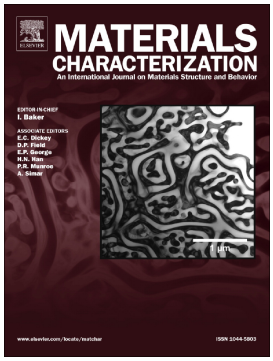

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Effect of current density and electrochemical cycling on physical properties of silicon nanowires as anode for lithium ion battery

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Abstract

Herein, we successfully fabricated vertically aligned silicon nanowires (Si NWs) via an electrochemical etching of n-type (100) silicon at different high current densities. The morphology of the prepared Si NWs was studied using SEM, FFT analysis and WSxM software. From FTIR spectroscopy analysis, the silicon dangling bonds of the as-prepared Si NWs layer have large amount of hydrogen to form weak Si–H bonds. The blue shift was observed in Photoluminescence due to decrease in the size of silicon crystallites, the crystallite size in the Si NWs varied from 5.9 nm to 4.8 nm depending on the current density. The contact angle varied from 74.7^0 to 149.1^0. From the wettability studies, the surface nature of the Si NWs was converted from hydrophilic to hydrophobic when the current density increased. The obtained Si NWs were used as an anode in lithium ion cell. The charge capacity of the anode is ~3452.47 $mAhg^{-1}$ at the first cycle with the coulombic efficiency over 85.8 %, and faded to 1134.34 $mAhg^{-1}$ with coulombic efficiency over 81.6 % after the 12^{th} cycle at a current rate of 1C. Scanning electron microscopy and selected area electron diffraction are performed to study the morphology and crystalline structure of the anode, respectively. The dislocation density decreased from 46.2×10^{15} m^{-2} to 0.06×10^{15} m^{-2} and the surface area decreased from 1.5×10^3 μm^2 to 0.05×10^3 μm^2 with cycle number increased