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Rational design of graphene-based adsorbents for CO_2 uptake

In the last three decades, carbon materials have been under the spotlight. The report of structures with nanoscaled dimensions such as fullerene molecules, carbon nanotubes and graphene has spurred an interest in applying these for technological applications as diverse as energy storage systems or environmental remediation.

The large-scale capture and storage of carbon dioxide is expected to mitigate climate change worldwide. One of the primary emitters of CO_2 are fossil-fueled power plants. To address these emissions, gas capture technology that can be retrofitted to existing facilities is required. In this respect, the CO_2 capture by physical adsorption in porous materials is considered to be the most feasible approach. Microporous carbons are one such material that can be easily tailored for this purpose. Interestingly, and while other options have been extensively studied (activated carbon, graphene, carbon nanotubes, etc.), the use of graphite/graphene oxide (GO) remains rather unexplored.

In this communication, we will illustrate how the synthesis conditions of graphene oxide flakes (Hummer's, HGO, and Improved Hummer's, IGO) [1] may influence its uptake capacity of carbon dioxide [2, 3]. To validate these results two benchmark materials, namely zeolite 13X and certified carbon nanotubes, were also studied under similar conditions to the GOs. As we changed the synthesis approach of GO, so was its surface area (Fig. 1a), porosity profile and CO_2 adsorption capacity modified significantly. In some instances, this resulted in doubling of gas uptake (Fig. 1b).

References

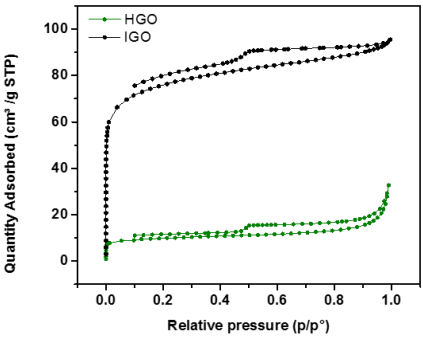
[1] Alazmi, A.; Rasul, S.; Patole, S. P.; Costa, P. M. F. J., Polyhedron 116 (2016), 153-161.

[2] A. Alazmi, O. El-Tall, M. N. Hedhili, P. M. F. J. Costa, submitted (2017).

[3] A. Alazmi, P. M. F. J. Costa, "Graphene materials and improved methods of making, drying and applications", Patent PCT/IB2017/054680.

Figures

a)



b)

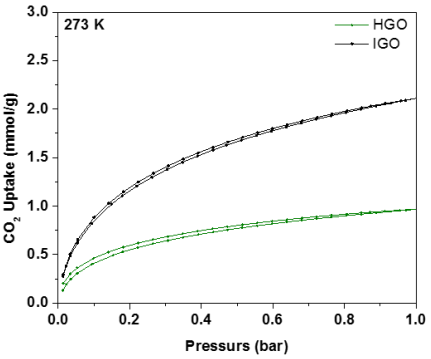


Figure 1: (a) N_2 adsorption–desorption isotherms of HGO and IGO, at 77 K; (b) Pure component CO_2 adsorption isotherms for the HGO and IGO materials.