Hydrogenated ZnO@Amorphous MnO₂ for Flexible Supercapacitors

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Specific energy storage devices possessing characteristics of flexibility, light weight, and even safety may meet the large proliferation of consumer electronics. Among various emerging energy storage technologies, supercapacitors (SCs), also named electrochemical capacitors, with combined high power and high energy density, have attracted much attention and will be a promising candidate energy source [1-2].

Compared to other transition metal oxides, manganese dioxide (MnO₂) has significant superiorities such as low cost, low toxicity, abundant resource, and high theoretical specific capacitance (1370 F/g) [3]. Although MnO₂ is a promising material for SCs due to its excellent electrochemical performance and natural abundance, its wide application is limited by poor electrical conductivity. Recently, the influence of hydrogenation on the electrochemical properties of metal oxide materials has been studied [4-5]. Inspired by our results that the electrochemical activity and electrical conductivity of ZnO nanowires were greatly improved after hydrogenation, we designed and fabricated hydrogenated single-crystal ZnO@amorphous ZnO-doped MnO₂ core–shell nanocables (HZM) on carbon cloth as SC electrodes, showing excellent performance such as areal capacitance of 138.7 mF/cm² and specific capacitance of 1260.9 F/g.

Fig. 1 (a) STEM image of HZM core/shell nanostructure. Inset is SAED pattern of HZM nanocable. (b) EDS line scan curves showing Zn, Mn, and O element profiles across the HZM core/shell nanocable indicated in (a). (c) STEM image of a select area. (d-f) EDS element mapping images from the same area as in (c). (g) HRTEM image of the HZM core/shell nanocable, confirming the single-crystal ZnO core and amorphous shell. (h) EELS mapping image showing Mn (red) and C (green) elements.

Fig. 2 (a) CV curves for ZnO, AZnO, and HZnO. (b) Mott-Schottky plots of ZnO, AZnO, and HZnO electrodes. (c) CV curves for ZM, AZM, and HZM electrodes. (d) Galvanostatic charge/discharge curves of ZM, AZM, and HZM.

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References