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सत्यमेव जयते

Tailoring Tantalum Nitrides and Oxy-Nitrides & Designing Electroctalytic Devices for Green Energy

2019 - 2021

SPARC

Scheme for Promotion of Academic and Research Collaboration

New materials for Green Energy Solutions

an Indo-German Approach

University of Cologne

IIT Madras

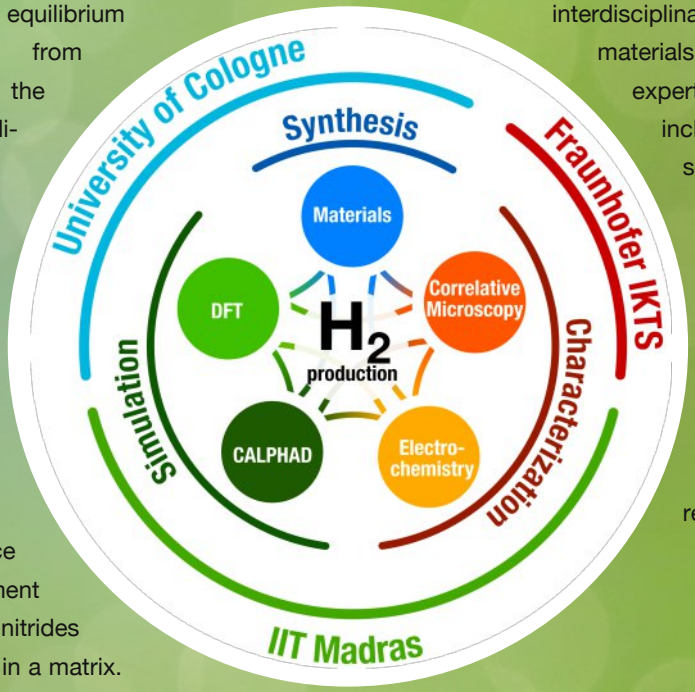
Fraunhofer IKTS

Project Outline

With continuing depletion of fossil fuels and natural gases and with ever increasing demand for alternate sources of energy, the current and as well as the next generation will have to seriously work on producing and storing non-polluting energy forms, referred to as Green Energy. While, in the Indian context, renewable forms of energy based on wind and solar forms are attractive enough and sufficient investments have already been made, other greener forms of affordable energy sources needs to be explored as well.

On the contrary, electrochemical splitting of water for the production of hydrogen which enables conversion of electrical energy to chemical energy and its reversibility is one of the most viable and potential approaches towards “Green Energy". It is imperative to understand that world eventually will make a transition to hydrogen-based economy from a depletable and non-sustainable fossil fuel based economy.

Transition metal nitrides (TMNs) and oxynitrides (free of precious metals such as platinum) have shown immense potential as electrocatalysts and coupled with plasmonic properties these classes of materials are attractive enough to be considered for possible hydrogen evolution reactions. Especially TaN is considered one of the best available TMNs for hydrogen evolution, which catalyses at -0.09V, with activation energies and Tafel reactions close to that of Pt(111) at equilibrium potential. Apart from theoretical studies, the experimental realization, is facing several issues that need to be addressed such as, mechanism for a broader electrochemical window, influence of micro-/nano-structuring, role of plasmonic resonance and role of confinement effect when such nitrides are produced in-situ in a matrix.



Fine-tuning the chemistry, material characterization that includes microscopy and spectroscopy combined with first principle calculations including CALPHAD are vital towards transforming lab-scale research to deployable device-level/reactor-level fabrication. In this research, a highly interdisciplinary team consisting of materials chemists, ceramicists, experts in characterization including correlative spectroscopy coupled with computational materials scientists would like to address these scientific issues at various length scales understanding fundamental scientific issues and transform lab-scale research to deployable reactors/devices.

Total budget
INR 66,000,000
EUR 85,000