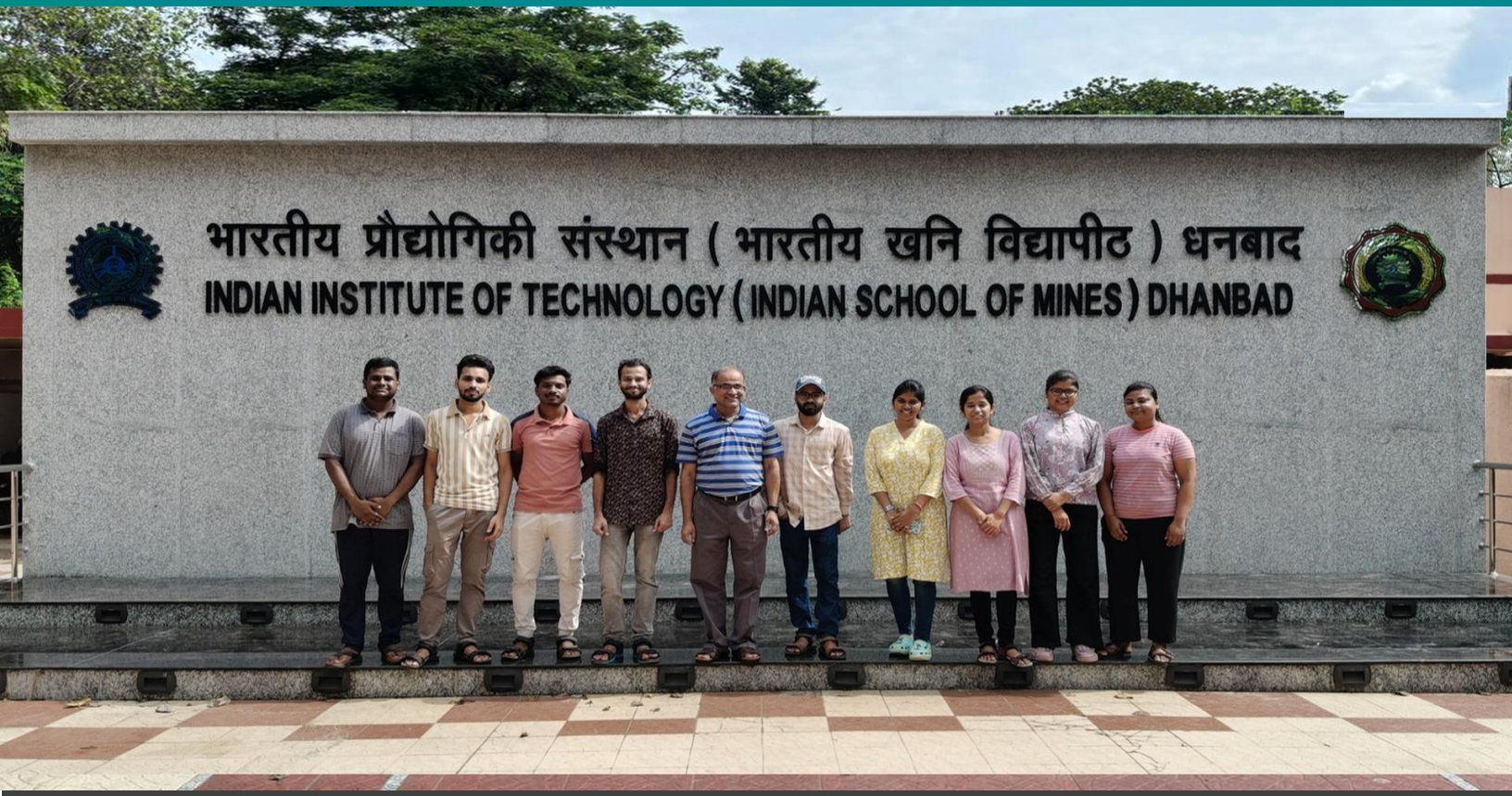
2025 | Annual Report



Artificial Photosynthesis Group

Department of Chemistry and Chemical Biology, IIT(ISM) Dhanbad

Annual Report-2025

Research Identity & Mission

The *Artificial Photosynthesis Research Group* at the Department of Chemistry and Chemical Biology, IIT(ISM) Dhanbad, focuses on molecular approaches to sustainable energy conversion and small-molecule activation, framed within the artificial photosynthesis paradigm. Principal research domains include CO_2 reduction and hydrogenation, NH_3 oxidation to green hydrogen, proton reduction, water oxidation, HCOOH dehydrogenation, and electrochemical transformations of organic compounds.

New Group Members

👨‍🔬 PhD Students

- Prativa Patra
- Kajal Gangwar

🎓 Master's (M.Sc.) Students

- Jyoti Prakash Behera
- Satyajit Tripathy
- Gopal Tudu

Dr. Sk Samim Akhter
Joined as Postdoctoral Fellow in Kumoh National Institute of Technology, South Korea

Dr. Manaswini Raj
Received IMTR Award for best paper in 2023.

Recognition, Visibility & Awards

The *Artificial Photosynthesis Research Group* at the Department of Chemistry and Chemical Biology, IIT(ISM) Dhanbad, focuses on molecular approaches to sustainable energy conversion and small-molecule activation, framed within the artificial photosynthesis paradigm. Principal research domains include CO_2 reduction and hydrogenation, NH_3 oxidation to green hydrogen, proton reduction, water oxidation, HCOOH dehydrogenation, and electrochemical transformations of organic compounds.

Key Achievements & Highlights

📌 **HOT Article Recognition (Dalton Transactions, 2025):** Published a highly acclaimed *HOT Article* elucidating mechanistic insights into **water oxidation catalysis using single-site Cu(II) complexes**, integrating experimental studies with DFT-based computational analysis. The work provides fundamental understanding relevant to **artificial photosynthesis**.

📌 **Prestigious International Fellowship Award.** The group secured the **JSPS LOTUS Fellowship 2026**, with Research Scholar **Mr. T. Natarajan** selected as the Indo-Japan Fellow under the mentorship of **Prof. S. K. Padhi**, in collaboration with **Prof. H. Ozawa** of **Kyushu University, Japan**. This fellowship strengthens the group's global research footprint and international partnerships.

🏅 Awards and Recognition by Group Members

📌 Dr. Manaswini Raj achieved the Inder Mohan Thapar Award for the best paper award for the year 2023.

📌 Mr. T. Natarajan received two Poster Prizes at *RAMSE-2025, IIT(ISM) Dhanbad* (13 Dec 2025):

- Dalton Transactions — *Small Molecule Activation*
- JEOL India Pvt. Ltd. — *Environmental & Green Chemistry Materials*

📌 Additional group recognitions at *RAMSE-2025*:

- Mr. Dev Raj — Breakthroughs in Electrocatalytic Materials (Sponsored by JEOL)
- Ms. Madhusmita — Sustainable Chemical Solutions (Sponsored by TCI Chemicals)

📜 Patents & Technology Development

📌Filed and granted multiple **patents** in:

- Catalyst & Process for Green Hydrogen Generation from Ammonia — Indian Patent Application No. 202431070872 (Published)
- Hydrogenation of CO_2 to Methanol — Indian Patent Application No. 202431048508 (Published)
- Methanol Production from Bicarbonate/CO_2 Captured from Air — Indian Patent Application No. 202431048509 (Granted)
- Fluoro-Bridged Mixed Valence Dinuclear Cu Complex for Oxidation Reactions — Indian Patent Application (Published)


पेटेंट कार्यालय भारत सरकार The Patent Office, Government Of India
पेटेंट प्रमाण पत्र | Patent Certificate
पेटेंट सं. / Patent No. 569239
आवेदन सं. / Application No. 202431048509
फाइल करने की तारीख / Date of Filing 25/06/2024
पेटेंटी / Patentee INDIAN INSTITUTE OF TECHNOLOGY (INDIAN SCHOOL OF MINES), DHANBAD
आविष्कारकों का नाम /Name of Inventor(s) 1.Aman Mishra 2.Prof. Sumanta Kumar Padhi
It is hereby certified that a patent has been granted to the patentee for an invention entitled A process for the preparation of methanol by the hydrogenation of bicarbonate and carbon dioxide (CO2) captured from air as disclosed in the above mentioned application for the term of 20 years from the 25th day of June 2024 in accordance with the provisions of the Patents Act,1970.
Date of Grant 29/07/2025
Controller of Patents


पेटेंट कार्यालय भारत सरकार The Patent Office, Government Of India
पेटेंट प्रमाण पत्र | Patent Certificate
पेटेंट सं. / Patent No. 572777
आवेदन सं. / Application No. 202431070872
फाइल करने की तारीख / Date of Filing 19/09/2024
पेटेंटी / Patentee INDIAN INSTITUTE OF TECHNOLOGY (INDIAN SCHOOL OF MINES), DHANBAD
आविष्कारकों का नाम /Name of Inventor(s) 1.Thilak Natarajan, M.2.Prof. Sumanta Kumar Padhi
It is hereby certified that a patent has been granted to the patentee for an invention entitled A catalyst for green hydrogen generation, a process for the preparation thereof and the use thereof for green hydrogen generation from ammonia as disclosed in the above mentioned application for the term of 20 years from the 19th day of September 2024 in accordance with the provisions of the Patents Act,1970.
Date of Grant 28/10/2025
Controller of Patents

🎨 Journal Cover Highlights — 2025

- Dalton Transactions — Back Cover: 54, 16993–16994
- Catalysis Science & Technology — Inside Back Cover: 15, 7251
- Dalton Transactions — Inside Back Cover: 54, 14227–14227
- European Journal of Inorganic Chemistry — Front Cover: Hydrogenation of CO_2 to Methanol by a Nickel Pincer Catalyst

📚 Publications — 2025

1. *Padhi, S. K. et al.* Dalton Transactions*, 2025, 54, 16993–16994. *(Back Cover)*
2. *Padhi, S. K. et al.* Catalysis Science & Technology*, 2025, 15, 7251. *(Inside Back Cover)*
3. *Padhi, S. K. et al.* Dalton Transactions*, 2025, 54, 14227–14227. *(Inside Back Cover)*
4. Mishra, A.; Makhal, K.; Raj, D.; Pasupalak, S.; Mallik, B. S.; Nordlander, E.; Padhi, S. K.* *Eur. J. Inorg. Chem.*, 2025, 28(21), e70000. *(Front Cover)*
5. Padhi, S. K.* *et al.* Chem. Rec.* 2025, 25, e202400170. (Invited Article for the special issue on "Catalytic Transformation of Small Molecules").

🎤 Major Invited Talks & Scientific Outreach

📌 University of Copenhagen, Denmark

2nd June 2025 – Dr. S. K. Padhi delivered an invited lecture titled “Understanding Cu(II)-Driven CO_2 Electroreduction: Competition and Synergy with Proton Reduction.” The talk highlighted mechanistic pathways of Cu(II)-mediated CO_2 electroreduction and its interplay with proton reduction. It concluded with productive discussions with Prof. Jiwoong and Prof. Craig S. Day, paving the way for potential collaborations in electrocatalysis and energy conversion.

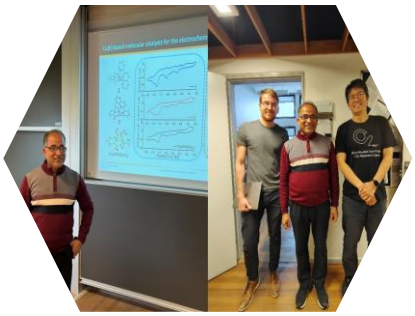
📌 Lund University, Sweden

12th June 2025 – Dr. S. K. Padhi delivered an invited talk on “Proton vs. CO_2: Understanding the Selectivity Switch between Cu(II)- and Co(II)-Catalyzed Electroreduction.” The lecture explored factors controlling product selectivity in metal-catalyzed electrochemical reduction, with engaging discussions involving Prof. Isaac Garcia-Bosch (Carnegie Mellon University) and Prof. Petter Persson, fostering prospects for future collaborative research. **Mr. Dev Raj**, PhD student delivered a talk at Lund University on electrochemical water oxidation by Cu(II) catalysts during a STINT-funded bilateral mobility program, Sweden.

One Day International Symposium-RAMSE 2025

- Recent Advances on Materials for Sustainable Energy 2025 (RAMSE 2025) based on the theme: Small Molecule Activation, was organized on 13th December 2025 by Dr. S. K. Padhi as the coordinator of the program.

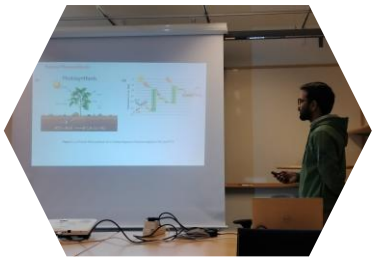
Galleries — 2025



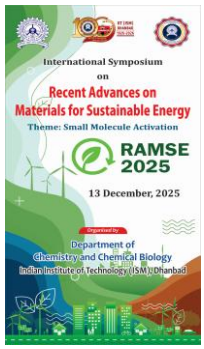
Dr. S. K. Padhi with Professor Dr. Jiwoong and Professor Craig S. Day at University of Copenhagen.

Dr. S. K. Padhi with Prof. Ebbe Nordlander and Professor Isaac Garcia-Bosch (Carnegie Mellon University, USA) at LUND University, Sweden.

Dr S.K. Padhi is delivering an invited talk at LUND University, Sweden.



Mr Dev Raj is delivering a talk at LUND University of Copenhagen.



RAMSE 2025