

Research Project Details for Graduate Research Assistant (GRA) Recruitment

Research Project Title Elucidating Plasmonic Photothermal Mechanism in Dendritic Fibrous Nanosilica Supported Nickel-based Bimetallic Catalysts of Solar-Driven CO ₂ Utilization for Green Hydrogen Production
Programme Name Master in New Energy Science and Engineering (Research Mode) Master in Chemical Engineering (Research Mode)
Details of Primary Supervisor 1. Name: Tan Ji Siang 2. Department and University: School of Energy and Chemical Engineering, Xiamen University Malaysia 3. Email address: jisiang.tan@xmu.edu.my 4. Research interests: Heterogenous Catalysis, Hydrogen, Solar Fuels, Photothermal Catalysis, Artificial Photosynthesis
Details of Research Project 1. Duration: 3 years 2. Monthly allowance: Up to RM 2,500.00/month 3. Summary: Anthropogenic CO₂ emissions have drastically intensified global climate change concerns, driving an urgent need to utilize CO₂ as a C₁ feedstock to sustainably produce value-added chemicals and energy carriers for a circular carbon economy. Although CO₂ reforming of methane is a well-established route for CO₂ utilization, it remains unsustainable due to high energy input requirements. Given the thermodynamic stability and kinetic inertness of both CH₄ and CO₂, solar-driven photothermal catalysis presents a promising alternative, enabling their activation and transformation under milder and more sustainable conditions. However, the scalability of this approach is constrained by the limitations of conventional photocatalysts, including rapid electron-hole recombination, narrow light absorption windows and insufficient density of active sites. Dendritic fibrous nanosilica (DFNS)-supported Ni_xM_y (M = Fe, Co, Cu and Zn) catalysts have gained significant attention due to their unique hierarchical architecture, high surface area, and favorable physicochemical properties. This project aims to develop Ni_xM_y systems with varied Ni:M molar ratios for photothermal CO₂ reforming of methane to produce hydrogen. Emphasis is placed on the

precise modulation of plasmonic site densities of Ni and M to tune optical properties, electronic band structures, charge dynamics and the extent of localized surface plasmon resonance (LSPR) effects. Additionally, the project involves a comprehensive investigation of charge carrier dynamics and mechanistic pathways driven by the synergistic interplay between plasmonic Ni_xM_y sites and oxygen vacancy sites in DFNS, aiming to establish precise structure–activity correlations. This proof-of-concept study is crucial in elucidating the fundamental aspects of high-efficiency solar-to-fuels energy conversion. The outcomes will advance the tunability of plasmonic nanomaterials and contribute to the development of sustainable photothermal reforming technologies. This project aligns with UN SDGs (i.e., 7, 9 and 13), as well as NETR and HETR under the National Energy Policy 2022–2040, supporting Malaysia’s clean energy transition and decarbonization goals.

4. Skills/techniques development: Synthesis of nano-structured Ni-based bimetallic catalysts; physicochemical characterization and analysis (XRD, N_2 physisorption/BET, SEM/TEM-EDX, XPS, H_2 -TPR, CO_2 -TPD, Raman, UV-Vis DRS, photoluminescence and EPR for oxygen vacancies); operation of a photothermal reactor and product analysis by gas chromatography; mechanistic studies of charge-carrier dynamics and surface intermediates (e.g., in situ DRIFTS); safe handling of CH_4 , CO_2 and H_2 gases; data analysis, scientific writing for high impact factor journal publication.
5. Location: No. 508, A4 building, Xiamen University Malaysia

GRA Requirements:

Number of Master vacancies available: 2

1. The candidate must be enrolled in XMUM Master or Ph.D. programme.
2. Bachelor’s degree in Chemical Engineering, Chemistry, Materials Science/Engineering, Environmental Engineering or a related field, with a minimum CGPA of 3.00 (or equivalent).
3. Basic knowledge of, or strong interest in, heterogeneous catalysis, nanomaterials synthesis, photocatalysis or renewable energy; hands-on laboratory experience in catalyst synthesis or characterization is an advantage.
4. Good command of English (written and spoken) with the ability to analyse experimental data, prepare technical reports and contribute to journal publications.
5. Self-motivated, able to work independently and as part of a team, follows laboratory safety practices, and is committed to full-time research for the funded period.