Electrodeposition polyaniline nanofiber on the PEDOT:PSS-coated SiNWs for high performance supercapacitors

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Abstract

In this article, a novel silicon-based electrode was designed with the facile solution methods. With the modification of highly conductive PEDOT:PSS layer on the SiNWs by the spin-coated method (SiNWs-PSS), three-dimensional (3D) porous network polyaniline nanofibers (PANI) film was uniformly electrodeposited on the silicon surface (SiNWs-PSS@PANI). The sheet resistances of the PEDOT:PSS layer with different surfactants as well as the deposition time of the PANI were investigated. After optimization, the fabricated SiNWs-PSS@PANI electrode displayed high capacitance about $301.71 \text{ mF cm}^{-2}$ at the current density of 1 mA cm^{-2} , which enhanced ~ 29 fold comparing to 10.18 mF cm^{-2} of electrode without the PEDOT:PSS layer between the SiNWs and PANI (SiNWs@PANI), outperforming most values of the reported silicon-based electrodes. The electrode designed in this paper provides a new idea to fabricate high-performance of silicon-based micro-supercapacitors with the simple and low-temperature method.

Full Text

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Figures

Figure 1

SEM images of different silicon substrates. a SiNWs synthesized with MACE method for 60 min, b SiNWs treated by PCl_5 solution for 2h. Insets are cross-section corresponding images. c PANI electrodeposited on the pristine SiNWs substrate using the Ag as the rear electrode for 10 min, the inset shows the image

at high magnification, d SiNWs-PSS. Inset is cross-section image, e and f different magnification images of SiNWs-PSS@PANI with the deposition time of 5 min.

Figure 2

a TEM image of electrodeposited polyaniline nanofibers, b FTIR spectra of PANI, c Raman spectra of PANI and d XRD patterns of PANI.

Figure 3

Electrochemical performance of the SiNWs-PSS@PANI electrodes with different top layer. a CV curves at the scan rate of 50 mV s⁻¹, b GCD measurement at the current density of 1 mA cm⁻², c areal capacitances at the current density of 1 mA cm⁻², d areal capacitance at different scan rates, e areal capacitance at different current densities and f Nyquist impedance plots at the open circuit voltage. The electrodeposition time is 5 min.

Figure 4

a CV curves at a scan rate of 50 mV s⁻¹, b GCD curves at 1mA cm⁻², c areal capacitance of different electrodeposition time extracted from the GCD curves, d CV curves at various scan rates, e GCD curves at different current densities and f Cyclic stability at 100 mV s⁻¹ of the electrode.

Figure 5

a Schematic diagram of a symmetric supercapacitor based on SiNWs-PSS@PANI electrodes, b CV curves at various scan rates, c GCD curves at different current densities, d areal capacitance at different current

densities and e Ragone plots of MSCs with other reported values for comparison.

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