Academic Team (Supervisor and Postdoctoral researcher) looking for a Secondment Enterprise for a project on Carbon dioxide (CO2) conversion to fuels

Contact: davide.tiana@ucc.ie

Project idea

The European Union commits to be the first climate neutral continent by 2050. To contribute to decarbonization of our economy, this research focuses on developing an advanced catalytic system that efficiently converts CO_2 into industrially valuable fuels. By integrating the exceptional surface area and tunable properties of metal-organic frameworks (MOFs) with the maximum atom utilization potential of single-atom catalysts (SACs), it is possible to avail of an homogeneous catalyst in an heterogenous phases with consequent possibility of flow chemistry reaction. Using this approach, this project aims to achieve selective conversion of CO_2 into formic acid, methanol, methane, and other fuels. The novel MOF-SAC hybrid system is expected to enhance catalytic efficiency, improve conversion rates, and contribute to sustainable chemical production.

This innovative process holds significant promise for industrial applications, enabling the production of high-demand fuels and feedstocks while simultaneously advancing the goal of a climate-neutral continent in Europe and beyond. The use of MOF-SAC catalysts in large-scale industrial operations will open avenues for cleaner energy alternatives, supporting industries such as manufacturing, transportation, and power generation. Additionally, the catalyst system developed in this project can be adapted for other essential industrial chemical transformations, improving efficiency across multiple production lines. By harnessing CO_2 as a raw material, industries can transition toward more sustainable practices while reducing dependency on fossil fuels.

Implementing this technology at an industrial scale will represent a breakthrough in carbon utilization, aligning with European Union efforts to combat climate change while promoting economically viable solutions. The successful deployment of MOF-SAC catalysts can revolutionize energy systems, making CO_2 conversion an integral part of industrial processes. This project not only advances scientific understanding of catalytic mechanisms but also paves the way for environmentally responsible fuel generation, transforming carbon waste into a valuable resource for future industries.

Relevant Industries:

Renewable Energy and Fuels, Chemical Manufacturing, Carbon Capture & Utilization (CCU), Transportations, Agriculture and Food Processing, Cement and Construction, Plastics and Polymers

About the Academic Supervisor

Dr Davide Tiana is a senior lecturer at the University College Cork. He has more than 10 years of experience in the discovery and engineering of MOFs. Dr Tiana is currently the Irish representative in the management committee of the European COST action EU4MOFs (https://eu4mofs.com) which specifically aims to: “to efficiently transform lab-designed metal-organic framework (MOF) candidates into practical solutions for healthcare, clean water, and sustainable energy. ” Dr Tiana has a tracked history of delivering what was funded for. He has more than 40 publications and an

h-index of 27. His works have been cited more than 3300 times with more than 40% of his publications in very high impact factor journals (ie quartile 1). Some of his main results in the field of create new MOFs for Carbon Capture and catalysis are: a) a defective MOF for the CO_2 photocatalytic reduction with the same performance of TiO_2 nanoparticles; b) a heterometal MOF for the overall water splitting into H_2 and O_2 under simulated sunlight irradiation, without the use of any co-catalyst or sacrificial agent; c) new Cerium based MOFs with enhanced CO_2 capture performance; d) a new MOF-catalyst system able to change the selectivity of the hydroformylation reaction; e) a new MOF-catalyst system able to catalyst Aldol-Tishchenko reaction.

About the Postdoctoral Researcher

Dr. Chizoba Ignatius Ezugwu is an experienced researcher in Material Chemistry, specializing in advanced hybrid nanomaterials, such as metal-organic frameworks (MOFs) for carbon dioxide capture and removal, gaseous pollutant mitigation, catalysis, and other environmental applications.

Following his PhD, Dr. Ezugwu advanced his expertise through postdoctoral research positions at Aarhus University (Denmark), the University of Alcalá (Spain) as a Marie Curie Fellow (COFUND), and Sun Yat-sen University (China). His contributions extend beyond research, he has guided several PhD and MSc students, served as an external PhD thesis evaluator, and acted as a scientific reviewer, shaping both academic and industrial advancements.

Dr. Ezugwu has published multiple scientific papers, co-edited a book with Elsevier, and authored several book chapters, establishing his presence in high-impact international journals. With an h-index of 17 and over 1,200 citations, his research significantly influences nanomaterials, climate change mitigation, catalysis, and environmental science. He has participated in several conferences, including as an invited speaker, and led pioneering research projects advancing CO_2 utilization and environmental remediation. His work continues to drive scientific innovation, industrial applications, and sustainable solutions in material science.