Approach for High Areal Capacity of Electrodeposited Si-O-C Composite Anode on Carbon Paper for Lithium Secondary Batteries

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Lithium secondary batteries are widely used for electric vehicles (EV), and portable electronic devices, etc. The energy density of lithium secondary batteries is important for their effective utilization. Nowadays, silicon has a lot of attention as promising anode materials because of its natural abundance, stable alloying-dealloying reaction with Li ion and much higher theoretical capacity (≒4,200 mA h g^{-1}) than that of conventional graphite anode (≒372 mA h g^{-1}). However, silicon-based anodes cause significant volume changes during charge/discharge process, which results in the rapid capacity degradation. In our previous report [1], we succeeded in fabricating a Si-O-C composite anode on copper substrate by electrodepositing silicon, oxygen, and carbon uniformly in order to suppress the volume changes, showing stable cycle life with comparably high gravimetric capacity (see. Fig1a). However, its areal discharge capacity showed less than 0.1 mA h cm^{-2} with deposition on copper substrate, which was not sufficient for its wide applications. In this report, therefore, we introduce a carbon paper (see. Fig1b) as a current collector instead of conventional copper metal substrate to increase its areal discharge capacity by raising the deposited amount of silicon. Herein, carbon paper was treated with SPM (sulfuric acid: hydrogen peroxide = 1:4(vol/vol)) to introduce hydrophilic groups on its surface, resulting in increase of bonding strength of Si on carbon fiber surface. As the result, the areal discharge capacity of the Si-O-C composite anode electrodeposited on the carbon paper with the SPM pretreatment was improved, delivering approximately 1.5 mA h cm^{-2} than without the SPM treatment (1.0 mA h cm^{-2}).

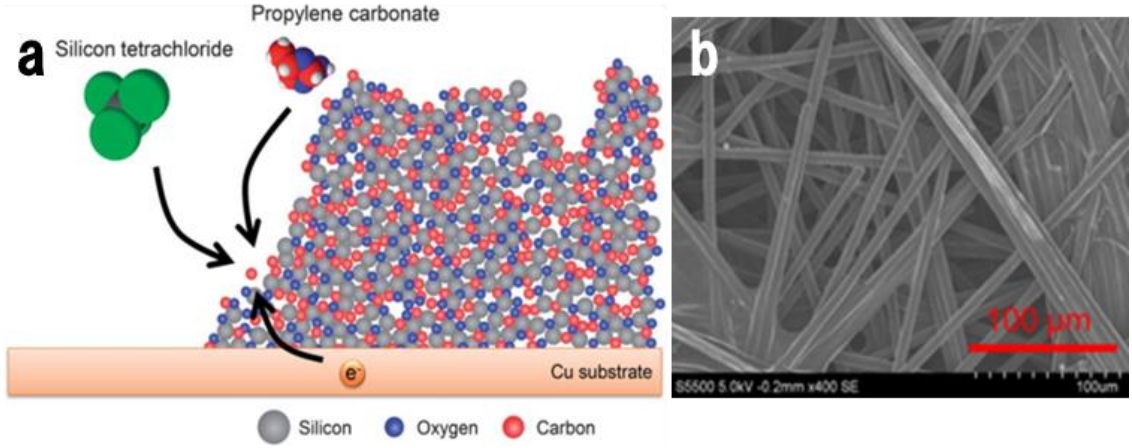

Figure 1 (a) Schematic of electrodeposition of Si-O-C composite anode [1] (b) SEM image of Carbon Paper

Reference:

[1] Hiroki Nara, Tokihiko Yokoshima, Toshiyuki Momma and Tetsuya Osaka, 'Highly durable SiOC composite anode prepared by electrodeposition for lithium secondary batteries', *Energy Environ. Sci.*, **5**, 6500-6505 (2012)