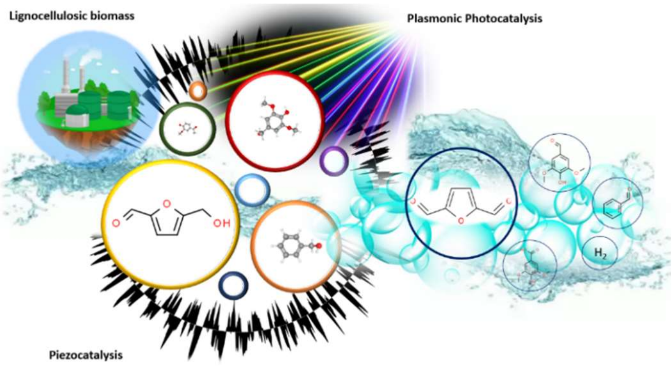

The world is presently facing detrimental environmental problems due to the huge consumption of fossil fuels and the associated **global warming** effects. The consumption of fossil fuels results in increasing levels of greenhouse gas (GHG) emissions. **CO_2 levels** have increased from 315 ppm in 1959 to **more than 400 ppm** in 2017. Global GHG emissions are expected to rise dramatically. If this situation continues, global average temperatures will increase by more than 2.5 °C above pre-industrial levels by 2050 which would have an adverse impact on the development of society and the economy. Under this scenario, biomass is a potential alternative feedstock to fossil fuels, chemicals and materials due to its high abundance, biodegradability, and remarkable sustainability as well as the low amounts of toxic gases, such as sulfur oxides and carbon dioxide that are released when used. 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 solar (solar-biorefinery concept: https://photo-catalysis.org/news/news_1276) and mechanical (the sound) energies 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 to achieve a sustainable society and economy within the Sustainable Development Goals (https://sdgs.un.org/goals)**.**

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 assist continuous flow photo-redox processes in obtaining high-value chemicals from biomass-inspired compounds**. The objective is to prepare metal-containing porous carbon-based piezophotocatalytic materials through the physicochemical effects of low/high-frequency sonication (e.g., effective mass transfer, microstreaming, cross-linked radical polymerization, etc, effects often inaccessible through conventional methods) as a promising approach **to disruptively improve the outcomes of conventional methods** (e.g, hydro(solvo)thermal, sol-gel method). It will be carried out the study of the physicochemical properties of the hybrid materials (before and after (sono)-(photo)-catalytic test reactions), and testing them in the **selective redox sonophotocatalytic C-C and/or C-O sonophoto-reductive coupling of biomass-inspired model compounds (in flow liquid-phase)** as a **futuristic approach of organic waste valorisation**. It will be carried out, a systematic basic research of the effect of green and unconventional source of ultrasonic energy on the synthesis of the hybrid materials, and its effect on the final optimisation of the synthesis method conditions. To get insight into the **mechanism of ultrasound-assisted methods**, the whole spectrum of materials characterization techniques, basic kinetic studies and piezophotocatalysts' stability/recycling studies (using the appropriate flow (sono)-(photo)-reactors) will be carried out. The use of ultrasound-based procedures offer a facile, versatile synthetic tool for the preparation of nanopiezophotocatalysts, often inaccessible through conventional methods.

This proposed project has the potential of strong influence on the field of **green and sustainable materials synthesis and processes**, **renewable energies**, and **chemicals production from organic wastes, all together in the frame of the UN Sustainable Development Goals**. Therefore, the final outcome of the proposal will lead to profound benefits to humanity in the long term. These pioneering studies will permit us to understand and optimize (a) the synergistic effect of combining ultrasound with conventional methods, and thus (b) predict piezophotocatalyst performances manipulated by the full control of ultrasound effects during the selective C-C/C-O redox coupling of aromatics and furanics compounds, what will result in (c) activity/selectivity/stability improvement of **promising multidimensional porous carbon-based hybrid piezophotocatalysts** working thanks to light utilization and sonication which open the possibilities for better ways of management and **valorisation of natural-polymers-associated organic wastes**. The uniqueness of this project rests on a combined approach of understanding/design/synthesis of effective heterogeneous hybrid piezophotocatalysts with optimized composition capable of working under continuous flow sonophotocatalytic conditions **for the synthesis of novel high-value chemicals for the pharmaceutical (e.g. new neurotransmitters) and food industries (e.g. new bio-nutraceuticals).**