Eco-friendly synthesis of a porous graphene-like material supported on clay

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The graphene derivatives are nanomaterials of great interest due to their distinctive physicochemical properties and versatile application in a wide range of fields. However, a challenging large-scale synthesis compromises their commercialization.[1] The development of eco-friendly strategies using non-toxic precursors, energy- and time- saving methods is necessary to reduce costs, mitigate the environmental impact, and facilitate the industrial production.[2] In this regard, the synthesis of carbon nanomaterials using natural precursors, such as clays and table sugar, is a step forward to address this issue.[3]

In this work, sucrose and sepiolite clay were used to prepare supported graphene-like materials at low temperatures. Moreover, we investigated the effect of the synthesis conditions: i) temperature of 200/500 °C; ii) type of furnace - tube furnace or a microwave muffle; and iii) post hydrothermal carbonization (HTC) step, on the carbon nanomaterials obtained. The structure, morphology and porosity of the carbon nanomaterials were characterized by STEM, ATR-FTIR, Raman spectroscopy, XRD, HRTEM, and N_2 adsorption-desorption isotherms. The morphology analysis revealed sepiolite fibres well blended with carbon. The structural analysis indicated that sucrose melted at 200 °C blocking the sepiolite pores. However, the post HTC provided a fundamental contribution to enhance the carbonization and develop the porosity (S_{BET}: 76-158 m^2g^{-1}). The materials produced at 500 °C presented higher specific surface areas (S_{BET}: 264-275 m^2g^{-1}) without requiring the post HTC step. In both cases, the materials synthesised using the tube furnace presented higher specific surface area than the ones synthesized using the microwave muffle. The HRTEM investigations showed that the carbon nanomaterials synthesized using the microwave were mainly amorphous, while the ones synthesized in the tube furnace were dominated by crystalline areas. The crystalline sample synthesized at 500 °C presented a d-spacing of 0.33 nm, which coincides with the graphitic lattice suggesting the formation of well-organized multilayer graphene, which is remarkable for occurring at temperatures as low as those adopted here. The supported graphene-like material, obtained with methodologies compatible with the large scale-production, displays suitable properties for the development of functional composite materials.

References

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