Electrochemically reduced Titania nanotube synthesized from glycerol-based electrolyte as supercapacitor electrode

ABSTRACT

In this paper the synthesis of self-organized Titania nanotubes (TNTs) by a facile potentiostatic anodization in a glycerol-based electrolyte is reported. The optimized TNTs were subsequently reduced through a cathodic reduction process to enhance its capacitive performance. FESEM and XRD were used to characterize the morphology and crystal structure of the synthesized samples. XPS analysis confirmed the reduction of Ti4+ to Ti3+ ions in the reduced Titania nanotubes (R-TNTs). The tube diameter and separation between the tubes were greatly influenced by the applied voltage. TNTs synthesized at voltage of 30 V for 60 min exhibited 86 nm and 1.1 μm of tube diameter and length, respectively and showed high specific capacitance of 0.33 mF cm−2 at current density of 0.02 mA cm−2. After reduction at 5 V for 30 s, the specific capacitance increased by about seven times (2.28 mF cm−2) at 0.5 mA cm−2 and recorded about 86% capacitance retention after 1000 continuous cycling at 0.2 mA cm−2, as compared to TNTs, retained about 61% at 0.01 mA cm−2. The charge transfer resistance drastically reduced from 6.2 Ω for TNTs to 0.55 Ω for R-TNTs, indicating an improvement in the transfer of electrons and ions across the electrode–electrolyte interface.

Keyword: Anodization; Titania nanotubes; Glycerol; Electrochemical capacitance; Morphology; Cathodic reduction