Graphene based materials for energy storage and conversion systems

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Graphene has attracted intense scientific interest due to its exceptional electrical, mechanical and chemical properties over the last couple of years. This strictly two-dimensional (2D) material has potential applications in advanced electronic devices[1] and composite materials. The challenge is to produce large area defect-free graphene necessary for electronic applications while bulk-production at gram scale of graphene with defects enabling anchoring sites for nanoparticles is required for applications like catalysis[2].

Graphene finds potential applications as an electrode material in electrochemical applications such as batteries and supercapacitors. Layered nature of graphene acts as a barrier against aggregation of nanoparticles in the electrode material. To illustrate, the use of chemically derived graphene (or reduced graphene oxide (CDG or RGO)) based materials as anode or cathode in Li-ion and metal-air battery technology promotes the improvement in the recent field due to the large surface-to-volume ratio and highly conductive nature of graphene. The formation of nanopores and disorders in the CDG through chemical synthesis promotes as lithium insertion active sites that are crucial in battery and supercapacitor technology. So the process fastens in the presence of graphene in the electrode (Figure 1, A)[3]. In addition, both anode and cathode of a battery might become bendable due to the flexibility feature of graphene (Figure 1, B)[4].

Herein, we report chemical synthesis of graphene that is established by oxidation of graphite to graphite oxide (GO) and followed by reduction process. Prior to reduction, GO is N-doped and B-doped in order to provide defects on the surface. Then, doped-GO is introduced to porous nickel foam to get 3D-porous doped GO. The aim of the work is to synthesize graphene/metal (Si, Sn and Ge), graphene/metal oxide nanoparticles (SnO_2, Fe_xO_y, Co_xO_y, Mn_xO_y and Cu_xO_y) and graphene/polimer (polyaniline and polypyrrole) based hybrid materials and use them as anode active in lithium-ion battery, as cathode active material in metal-air battery and as electrode in supercapacitor.

References

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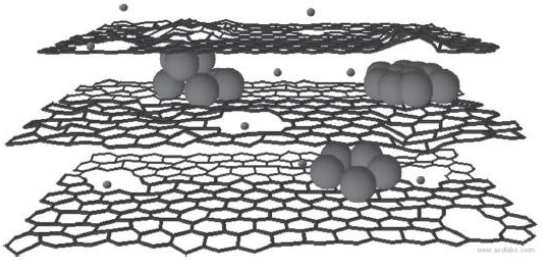
Figures

A



B

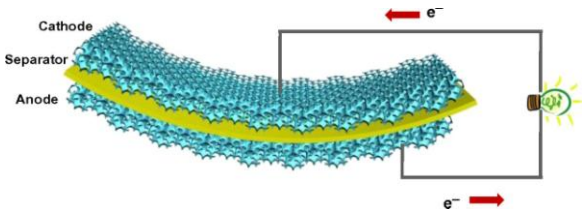


Figure 1: Examples of CDG graphene-based electrodes in Li-ion battery. A. Si/Graphene as an anode[3] B. Flexible $Li_4Ti_5O_{12}$ /Graphene Anode and $LiFePO_4$ /Graphene Cathode[4]