



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
PhD-17 SHORT ABSTRACT OF THESIS



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Thesis Title: **Design of Homogeneous / Heterogeneous Interfacial Electrocatalytic Systems for Value-Added Products**

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SHORT ABSTRACT

A comprehensive overview of electrocatalytic systems for sustainable value-added product formation via water electrolysis and CO₂ reduction is presented in this work. The study focuses on the design and development of efficient catalytic interfaces, functional membranes, and hybrid reaction environments to achieve improved charge separation, accelerated reaction kinetics, and enhanced product selectivity. Emphasis is placed on understanding the mechanistic aspects of hydrogen and oxygen evolution reactions, highlighting the significance of interfacial charge transfer and catalyst–electrolyte interactions. The role of bipolar membranes in promoting water dissociation and maintaining distinct pH conditions is explored as a strategy to achieve efficient ion transport and separation of HER and OER processes. Furthermore, the investigation extends toward CO₂ electroreduction, where synergistic homogeneous–heterogeneous interfaces enable selective conversion of CO₂ into value-added fuels. Overall, the study establishes a unified approach combining catalyst design, interfacial engineering, and membrane optimization to advance integrated electrochemical systems for sustainable energy generation and carbon utilization.