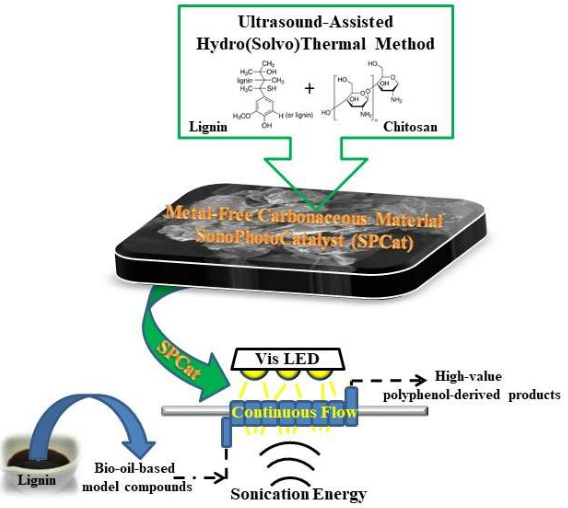

Climate change mitigation has become the focus of incoming worldwide initiatives and policies with the first and foremost mission of disrupting the strong reliance of our society on fossil fuels to guarantee sustainable development. Establishing a **biorefinery model** capable of feeding the entire industry with the key bulk and fine carbon-based chemicals that otherwise rely on petrochemical processes is the cornerstone for this technological transition. **Lignocellulosic** and **sea-food-based organic wastes** have been recognized early on as the ideal feedstock not only for being the largest renewable source of carbon not competing with food reserves but also for its unique chemical composition; being made up of a nitrogen-containing polysacharide-based fraction (chitosan derived from partial deacetylation of chitin which is coming from the sea-food waste) and sulphur-containing complex aromatic polymer (e.g., Kraft lignin), such biomass could potentially give access to an immense portfolio of key molecules and materials. Currently, only the carbohydrate fraction is effectively used in lignocellulosic biorefineries, while a large side-stream of lignin (technical lignin) is discarded in the process by delignification treatments, serving at most as a low-grade fuel or low-value resins and lubricants given the lack of effective valorization routes for this component. From the side of chitin, which is a straight-chain biopolymer, it is also an underutilized resource due to its inherent insolubility in common (organic) solvents and the expensive and wasteful methods employed for the extraction of chemicals from it.

This project aims to develop a **novel method for the transformation of lignin and chitosan into valuable metal-free nitrogen(N)- and/or sulphur(S)-containing carbonaceous photocatalysts**. New catalytic materials possessing **excellent sonophotocatalytic redox properties to assist continuous flow photo-redox processes in obtaining high-value chemicals from bio-oil-based molecules upgrading**. The objective is to prepare metal-free carbon-based photocatalytic 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 pre-treatment step before ending the synthesis of the materials under hydro(solvo)thermal conditions. It will be carried out the study of the physicochemical properties of carbon-based materials (before and after (sono)-(photo)-catalytic test reactions), and testing them in the selective sonophotocatalytic oxidation and C-C sonophoto-reductive coupling of bio-oil-inspired model compounds (in flow liquid-phase) as a **futuristic approach of bio-oil-based molecules valorization**. Systematic basic research of the effect of green and unconventional source of ultrasonic energy on the pre-treatment of chitosan (precursor of C, N, O) and lignin (precursor of C, S, O, aromaticity) and its effect on the final material obtained after optimization of hydro(solvo)thermal conditions, will be carried out. To get insight into the **mechanism of ultrasound-assisted hydro(solvo)thermal method**, the whole spectrum of materials characterization techniques and basic kinetic studies and photocatalysts' 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 nanophotocatalysts, 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**. 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 hydro(solvo)thermal, and thus (b) predict carbon-based photocatalyst performances manipulated by the full control of ultrasound effects during the selective oxidation and C-C reductive coupling of bio-oil-based molecules, what will result in (c) activity/selectivity/stability improvement of **promising metal-free carbon-based photocatalysts** working thanks to light utilization and sonication which open the possibilities for better ways of management and **valorization of lignin- and chitin-containing organic wastes**. The uniqueness of this project rests on a combined approach of understanding/design/synthesis of effective metal-free carbon-based photocatalysts with optimized composition capable of working under optimized continuous flow sonophotocatalytic conditions for the valorization of bio-oil-based model compounds.