

### Microstructure study of Si-alloy thin film anode electrode for Li-ion batteries

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Recent surge in mobile devices, combined with urgent needs for electric cars, fueled global research efforts to develop rechargeable lithium batteries with higher energy density and longer cyclic life. Among the batteries, thin-film battery has a large potential in many applications, such as the part of smart cards, RFIDs, and sensor networks. Also, thin-film batteries are the breakthrough in embedded systems that work to minimize the size of an electronic device. Therefore, thin-film Li-ion batteries have to obtain the high-capacity electrode materials. At the forefront of the wave of the efforts is silicon, which possesses a low discharge potential and the highest known theoretical charge capacity (4,200mAh/g), and hence has emerged as a promising next anode material to replace the conventional carbon-based materials. Nevertheless, one of the serious drawbacks of this material is its poor cyclic stability, which arises from a large volume change (nearly 400%) that the material experiences during insertion and extraction of lithium. Thus, researchers have recently striven to improve the cyclic stability of Si-based anode.<sup>1-3</sup>

This study examined the effects of Si-alloy structure on the microstructure evolution and electrochemical performance of sputtered Si-alloy thin film. Si-alloy thin film anode electrodes were grown on Cu foil current collector by sputtering

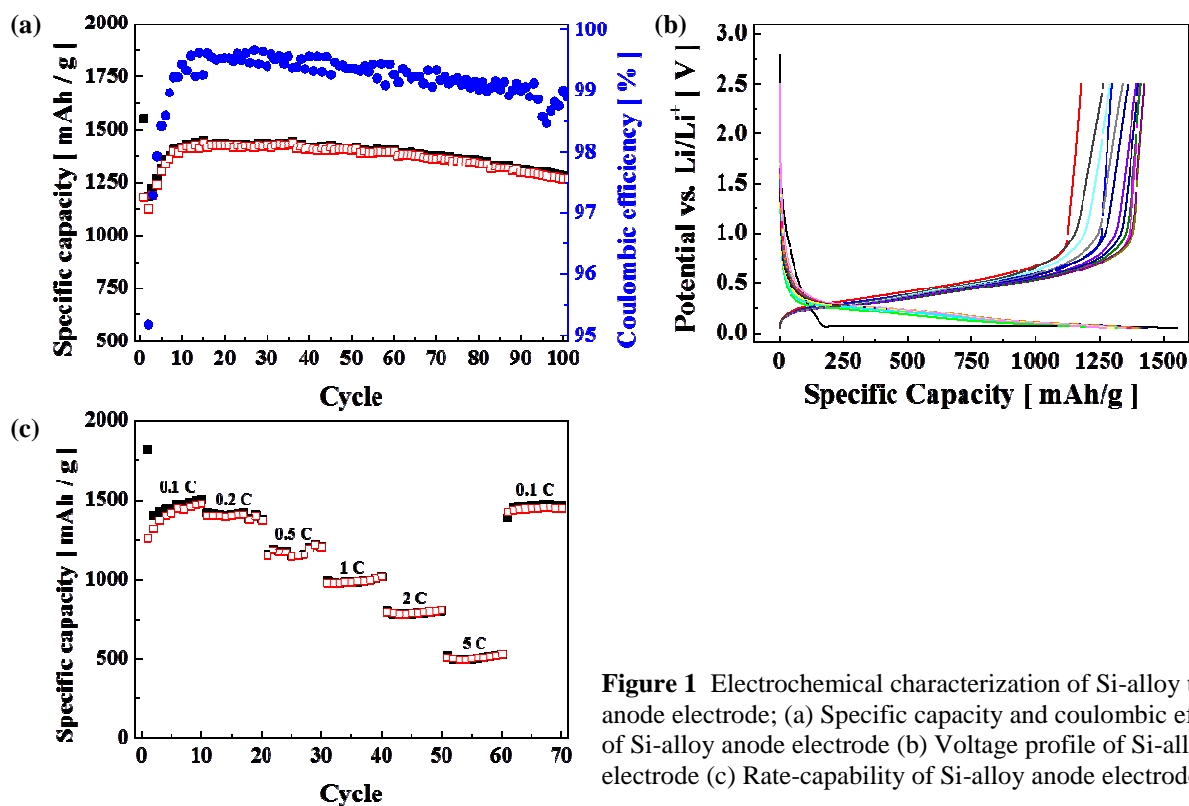
deposition with adhesion layers. The capacity retention shows a significant improvement up to 100 cycles. Electrochemical measurements were conducted with a typical coin-type half cell system. Si-alloy film as working electrode and lithium foil as a counter electrode were used in the electrolyte of 1M LiPF<sub>6</sub> in a 1:1 mixture of ethylene carbonate (EC) and diethyl carbonate (DEC). A careful characterization of the structure changes after cycling has been carried out using various characterization tools such as X-ray diffraction (XRD), scanning electron microscope (SEM) and transmission electron microscope (TEM). The results show that the morphology and microstructure of the electrode critically determine the electrochemical properties of the electrode.

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#### References

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**Figure 1** Electrochemical characterization of Si-alloy thin film anode electrode; (a) Specific capacity and coulombic efficiency of Si-alloy anode electrode (b) Voltage profile of Si-alloy anode electrode (c) Rate-capability of Si-alloy anode electrode