikanth. On The Eternal Non-Markovianity of Non-Unitary Quantum Channels. (2024) *International Journal of Quantum Information*, 22 (01), 2350039
26. R. K. Jha, M. Manikandan, M. Prabu, N. R. Vineeth, P. Dharmalingam, R. Archana, M. Harsha, S. R. Shankar, K. Bhatte, T. Raja Temperature-Controlled Hydrothermal Synthesis of  $\alpha$ -MnO<sub>2</sub> Nanorods for Catalytic Oxidation of Cyclohexanone (2024) *ChemPlusChem*, 89 (7) e202300589 (Collaboration work with CSIR-NCL, Pune).



### **Book chapter:**

1. B J Vaishnavi and Ganapati V. Shanbhag Chapter 24: Catalytic hydrogen generation from biomass and its derivatives in the book: Handbook of Emerging Materials for Sustainable Energy, Jan 2024, Elsevier, USA.
2. Bhavana B. Kulkarni, Kempanna S. Kankikodi, Sathyapal R. Churiparad and Sanjeev P. Maradur, "Mesoporous polymers for the catalytic conversion of biomass platform molecules to value-added chemicals" Chapter 22, Handbook of Emerging Materials for Sustainable Energy, Elsevier publisher, 2024.
3. Naresh Nalajalia, Asha Devi, "Shape-engineered Bimetallic Nanostructures for Electrochemical Oxidation of Liquid Fuels" (Chapter 1) of the book "Bi Metals: Formation, Properties and Applications" published by Nova Science Publishers

### **Manuscripts under communication:**

Nearly 21 manuscripts are in the process of submission/review

### **Patents:**

1. Biologically active zinc-free hexameric insulin analogues, (2023), **Indian Patent Application** No. 202341002384, Inventors: Ramagopal UA, Rao SS, Kundapura S, Ananda K.
2. High affinity PD-1 mutant as lead molecules for cancer immunotherapy, (2023), **Indian Patent Application** No. 202341044329 and Inventors are Ramagopal UA, Kundapura S.
3. Catalyst for carbon dioxide hydrogenation to methanol and method of preparation thereof, (2023) **Indian Application number:** 202341022626, Inventors: S. Kotni, G. Valavarasu, G. V. Shanbhag, R. Vetrivel, A. B. Halgeri, S. Sujith, C. N. Mallannavar and K.M.R Vaibhava (filed by HPCL; outcome of collaborative project).
4. Poly(vinyl chloride)-G-1-(2-aminoethyl piperazine) polymer for antimicrobial paint composition and its method of preparation thereof: **Indian Patent Application** filed by MAHE Manipal, and inventors are Dr.Yashoda M. Puttaiahgowda (MIT, Manipal) , Dr.AnandaKulal (PPISR, Bengaluru) and Ms.Sonali Gupta (MIT, Manipal)

### **Conferences/Seminars/Workshops**

Based on the ongoing research projects, our faculty members and research scholars of have attended many National/International conferences held at various locations in India and won many Best presentation awards.

### **Academics**

The course work for the new batch of Ph.D. students has been started and DAC reports are being sent to Manipal University periodically. The Doctoral Advisory Committee and

Research Advisory Committee are being held periodically to further improve the quality of research work carried out in all three areas of sciences.

### **In-house Seminars and Invited Lectures**

We had organized 10 In-house seminars based on the research work carried out by faculty and students of PPISR.

Few eminent scientists both from India and abroad visited PPISR and also delivered an Invited lecture in all three areas.

### **Successful completion of the industry sponsored project:**

A project sponsored by Sulzer-GTC Technology Inc, USA was successfully completed its 3<sup>rd</sup> term in December 2023. The novel solid catalysts were designed for the transformation of natural gas and LPG via halogen mediation to make value added products like alkenes, ethers, alkylated amines, carbon etc in batch and continuous mode. Dr Nikolay Nesterenko, Head, Technology Commercialization Gas Solutions CFCL of Suzer Chemtech, Zurich visited PPISR from 21<sup>st</sup> to 24<sup>th</sup> June, 2023. During these 4 days, there were series of review meetings on the sponsored project that was conducted since two and half years at PPISR sponsored by Sulzer GTC. He appreciated the overall progress made in this project by Dr. Shanbhag and his team.

### **Procurement of items for cell culture room:**

Dr. Ananda under the VGST research grant procured instruments namely, Biosafety cabinet, Digital balance, PCR and fridge required for the cell culture room during April to June 2023.

### **Project Internship programme:**

Nearly 30 students from various colleges/universities in and around Karnataka, as a partial fulfillment of the requirement for the award of Masters degree, completed their MSc projects under the guidance of all faculty members of PPISR

### **Memorandum of Understanding (MOU) with reputed organizations:**

Based on the research expertise and instrumentation availability at PPISR, an M O U between PPISR and Galgotias University, Greater Noida, UP was signed on June 30, 2023 in the Presence of PPISR Director and the Vice Chancellor of Galgotias University for exchanging academic, scientific and research activities between both the Institutes and also to get recognition for award of PhD degree from Galgotias University

### **Course work lectures:**

As part of course work for our first year Ph. D. students, organized guest lectures on XPS and In-situ XPS by Dr. K. P. Reddy, Brokehaven National Laboratory, USA as well as Dr. Kallol Roy, currently working as an Assistant Professor at the University of Tartu, Estonia, and a former student of Dr. R Srikanth has delivered a series of 14 course work lectures

### **Miyawaki Forest at PPISR:**

In response to escalating concerns regarding environmental pollution and a steadfast dedication to environmental conservation, PPISR has established a Miyawaki forest. Afforestation serves not only as a scientifically proven method but also as a promising strategy for safeguarding soil, air, water, and climate. This was personally initiated by His Holiness Shree Eeshapriya Theertha Swamiji on May 24, 2023. The forest consists of 1500 saplings planted in an acre of desert land, encompassing 25 different plant species, including fruits and medicinal plants. A dedicated team ensures the well-being of the saplings and provides periodic updates on the forest's growth to the revered Swamiji.

### **FOUNDER'S DAY 2023:**

Founder's Day was celebrated on July 6, 2023, at PPISR Bidalur campus. The Program was started with the invocation by Ms. Meghana HK, Research Scholar and Dr. Anand B Halgeri, Director, PPISR welcomed and addressed the gathering. In his address he briefly explained all the achievements of PPISR after he took over the charge as Director of PPISR. Dr. Shubha V, former Distinguished Scientist, CSIR, National Aerospace Laboratories, Bengaluru inaugurated the function by lighting the lamp along with other dignitaries on the dais. Dr. Ganapati V Shanbhag, Dean of academics, PPISR gave details of the founders day program. Later he introduced Dr. Shubha V, Founder's day's Chief Guest. The Chief Guest, in her speech, spoke about the indigenous Dristi (A Transmissometer for Airport Runway Visibility), its working capabilities and operational practices etc. Dristi is her inventive product and she explained how much of revenue could be saved for India by this. Now the product is recognized by the international market and airports. She also inspired the audience by explaining many of her other inventions.

The inaugural program was concluded by honouring the chief guest.

Later, the technical programme was continued; First session was on Materials Science and Catalysis division. Dr Navaneet Kumar Gupta, Scientist from Centre for Sustainable Technologies, Indian Institute of Science Bengaluru gave a talk on "*Embracing the future: circular economy in the chemical industries*".

The afternoon session was begun with Technical sessions from Theoretical Physics. Dr. Banibrata Mukhopadhyay from Department of Physics, Indian Institute of Science Bengaluru gave a talk on the topic "*Gravitational geometric phase*". He explained about Dirac equation in electromagnetic field, gravitational field and also about Dirac. The final session was on Biological Sciences division. Dr. Manjunatha M V, Scientist from Department of Neurovirology, NIMHANS, Bengaluru gave a lecture on the title "*Understanding neurological complications of COVID-19: a lab based approach*". In his speech he gave a detailed explanation of Covid virus and its different types. The post infection complications were also discussed, mainly focussing on neurological complications related to the post covid infections.

At the end of the program, Dr. Ananda K, Associate professor, Biological Sciences, summarised the whole proceedings of the founders day celebration to the audience. Dr. Naresh Nalajala gave the vote of thanks to all the dignitaries, gatherings and people who are behind in the success of this program. Overall, the Founder's Day 2023 ceremony went quite well by paying honour to the founder Swamiji.

### **International Conference In Association With The Catalysis Society Of India, Bangalore Chapter:**

PPISR in association with Catalysis Society of India (CSI), Bangalore Chapter and GITAM has conducted an international conference on International Conference on Green Chemistry Solutions for Sustainable Future. During the inaugural session of the conference, our director Dr. A. B. Halgeri, was honored by vice-chancellor of GITAM University. Dr. A. B. Halgeri participated in panel discussion on “Career Opportunities in Industry and Academia – Participants interaction with Industry and Academia experts”. One of our faculty Dr. Ganapati V. Shanbhag invited as a keynote speaker. Many of our Ph. D. scholars presented their work at this international platform and Dr. Vaishnavi B. J. won the best oral presentation award for her outstanding research work. Our faculty was actively involved as chairs for various oral and keynote talks of this conference.

### **Visit of Dr. Mallikarjun Shakarad (Former Faculty of PPISR):**

The former Faculty alumni of PPISR Dr. Mallikarjun Shakarad, presently a professor in the Department of Zoology of University of Delhi visited the campus on August 13, 2023 and delivered a lecture. He was honored during his visit to the campus. He also cherished the memories of his association with the Founder Chairman HH Shree Vibudhesha Theertha Swamiji in establishing this institute.

### **Celebration Of 77<sup>th</sup> Independence Day At Bidalur Campus:**

The 77<sup>th</sup> Independence Day was celebrated on August 15, 2023 with the remarkable fervor at the Bidalur Campus. The Flag was hoisted by Dr. A B Halgeri, the Director, and he also delivered a talk to the small gathering on the occasion of the Independence Day. After the distribution of the sweets, the members who were present at that time cleaned the campus by removing plastic and other wastes from the premises.

### **Outreach Programme for PPEC Schools:**

In order to create interest in basic science in young minds, PPISR has taken up an initiative of an outreach program with a theme of “Today’s Science for Tomorrow’s Scientists” for Poornaprajna School students. Xth standard Students from five Poornaprajna Schools in Bangalore were called to visit PPISR one day each as a part of the outreach program held for 5 days in the month of September- October 2023. The objective of the program is to motivate and inspire young students to take science as a career in the future. Around 124 students from Sadashivanagar, 90 students from Indiranagar, 86 students from Yelahanka, 148 students from Widia and 61 students from Krishnanagar Poornaprajna high schools participated in this program along with their teachers. The research scholars of PPISR conducted experiments in Physics, Chemistry and Biology and explained the theory behind it. All the students were taken for a laboratory visit and given explanation of the research facilities that are available in the institute. Students interacted with the faculty and research scholars of the institute about the ongoing research and showed a lot of interest. The program was conducted in three sessions, the morning session started with the brief introduction and over of PPISR by Dr. Sanjeev P. Maradur, followed by four

experiments in Chemistry. The second session started with the Physics experiments followed by a talk by a research scholar and the session was coordinated by Dr. Srikanth. The third Session was related to biology experiments which were coordinated by Dr. Ananda and his research Scholars. Finally, a day long program was ended with the concluding address by Dr. Halgeri, Director, PPISR to all the students of PPEC. The feedback got from the teachers and students on the outreach program were very favorable and they appreciated the Director, faculty and students of PPISR for this initiative. In addition, they also requested us to organize many more such programmes and invited our faculty and students to give a talk/demonstration at their schools

### **A 2-Day Science Exhibition for Poornaprajna Education Centres in Bengaluru:**

A Science exhibition spanning two days, themed "The Significance of Chemistry in Daily Life," was conducted in collaboration with the Royal Society of Chemistry Local Session, the Poornaprajna Institute of Scientific Research, and the Poornaprajna Education Centre, Bengaluru, from November 21<sup>st</sup> to 22<sup>nd</sup>, 2023. A total of 100 students from five different Poornaprajna Education Centers across the city participated in the event.

The first day, November 21<sup>st</sup>, 2023, marked as the 'Scientist-Student Interaction Day,' commenced at 10:00 am with students singing the Invocation song (dhyana shloka). Dr. A B Halgeri, the Director of PPISR, extended a warm welcome to the Chief Guests, followed by the ceremonial lighting of the lamp by all dignitaries. Mrs. Lalitha Bai, Principal of PPEC Sadashiv Nagar, introduced the speakers for the day. Prof. C V Yelamaggad from CeNS, Bengaluru, Vice Chairman of RSC-LSD, delivered a talk titled "Fourth State of Matter-Science and Technology of Liquid Crystals." Dr. Gurusurthy Hegde spoke on "Green Chemicals," and Dr. Ganapati Shanbhag addressed "Catalysis and its Role in Green Synthesis of Fuels and Chemicals." Mrs. Thirumalai, Headmistress of PPEC Sadashiv Nagar, delivered the vote of thanks.

On the second day, students showcased their exhibits on "Energy and Environment Concerns" under the Chairmanship of Dr. A B Halgeri. Prof. S V Raman, Prof. C V Yelamaggad, Dr. Sanjeev P Maradur, Dr. Pradeep Shanbhog, Mrs. Lalitha Bai, Mrs. Thirumalai, and teacher coordinators from all five schools were present. The participating schools included PPEC Indiranagar, PPEC Shri Krishnanagar, PPEC Yelahanka, PPEC Widia, and the host school PPEC Sadashiv Nagar. Each branch presented 10 exhibits comprising models, experiments, and idea presentations, with two students per exhibit, totaling 20 participants per branch and 100 participants overall.

Prizes were awarded to students from PPEC Yelahanka and PPEC Sadashivanagar for the 'Idea Presentation' category, while 'Best Model' awards went to students from PPEC Yelahanka, and one was shared by PPEC Widia and PPEC Sadashivanagar. The 'Best Experiment' award was secured by students from PPEC Indiranagar and PPEC Shri Krishnanagar. Each recipient received a certificate and a voucher worth 250/- from Sapna Book House. The event concluded with a vote of thanks delivered by Mrs. Usha of PPEC Sadashiv Nagar.

## **Annual Day Celebrations**

The Annual Day of 2023 at PPISR was a celebration of scientific achievements and contributions to the institute. Dr. Ananda K, director Dr. A. B. Halgeri, Financial Advisor Sri. Sreenivasa Rao, honorary Treasurer Sri G. V. Krishna, and personal secretary Sri Gopal Sabaraya were present on this occasion. H H Shree Eeshapriya Theertha Swamiji graced the occasion by his August presence. Dr. Anand Halgeri gave the welcome address. This was then followed by research highlights of PPISR by Dr. Ganapati V. Shanbhag, Dean and HoD.

On this occasion, Ms. Bhavana Kulakarni was honored as the Best Research Scholar for 2023, while Mr. Sujith received the Best Presentation Award for 2023. The 14<sup>th</sup> volume of the 2023 newsletter showcased PPISR's activities and achievements. The DRISHTI visit by Poojya Swamiji was a highlight of the event.

The annual sports competition winners were honored by Poojya Swamiji His Holiness Shree Eeshapriya Theertha Swamiji, and Director Dr. A. B. Halgeri and Financial Advisor Sri Sreenivasa Rao also joined in honoring the deserving winners.

The celebration was extremely noteworthy since Dr. R. Vetrivel graciously donated 2.5 lakhs to PPISR, which Poojya Swamiji acknowledged. Dr. Vetrivel then gave an amazing speech which enriched the programme even more.

The event was further enhanced by the release of the 2023 newsletter by Poojya Swamiji. The 14<sup>th</sup> volume of the newsletter showcased the comprehensive activities and achievements of PPISR throughout the year 2023. Subsequent to the aforementioned event, Poojya Swamiji gave benediction to the gathering which mesmerized the audience who were present. After this, the event concluded with a vote of thanks by Ms. Bhavana Kulakarni.

## **National Science Day Celebrations:**

PPISR celebrated National Science Day on March 1, 2024, under the theme "Science and Technology Advancements." The event commenced at 10:30 a.m. with a warm welcome from Dr. Ananda K., followed by the presence of Director Dr. A. B. Halgeri, and the Chief guest Dr. Nagesh Kini, Co-founder and CTO of Vimano Inc. Also in attendance were Dr. Ganapati V. Shanbhag (Dean of Academics and HoD, as well as the event coordinator), along with other invited speakers, faculty, guests, and students. Dr. Halgeri delivered the opening address, reflecting on the significance of the occasion and sharing memories of Sir C. V. Raman's visit to Bangalore Central College.

Session I began with a presentation by Dr. Nagesh Kini on "Developing Businesses Based on Cutting-Edge Technologies." This was followed by Dr. Ganapati V. Shanbhag's talk on "Ozone Layer Depletion and the Application of Ozone in Chemical Synthesis" and Dr. Sanjeev P. Maradur's tribute to "Dr. Srinivasa Sourirajan: Father of Reverse Osmosis." Mr. Manjunath Reddy also presented on "Carbon Capture and Utilization Strategies," with Dr. R. Vetrivel chairing the morning session.

In the afternoon, Session II featured talks by Dr. Urmi Bandyopadhyay on "Lysosome in Novel Nutrient Homeostasis" and Mr. Mallikarjun M. on "Cinderella of Genetics: A Story about the Fruit Fly," chaired by Dr. Ananda.

Session III concluded the event with presentations by Mr. Animesh Aryan on "Interfacing Quantum Information Science and Technology" and Mr. Shubhodeep Gangopadhyay on "Magic in Non-linear Dynamics," chaired by Dr. Sujit Sarkar.




Dr. Ganapati V. Shanbhag organized the proceedings, and Dr. A. B. Halgeri distributed certificates of appreciation to all the speakers.

### **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 | <p><b>Powder x-ray diffractometer (PXRD)</b> The d2 phaser – table top x-ray powder diffractometer from Bruker is ideal for qualitative, quantitative and structure analysis of polycrystalline samples.</p>   |    |
| 2 | <p><b>Fourier transform infrared spectroscopy (FTIR)</b><br/>The Bruker-Alpha FTIR spectrophotometer is a compact instrument and measures the infrared spectrum, which represents the molecular absorption and transmission of a sample.</p>   |    |
| 3 | <p><b>Fluorescence spectrophotometer</b><br/>The Varian Cary Eclipse fluorescence spectrophotometer is a compact instrument and measures the fluorescence, phosphorescence, chemi/bio-luminescence, and time resolved phosphorescence.</p>   |   |
| 4 | <p><b>Ultraviolet – visible spectroscopy</b><br/>The UV-Visible spectrophotometer from PerkinElmer 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.</p>   |  |
| 5 | <p><b>Atomic absorption spectroscopy (AAS)</b><br/>This instrument from PerkinElmer 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.</p> |  |



|   |  |  |
|---|--|--|
| 6 | <p><b>Temperature program desorption (TPD) analyzer</b><br/>         Bel's new fully-automated catalyst analyzer, enables comprehensive catalyst study by using the techniques;<br/>         1) temperature programmed desorption (TPD)<br/>         2) temperature programmed reduction (TPR)<br/>         belcat ii will be the strong tool for the catalyst evaluation.</p> |   |
| 7 | <p><b>Surface area analyzer</b><br/>         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.</p>                                |   |
| 8 | <p><b>Thermo gravimetric analyzer (TGADTA/DSC)</b><br/>         Sta6000 (perkin elmer) is simultaneous thermal analyzer for simultaneous measurement and analysis of weight change and heat flow</p>   |  |

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## PPISR FOUNDER'S DAY CELEBRATION AT BIDALUR CAMPUS 06.07.2023



The Founder's Day for the year 2023 was celebrated on July 06, 2023 at Bidalur campus. Dr. Shubha V., the former distinguished scientist of CSIR, National Aerospace Laboratories, Bengaluru was the Chief Guest. Dr. Navneet Kumar Gupta from Centre of Sustainable Technologies, IISc, Dr. Baanibrath Mukhyopadhyay, Department of Physics, Indian Institute of Science, Bengaluru and Dr. Manjunath M. V., Department of Neurovirology, NIMHANS, Bengaluru delivered Invited lectures on this Day. Dr. A B Halgeri, Director PPISR and Dr. Ganapati V Shanbhag Dean (Academics) were also shared the stage.



Few of the sophisticated and common instrumentation facility in the Materials Sciences and Catalysis Division of PPISR





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