

## **Project 3.7 Innovative Piezophotocatalytic Hybrid Materials for Biomass-Inspired Compound Transformations**

**Supervisor:** Prof. dr hab. inż. Juan Carlos Colmenares Quintero / dr Nilesh Manwar

**Institut:** Physical Chemistry

**Unit:** Research group no. 28. Catalysis for sustainable energy production and environmental protection - Prof. dr hab. inż. Juan Carlos Colmenares Quintero (contact to [nmanwar@ichf.edu.pl](mailto:nmanwar@ichf.edu.pl))

**www:** <http://photo-catalysis.org/>

### **Background:**

Biomass is a unique and renewable resource known for its inexhaustible feedstock potential, containing a variety of organic compounds that can be harnessed for the synthesis of valuable products. Converting biomass-derived compounds into affordable hydrocarbons presents particular challenges, including; i) The need for effective photocatalytic methods. ii) The cleavage of glycosidic linkages within biomass feedstock/biopolymers (e.g., cellulose, lignin, pectin, chitin, and xylan), which reduces the oxygen content. iii) The potential role of hybrid catalysts and their degree of polymerization. Solar light is another ideal alternative energy source to fossil fuels due to its abundant, renewable, and sustainable characteristics. Therefore, the effective utilization of lignocellulosic biomass using sunlight to produce valuable chemicals and materials that are currently being produced from fossil fuels has attracted significant research interest. This strategy could definitely decrease our dependency on fossil fuels, and ultimately assist in achieving a sustainable society and economy within the Sustainable Development Goals (<https://sdgs.un.org/goals>).

A novel multi-catalytic approach, known as piezo-photo-catalysis, has been introduced recently, examining the synergy between photocatalysis and piezocatalysis for energy and environmental applications. This innovative piezo-photocatalytic hybrid approach holds great potential for achieving superior catalytic activity, as it combines the strengths of photocatalysis and piezocatalysis to efficiently convert lignocellulosic platform compounds into valuable chemicals. Therefore, the development of advanced hybrid materials with a piezo-photocatalytic approach represents a promising technology for the transformation of lignocellulosic biomass into high-value chemicals.

### **Aim:**

This project aims to develop a novel method for the transformation of natural polymers (e.g., cellulose and chitosan) into valuable porous supports to manage the incorporation of plasmonic nanophotocatalysts with the co-photocatalytic piezoelectric element (earth abundant ZnO) to strengthen the overall physicochemical properties of those hybrids. New catalytic materials possessing excellent piezophotocatalytic redox properties to obtain high-value chemicals from biomass-inspired compounds. The main objective is to prepare metal-containing 2D carbon-based piezophotocatalytic hybrid materials as a promising catalyst for biomass transformation. Physicochemical characteristics of these hybrid materials is being checked (before and after photocatalytic test reactions), and testing them in the selective redox photocatalytic C-C and/or C-O photoreductive coupling of biomass-inspired model compounds as a futuristic approach of organic waste valorisation. Conducting optimization experiments for the thermo-photocatalytic applications. Focus to understand the plausible reaction mechanisms through various spectroscopic techniques (NMR, Mass Spectrometry, ESR, and XPS). Preparing research drafts, publication and active participation in networking conferences.

**Requirements:**

- Expertise sought from a Ph.D. student: Graduates of chemistry, physics, materials science, and related university faculties, holding a Master of Science or equivalent degree with an aptitude and passion for natural and exact sciences, with good knowledge of English and outstanding motivation and open mind for interdisciplinary research at the border of chemistry-physics are invited to join this project research group.

**Additionally:**

- CV
- copy of MSc diploma
- distinctions granted by virtue of scientific research, grants, awards and scientific experience acquired outside your own research work place in the country or abroad; participation in workshops and scientific trainings; participation in research projects.
- experience in conducting scientific research in the field of catalysis, organic synthesis and materials characterization.
- at least the opinions of two independent research scientists, specialists in the field of chemistry and related sciences.
- very welcome are publications in reputable publishing houses / scientific journals.