

Catalysis for Energy Storage

Overview

The advancement of catalysis has had a significant impact on society. As chemists strive to improve the efficiency of chemical synthesis and to enable green and renewable energy conversion and storage technologies, fundamental research in catalysis is as important today as at any time in the past. This course covers the fundamental and applied aspects of electrocatalysis related to renewable energy conversion and storage. The focus is on catalysis for hydrogen evolution, oxygen evolution, and CO₂ reduction reactions. Both homogeneous and heterogeneous catalysts are discussed, with an emphasis on the mechanistic understanding of these reactions.

Objectives

- (1) Describe the capacity of available renewable energy resources; Explain the major advantages of hydrogen economy.
- (2) Compare major hydrogen storage methods.
- (3) Derive the overall reactions of hydrogen evolution, oxygen evolution, and CO₂ reduction.
- (4) Assess overpotential; judge efficiency of electrocatalysts using a few key parameters; apply exchange current density and Tafel slope to compare catalysts.
- (5) Interpret heterogeneous and homogeneous electrocatalysis from electrochemical data.
- (6) Elaborate the key bond forming steps in hydrogen evolution, oxygen evolution, and CO₂ reduction reactions.
- (7) Construct catalytic cycles for electrochemical hydrogen evolution, oxygen evolution, and CO₂ reduction reactions, if sufficient information about the catalyst and reaction condition is provided. The catalyst can be homogeneous or heterogeneous.
- (8) Differentiate coordination modes of CO₂; Construct catalytic cycles for chemical CO₂ reduction; Judge the origin of catalyst selectivity in CO₂ reduction reactions.

Modules	March 21 to April 1, 2016
You Should Attend If...	<ul style="list-style-type: none">▪ You are a chemist interested in catalysis for energy storage.▪ You are a material scientist interested in catalytic materials and energy conversion.▪ You are a chemical engineer interested in water splitting devices.▪ You are doing PhD in Inorg. Chem. in the area of catalysis and/or bio-inorganic chemistry
Fees	The participation fees for taking the course is as follows: Participants from abroad : US \$500 Industry/ Research Organizations: INR 10000 Academic Institutions: INR 1000 The above fee include all instructional materials, computer use for tutorials and assignments, laboratory equipment usage charges, 24 hr free internet facility. The participants will be provided with accommodation on payment basis.

The Faculty



Prof. Xile Hu studied chemistry at Peking University and obtained a B.S. degree in June 2000. Shortly thereafter, he moved to the United States and began his doctoral study under the guidance of Prof. Karsten Meyer at the University of California, San Diego. His dissertation research focused on the coordination chemistry of tripodal N-heterocyclic carbene ligands. After receiving a Ph.D. degree in inorganic chemistry in December 2004, he became a postdoctoral scholar in the group of Prof. Jonas C. Peters at the California Institute of Technology in February 2005. At Caltech, he worked on the development of transition metal complexes for electrocatalytic hydrogen production, in collaboration with Prof. Nathan S. Lewis and Dr. Bruce S. Brunschwig. In July 2007, he was appointed as a tenure-track assistant professor of chemistry in the Institute of Chemical Sciences and Engineering at the École Polytechnique Fédérale de Lausanne (EPFL) in Switzerland. He is the founder and director of the Laboratory of Inorganic Synthesis and Catalysis. His laboratory is developing catalysts made of Earth-abundant elements for chemical transformations pertinent to synthesis, energy, and sustainability. Since January 2013, he is an associate professor (with tenure) at EPFL.



Dr. Raja Angamuthu received Bsc (2000) and MSc (2002) degrees from Bharathidasan University, Tiruchirappalli. He worked with Prof. Jan Reedijk and Prof. Elisabeth Bouwman for his PhD (2009) at Leiden University, The Netherlands. Then he moved to University of Illinois at Urbana-Champaign with a RUBICON fellowship from Dutch Organisation for Science and Technology to work with Prof. Tom Rauchfuss. He is a recipient of Young Scientist Research Fellowship from DAE, India. His laboratory focuses on inorganic synthesis and bioinspired catalysis in addition to a special focus on SO₂ sequestration.



Professor J. K. Bera received his M. Sc. from the University of Kalyani in 1993 and his Ph. D. from the Indian Institute of Science in 1999. After a couple of postdoctoral stints at Purdue University and at Texas A&M University, he joined the faculty at IIT Kanpur in 2003. He is presently Satish Chandra Agarwal Chair Professor and associate Dean of faculty affairs. He recently received DAE-SRC outstanding investigator award. He is also the recipient of the Ramanna fellowship and the SwarnaJayanti fellowship from DST, India, and has received the CRSI bronze medal for the year 2011. He is the fellow of the National Academy of Sciences (FNASc) and Indian Academy of Sciences (FASc). Bera's research interests span synthetic, structural and mechanistic organometallic chemistry. Recent efforts are directed toward bifunctional activation of small and abundant molecules and their catalytic transformations to useful and value-added chemicals.

Course Co-ordinator

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<http://www.iitk.ac.in/new/raja-angamuthu>