Enhanced Electrochemical Properties of SnO_2 Anode by Nanoparticle Coating

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Amorphous tin-based composite oxides with the theoretical gravimetric capacity over two times higher than carbon (372 mAh/g) were a very important discovery for developing high-capacity Li-ion cell in 1997 [1]. Reaction mechanism of SnO_2 with lithium has been reported as follows [2]:

$$SnO_2 + 4Li^+ + 4e^- \rightarrow Sn + 2Li_2O \quad (1)$$

$$Sn + xLi^+ + xe^- \leftrightarrow Li_xSn \ (0 \le x \le 4.4) \quad (2)$$

On the first discharge, the lithium bonds to the oxygen in SnO_2, leaving the tin metal and Li_2O, and Sn then alloys up to the theoretical limit of $Li_{4.4}Sn$ [3]. The formation of Li_2O is followed by the subsequent alloying/dealloying of lithium with tin. However, the SnO_2 has exposed some critical problems to be overcome for commercial use in Li-ion cell: i) larger irreversible capacity with > 700mAh/g, and therefore the cycling efficiency during the first cycle is very low, and ii) depending on the grain size and cut-off voltage, cyclability and rate-capability are greatly affected [2].

In this presentation, we will report the electrochemical properties of nanoparticle-coated SnO_2. Preliminary results showed that nanoparticle coating reduced the irreversible capacity and capacity fading on cycling, compared to the bare SnO_2. Besides, nanoparticle coating led to decreased formation of surface cracks of the SnO_2 particles from the two-fold volume change during the reaction in $Sn + xLi^+ + xe^- \leftrightarrow Li_xSn$.

References

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