Graphene-based Electrode Materials for Supercapacitors

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Graphene has attracted much attention since it was firstly stripped from graphite by two physicists in 2004, and the supercapacitor based on graphene has obtained wide attention and much investment as well. However, there are many problems to solve in practical application of graphene-based supercapacitors, for instance, how to reduce the cost and simplify the fabrication process and how to improve further the electrochemical performance. In this talk, I will present our recent breakthroughs in fabricating graphene-based electrode materials for high-performance supercapacitors. First of all, to avoid graphene restacking, we come up with a pumping paper process, that is, when we use force to draw the paper from a small pore, the paper would fold. So here, we report a novel strategy to prepare wrinkled flower-like graphene through a simple suction filtration process. The wrinkled flower-like graphene shows a high specific capacitance of 272 F g^{-1} and a perfect capacitance retention of 99.5% after 2,000 times of charging/discharging cycles. Second, graphene/MnO_2, graphene/Fe_3O_4 and graphene/$Ni(OH)_2$ composites with high electrochemical performance are prepared. Last but not least, 3D hierarchical porous carbon-based electrode materials (3DHPCs) with a composite structure are prepared from a biomass waste, sheep manure, by a facile carbonization and activation process without using any additional template. Benefiting from the composite structure, the ions experience a variety of environments, *i.e.*, graphene-like sheets, nanotube- and microtube-like pores coexist in the same material, which, in turn, contribute significantly to the excellent electrochemical properties of supercapacitors, comprising high specific capacitance, outstanding rate capability and excellent long cycle stability. The specific capacitance at large current densities of 1 A g^{-1} and 50 A g^{-1} reaches as high as 486 F g^{-1} and 411 F g^{-1}, respectively, in 6 M KOH electrolyte. Furthermore, the supercapacitor device based on 3DHPCs shows a superior cycle stability with almost 100% retention of the initial specific capacitance after 10,000 cycles; in addition, it yields a Ragone curve with high energy and power density combinations of 57.08 Wh kg^{-1} at 25.37 kW kg^{-1}.