Graphene decorated with uniform nanoholes via an electrochemical route for energy storage applications

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Graphene nanosheets decorated with nanometer-sized holes are of interest in different technological applications, such as electrochemical energy storage or molecular separation [1]. They are usually obtained by selective etching of the highly oxidized domains of graphene oxides derived from traditional (e.g., Hummers) methods. However, control over the size uniformity of the nanoholes can be difficult due to the spatial randomness and high connectivity of the oxidized domains. Here, we propose a new route to obtain graphene decorated with uniform nanoholes by using oxidized graphene nanosheets prepared by an electrochemical exfoliation/oxidation approach [2,3]. This oxidized graphene is shown to have larger and better interconnected aromatic domains (higher electrical conductivity) as well as smaller and more labile oxidized domains than those of its counterpart obtained by traditional oxidation routes (standard graphene oxide). As a result, selective removal of the oxidized domains by H_2O_2 treatment led to holey graphene nanosheets with smaller and more uniform nanoholes (typically ~4-6 nm) than those attained using standard graphene oxide (Figure 1). When used as an electrode material for electrochemical charge storage, the electrochemically derived holey nanosheets exhibited a higher capacity and energy density than those of their counterpart prepared by the traditional oxidation route.

References

[1] A.C. Lockhande, I.A. Qattan, C.D. Lockhande et al, J. Mater. Chem. A 8 (2020) 918-977.
[2] S. Pei, Q. Wei, K. Huang et al, Nat. Commun. 9 (2018) 145.
[3] D.F. Carrasco, J.I. Paredes, S. Villar-Rodil et al, Carbon 195 (2022) 57-68.

Figures

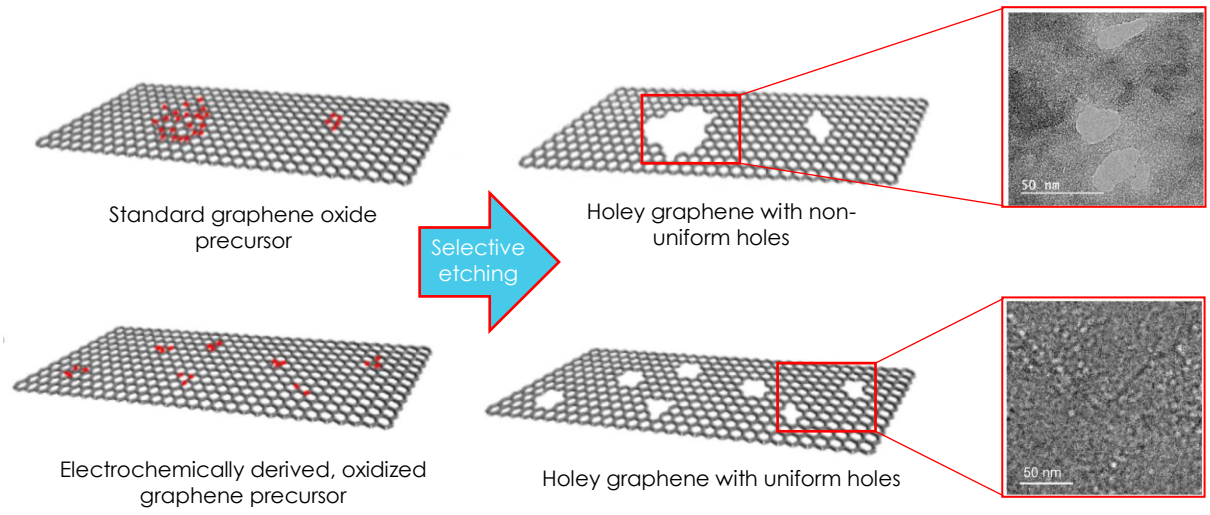

Figure 1. Schematic of the preparation of holey graphene from structurally/chemically different oxidized graphene precursors and TEM images of the corresponding holey nanosheets