DESIGN AND DEVELOPMENT OF NOVEL POROUS CARBON MATERIALS FROM FOOD WASTE FOR ENVIRONMENTAL AND ENERGY APPLICATIONS

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ABSTRACT

Plastic waste is one of the most serious environmental issues nowadays, with tons of plastic ending up in landfill or water each year. This can lead to the contamination of both land and water with plastic debris. Taking into account their very slow degradation, plastics remain in the environment for a very long time, with estimated values of around five hundred years for complete decomposition. For all these issues the photochemical upcycling of plastic waste to make products of higher value, has emerged as a requisite solution in reversing the growth of plastic waste landfills.

The main target of this work is the design, synthesis, and characterization of novel 2-D and hierarchical porous scaffolds to be used as photocatalysts in novel photochemical upcycling processes of plastic waste from land or aquatic systems, in order to create products of higher quality or value than the original. More specifically effective low-dimensional silicon-based and germanium-based materials as well as hierarchical porous carbon materials with high surface areas and surface functionalities will be designed that can be feasible interact with photoactive compounds such as organic molecule fragments such as anthraquinone.

MXenes such as ***2D siloxene and germanane*** will be produced from the topotactic de-intercalation of the corresponding *β*-zintl phases ($CaGe_2$ and $CaSi_2$) using strong and mild acids, while appropriated chelating agents, such as ethylenediaminetetraacetic acid, will be used for further purification.[1] Hierarchical porous carbons will be synthesized via a combination of a soft template (polysaccharides of high MW bearing different functionalities such as oxygen or nitrogen moieties such as sucrose, starch, cellulose etc.) along with a hard template which is colloidal silica of different surface energy (different sizes in nanometers) and ice templating (freeze dry) which is the template responsible for the macroporosity. Ensue physical activation with CO_2 which induce micropores and higher surface areas. Hence hierarchical porosity comes from micron sized macropores (cryo-template), mesopores (silica template) and micropores (CO_2 activation).

A detailed structural, morphological and physicochemical characterization will be performed using a series of analytical techniques such as XRD, XPS, FTIR, Raman, porosimetry measurements, DTA/DSC/TGA, TEM/SEM,

KEYWORDS: Porous carbon materials, Siloxene, Germanane, Photocatalysts.

REFERENCES

[1] T. Giousis, G. Potsi, A. Kouloumpis, K. Spyrou, Y. Georgantas, N. Chalmpes, K. Dimos, M-K. Antoniou, G. Papavassiliou, A. B. Bourlinos, H. -J. Kim, V. K. S. Wadi, S. Alhassan, M. Ahmadi, B. J. Kooi, G. Blake, D. M. Balazs, M. A. Loi, D. Gournis, P. Rudolf, *Synthesis of 2D Germanane (GeH): a New, Fast, and Facile Approach Angewande* **2021**, 60, 360-365.

[2] A. Kouloumpis, G. Potsi, T. Giousis, N. Chalmpes, D. Gournis, P. Rudolf, Ultrasonic-Assisted Synthesis of Germanane and Siloxane Nanostructures *Solid State Phenomena* **2022**, *336*, 63-68.

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