Binder-free, two-step synthesis of sulfur doped nickel phosphate for supercapacitor application

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Abstract:

In this work, a two-step synthesis strategy was employed to fabricate sulfur-doped nickel phosphate thin film electrodes for supercapacitor applications. In the first step, nickel phosphate thin films were successfully deposited on a conductive substrate via the chemical bath deposition method. Subsequently, in second step, sulfur doping was achieved through a hydrothermal method of the as-prepared nickel phosphate films. X-ray diffraction (XRD) analysis revealed that the pristine nickel phosphate exhibited a monoclinic crystal structure, while sulfur doping induced a phase transformation to a rhombohedral structure, indicating successful incorporation of sulfur into the nickel phosphate thin films. Morphological investigations using transmission electron microscopy (TEM) showed that both pristine and sulfur-doped nickel phosphate films possessed nanosheet-like architectures, which are favorable for electrochemical charge storage. Electrochemical performance was evaluated using cyclic voltammetry, galvanostatic charge-discharge and electrochemical impedance spectroscopy measurements. The pristine nickel phosphate thin film delivered a specific capacitance of 240 F g-1 at a current density of 1 A g-1. Remarkably, the sulfur-doped nickel phosphate thin film demonstrated a significantly enhanced specific capacitance of 740 F g-1 at the 1 A g-1 current density. The improved electrochemical performance is attributed to enhanced electrical conductivity and increased electroactive sites resulting from sulfur doping, making the material a promising electrode candidate for high-performance supercapacitors.

Keywords: Chemical bath deposition, Hydrothermal method, Sulfur doped nickel phosphate, Supercapacitor,