Graphene-based assemblies as electrode materials for supercapacitors

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Reduced graphene oxide (RGO) based electrochemical double-layer capacitors (EDLC), have been extensively studied, as they offer good power capability. However they suffer from medium capacitances, as the reduced graphene sheets partially restack through π- π interactions limiting the resulting adsorption active surface area. Different paths have been followed in the literature to circumvent or partially avoid this restacking: using graphene aerogels [1] or expanded graphene structures.[2] In this latter case, an intercalate or pillar (*eg.* CNT, AC, diamines…) is used to space out the graphene layers and recover active surface area. Both methodologies lead to graphene sheets assemblies, either at the macroscale for aerogel or at the nanoscale for pillared graphene structures.
Hence, the results, that will be presented, depict the laboratories researches devoted to the development and study of graphene based assemblies, tested as electrode materials for supercapacitors. The macro-scale assemblies (Fig.1a) consist in graphene hydrogel prepared in a one-step process using hydrazine hydrate.[3] In turn, the nanoscales assemblies (Fig.1b) consist in graphene sheets cross-linked using alkyl-diamines. The preparation, physico-chemical and electrochemical characterizations of these graphene derivatives will first be described separately in order to underline the beneficial properties of each of these materials, in terms of structure and storage performances. Finally, these two assembly scales have been combined in the formation of a pillared graphene hydrogel designed to display the advantage of both graphene materials. This particular type of sample is also a good platform to try to densify the sample. Hence the high volumetric capacitances achieved for these materials will be discussed.[4]

References

[1] Hu et al., Adv. Mater., 25 (2013) 2219.
[2] Sun et al., Carbon, 120 (2017) 145.
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[4] Banda et al., ACS Nano, 13 (2019) 1143.

Figures

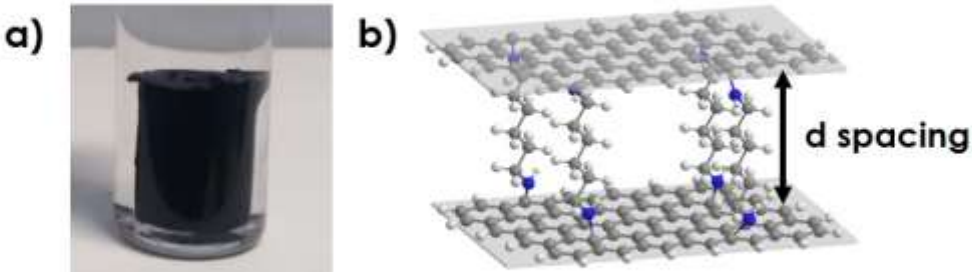

Figure 1: The macro- and nano-scale assemblies: a) Picture of a graphene hydrogel; b) Schematic representation of a pillared graphene.