Next Generation Supercapacitor for Ultra-Fast Energy Harvesting

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The supercapacitors are getting considerable attention in recent years because they have quick charge/discharge capabilities, long cycle lives and are also environmentally friendly. Supercapacitors are already being used heavily in hybrid vehicles, laptops, airplanes, and electric trains where a sudden burst of power is needed in a very short time. Supercapacitors store and release energy by the electrostatic interactions between the ions in the electrolyte and the charge accumulated at the active electrode during the change/discharge process. As such, an electrode material is one of the key components which determines the performance of the supercapacitor. In this work, new composite electrodes made from nitrogen or boron doped graphite and porous carbon were synthesized using an ion implantation process to increase the energy and power densities. Initially, the surfaces of the graphite sheets were doped with nitrogen or boron ions at different doses. The composite electrode was made by spraying the implanted surfaces with porous carbon. The implanted surfaces were characterized by X-Ray photoelectron spectroscopy and helium ion microscopy for surface composition and morphology. Several supercapacitors were fabricated using these electrodes with ionic liquid as electrolyte. Electrochemical performances of these supercapacitors were studied using cyclic-voltammetry and electrochemical impedance spectroscopy. Supercapacitors made with nitrogen and boron doped electrodes show a very large increase in energy density (more than 50%) and power density (more than 150%) compared to the supercapacitors made with undoped electrodes. All these values are significantly higher (more than 200%) than the commercially available supercapacitors in the same voltage rating.

Awards Won:
Third Award of $1,000