Magnetron Sputtering Silicon Thin Film Electrodes for Lithium-Ion Batteries

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Thin silicon films were deposited on surface-modified copper foil by magnetron sputtering; Si mass loading varied from 0.013 to 0.400 mg/cm. Scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS), X-ray diffraction (XRD), and transmission electron microscopy (TEM) were used to characterize the structure, morphology, and composition of the Si films as a function of mass loading. It was established that Si films repeated the hill-like morphology of Cu foil surface and consisted of nearly spherical agglomerates of amorphous silicon; the average size and packing of agglomerates varied as the Si mass loading changed. Galvanostatic half-cell electrochemical measurements were carried out within the range of 0.04–2.0 V with a lithium foil as the counter electrode and 1M solution of LiPF₆ in 1:1 (v/v) mixture of ethylene carbonate (EC) and diethyl carbonate (DEC) as the electrolyte. According to the results obtained, the highest value of the reversible capacity of about 1200 mAh/g after 50 charge-discharge cycles at 0.1 C was observed in the electrodes with a Si mass loading of 0.293 mg/cm. The non-monotonic dependence of the reversible capacity vs. Si mass loading is likely to be caused by the structural evolution of the amorphous Si thin films.

Keywords: Li-ion batteries, Silicon electrode, Thin film, Magnetron sputtering, Morphology, Cycling performance

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