

Advanced Electrolytes for Silicon Oxide Negative Electrodes

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Lithium ion batteries have become the most popular choice for customer electronics and continued to penetrate into the electric vehicle market and other large scale applications due to its superior energy density. The pursuit of even higher energy density has stimulated great interest of replacing carbonaceous negative electrodes with silicon-based materials. Silicon has the highest theoretical specific capacity of known materials and offers better safety features compared to graphite.¹ However, the practical use of these materials has been impeded by their poor capacity retention that is usually associated with the huge change of the material during lithium insertion/ extraction process.²

To mitigate this problem, most attention has been paid to the modification to the material, such as making nanostructured particles or amorphous silicon thin film,³ creating active/inactive matrix,⁴ coating with carbon⁵ and so on. In contrast, only a few reports examined the importance of binder and electrolyte for these Si-based negative electrode materials.⁶⁻⁸ In this work, efforts were devoted to optimize the electrolyte system to improve the electrochemical performance of silicon oxide (SiOx) composite electrodes.

Figure 1 shows the performance of SiOx electrode in different carbonate-based systems. After first formation cycle, all the cells showed a capacity of about 1200 mAh/g. However, without any additives, all the carbonate electrolytes showed very poor capacity retention.

In our studies, several compounds have showed promise as an additive/co-solvent candidate to improve the electrochemical performance of Si-based electrodes. As shown in Figure 2, additive 1, 2 and the combination of additive 1 and 3 can greatly enhance the cell capacity retention. The cells using additive 1 showed a capacity of about 1100 mAh/g after 160 cycles. The impact of different salts and other electrolyte formulation have been also investigated and the results will be presented at the meeting.

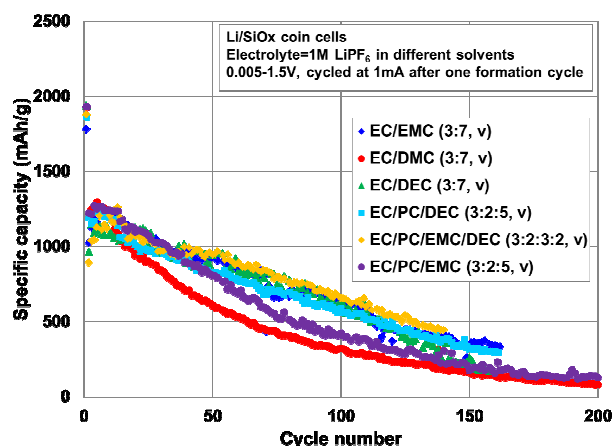


Figure 1 Discharge capacity vs. cycle number for Li/SiOx cells in different carbonate electrolyte systems. After one formation cycle, the cells were cycled at 1mA between 0.005 and 1.5 V at room temperature.

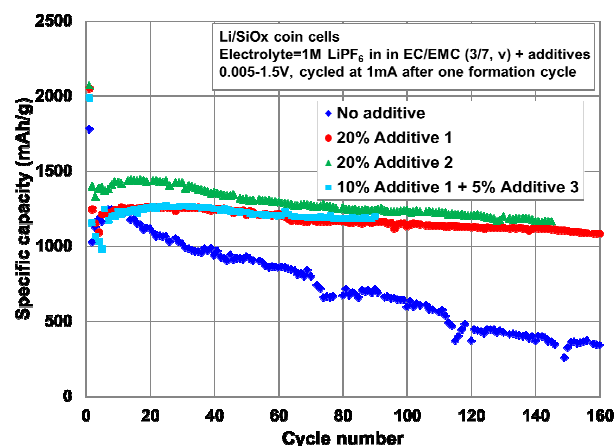


Figure 2 Discharge capacity vs. cycle number for Li/SiOx cells using different electrolytes. After one formation cycle, the cells were cycled at 1mA between 0.005 and 1.5 V at room temperature.

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