Low-temperature synthesis of TiO2 nanocrystals for high performance electrochemical supercapacitors

ABSTRACT

Titanium dioxide (TiO2) nanocrystals in intermediate phase of amorphous and anatase has been successfully synthesized through a simple, low temperature peroxo sol gel approach. Transmission electron microscopy revealed that the TiO2 nanocrystals obtained have an average diameter of 8–133 nm. The effects of calcination temperature on the morphology and phase transformation were studied by annealing the samples at 200–800 °C. TiO2 nanocrystals annealed at 200 °C with diameter of 12 nm exhibited the highest specific capacitance of 146 F g−1 at current density of 0.2 A g−1 in 1 M KOH as the electrolyte. The high specific capacitance is attributed to the intermediate phase of amorphous and anatase structure which enhanced the redox active sites of the TiO2 nanocrystals. Using the TiO2 nanocrystals annealed at 200 °C and activated carbon as the anode and cathode electrodes, respectively, an asymmetrical supercapacitor was successfully prepared. The asymmetric supercapacitor demonstrated outstanding electrochemical performance with wide potential window of 1.45 V, high energy density (35.38 Wh kg−1) and power density (408.23 W kg−1) and excellent stability 80.4% capacitance retention after 3000 cycles, suggesting that it is an auspicious electrode material for supercapacitors.

Keyword: Titanium dioxide nanocrystals; Peroxo sol gel; Supercapacitor; Calcination