

The University of Queensland - IIT Delhi Academy of Research Joint PhD Project

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| PROJECT TITLE | FUNCTIONAL BIOMASS-DERIVED ELECTROCATALYSTS FOR HYDROGEN PRODUCTION VIA ELECTROCATALYTIC WATER SPLITTING |
| PROJECT CODE | UQIDAR 00186 |
| PROJECT DESCRIPTION | <p>Water splitting technology provides an effective way to produce hydrogen in a green and sustainable manner with high efficiency and minimal environment pollution. Water electrolysis generates hydrogen and oxygen from water by the hydrogen evolution reaction (HER) and the oxygen evolution reaction (OER). State-of-the-art-catalysts based on noble metals suffer from high cost, low abundance, and ease of poisoning. Therefore, the development of inexpensive, non-precious metal electrocatalysts for water splitting using low-cost and scalable methods is needed to promote the commercialisation of this technology. This project aims to develop low-cost and highly efficient transition metal/carbon composite electrocatalysts for water splitting technology by employing biomass as a 'two-in-one' precursor for preparing active transition metal-based electrocatalysts as well as the conductive porous carbon supports for enhancing activities of the electrocatalysts. The methodology involves several steps, including (i) Extraction of phytochemicals from biomass resources, such as agricultural by-products by solid-liquid extraction. The profiling of the phytochemicals will be conducted by Fourier-transform infrared (FTIR)/Raman spectroscopy, liquid chromatography-mass spectrometer (LC-MS), nuclear magnetic resonance (NMR), and carbon-hydrogen-nitrogen (C-H-N) analyzer; (ii) Fabrication of various porous transition metal-based composites using biomass as precursors/templates via wet-chemical methods combined with high-temperature calcination. The developed electrocatalysts will be characterized by using various techniques, such as X-ray diffraction (XRD), scanning/ transmission electron microscopy (SEM/TEM), X-ray photoelectron spectroscopy (XPS), BET surface area analysis, inductively-coupled plasma spectroscopy (ICP), etc.; (iii) Performance evaluations of the developed electrocatalysts for OER and HER in terms of activity, charge transfer resistance and other kinetics parameters.</p> |
| PROJECT OUTCOMES | <ol style="list-style-type: none"> (1) New technology for converting biomass resources into functional porous carbon and inorganic materials and their composites. A joint patent will be applied based on this technology. (2) New methods for extracting phytochemicals from various biomass resources, such as agricultural by-products, plants, etc. These extraction methods will potentially lead to several new joint patents. (3) New knowledge on the roles of naturally-derived phytochemicals in the formation mechanisms of porous transition metal-based composites. (4) Cost-effective and high-performance biomass-derived functional electrodes for water splitting reactions will be developed. (5) Several joint publications between AIBN and IITD in high-impact materials science and chemistry journals, such as Angewandte Chemie International Edition, Journal of American Chemical Society, Advanced Materials, ACS Nano, Materials Horizons, Nature Communications, etc. |
| ADVISORY TEAM | <p>Professor Yusuke Yamauchi Australian Institute for Bioengineering and Nanotechnology (AIBN), UQ https://aibn.uq.edu.au/profile/4422/yusuke-yamauchi</p> <p>Professor Ashok Ganguli Chemistry, IITD</p> |

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| TYPE OF STUDENT | http://web.iitd.ac.in/~ashok/home.html |
| DISCIPLINE BACKGROUND OF STUDENT | Applications are open to i or q students who meet eligibility criteria. |
| IDEAL CANDIDATE | Ideally, this project requires students with a background in: Inorganic chemistry, materials science/engineering, chemical engineering, environmental science/engineering |
| APPLICATION PROCESS | Essential capabilities: Nanomaterials synthesis , Materials characterisation (such as X-ray diffraction (XRD), scanning/transmission electron microscopy (SEM/TEM), thermogravimetric analysis (TGA), etc.) |
| | Desirable capabilities: Scientific paper writing experience, Electrochemical analysis, Electrode fabrication |
| | Expected qualifications (courses, degrees, etc): Bachelor or Master degree in Materials Science, Chemistry, Nanotechnology, Chemical Engineering |
| | Apply online by the due date: https://www.uqidar.org/students/how-to-apply/ |