chem2Dmat
August 31 - September 03, 2021 • Bologna, Italy
European Conference on Chemistry of Two-Dimensional Materials

Graphene derivatives for energy storage

Michal Otyepka
Regional Centre of Advanced Technologies and Materials, Czech Advanced Technology and Research Institute (CATRIN), Palacký University, Šlechtitelů 27, Olomouc, 779 00 Czech Republic
Michal.Otyepka@upol.cz

Graphene, its composites, and derivatives are promising materials for energy storage applications. Graphene derivatives are particularly interesting because they offer new horizons for supercapacitor and battery electrode materials. Preparation of graphene derivatives directly from graphene/graphite is, however, hampered by a high graphene inertness. A low reactivity of graphene can be bypassed by utilization of chemistry of fluorographene, which can be carried out at mild and controllable conditions.[1] The fluorographene chemistry benefits also from an easily available pristine material, graphite fluoride, on the market. We have shown that the fluorographene can be converted into various graphene derivatives, which show promising properties as electrode materials of supercapacitors and batteries. A two-step synthesis leads to graphene acid, i.e., graphene bearing ~15% of covalently grafted carboxyl groups on both sides [2]. Graphene acid is perfectly water dispersible, and conductive (~25 S/m) material. These features predispose it as an electrode material for supercapacitors with a capacitance of ~100 F/g and very high specific capacitance retention above 95% after 60,000 C/D cycles at a current density of 3 A/g in a two-electrode cell system [3,4]. The performance of GA can be significantly enhanced by its hybridization with a metal-organic network (UiO-66-NH_2). The hybrid acts as an effective charge storing material with a capacitance of up to 650 F/g.[5] Reduction of fluorographene by nitrogen-containing compounds leads to nitrogen doped graphenes.[6] The nitrogen-doped graphenes with high-level of nitrogen doping represent another class of interesting supercapacitor electrode materials with high energy and power density. The chemistry of fluorographene can be used to conjugation of graphene with polysulfide chains. The as obtained highly (80 mass%) sulfur doped graphene delivers very high full-cathode-mass capacity and rate capability, combined with superior cycling stability. These features predispose it as an efficient cathode material of LiS batteries with a low shuttling effect [7].

The work is supported by ERC grant (2Dchem.org) ID 683024 from H2020 programme.

References

[1] Chronopoulos et al. Appl. Mater. Today, 9, 60, 2017.

[2] Bakandritsos et al. ACS Nano, 11, 2982, 2017.

[3] Cheong et al. ChemElectroChem, 6, 229, 2019.

[4] Šedajová et al. Nanomaterials, 10, 1731, 2020.

[5] Jayaramulu et al. Adv. Mater. 33, 2004560, 2021.

[6] Zaoralová et al. ACS Sustainable Chem. Eng., 8, 4764, 2020.

[7] Tantis et al. Adv. Funct. Mater., in press, 2021 (DOI: 10.1002/adfm.202101326).