Chemically modified graphene

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Graphene covers a continuously growing scientific area, due to its extraordinary mechanical, electronic and thermal properties, which make it an ideal candidate in nanotechnology applications, ranging from energy storage and conversion systems to biosensors and nanoelectronics. However, the large production of single or oligo-layered graphene sheets is still a struggling issue and several methods have been developed toward this direction.

Herein, we summarize research findings from our group based on the exfoliation and functionalization of graphene. In this frame, we succeeded on the exfoliation of graphite to oligo-layered graphene sheets in liquid phase via tip sonication and found that *o*-dichlorobenzene (o-DCB) and N-methyl-1,2-pyrolidone (NMP) produce the most stable dispersions of graphene sheets. Furthermore, the dispersions of exfoliated graphene sheets in NMP were studied in terms of switching their solubility from the organic phase to an aqueous environment and found that treatment with poly(styrene-b-2-vinylpyridine) block copolymer, under acidic conditions, resulted on aqueous solubilization of graphene. Similar results were obtained when poly(isoprene-b-acrylic acid) block copolymer was added on exfoliated graphene in NMP.[1]

Moving forward, we also succeeded on the covalent functionalization of exfoliated graphene in o-DCB via direct nucleophilic addition of the custom synthesized photoactive (2-aminoethoxy)(tri-*tert*-butyl)-zinc phthalocyanine (ZnPc).[2] The new hybrid material, ZnPc-graphene, was characterized by complementary spectroscopic, thermal and microscopy techniques. Furthermore, photoinduced intrahybrid electron transfer phenomena were investigated and significant photophysical parameters were evaluated. Most importantly, a prototype device was constructed by fabricating the graphene-based hybrid material as photoanode in a photoelectrochemical cell and its efficiency and response were examined.

On a different approach, oxidation of graphite was used for the introduction of numerous oxygenated species at the peripheral edges and the basal plane of graphene sheets in order to obtain oligo-layered graphene oxide, which is readily dispersible in polar organic solvents and water. Subsequently, graphene oxide was treated with oxalyl chloride and then with 5-(4-aminophenyl)-10,15,20-triphenyl-21,23H-porphyrin (H_2P) to form the H_2P-GO hybrid material as a stable dispersion in DMF.[3]

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