High-Loading Sulfur-Graphene Oxide Electrodes toward Practical Li/S Cells

Yoon Hwa and Elton J. Cairns

Presented at the ACS Meeting, April 2017

Since the advent of full electrical vehicle (EV) technologies, the demand for high specific energy rechargeable batteries has dramatically increased because the desired battery specification for EVs (> 300 Wh/kg) is beyond the practical limits of conventional Li ion batteries. Among the alternatives, the lithium/sulfur (Li/S) cell can offer a high theoretical specific energy of 2680 Wh/kg which is very promising in terms of specific energy. In recent years, much scientific effort has been invested in developing advanced sulfur electrodes and significant progress has been made at the lab scale.

Nevertheless, there are still several challenges for transferring the lab-scale technology to industry, most prominently increasing the sulfur loading and the reducing 'dead weight' of the cells to a practical level while maintaining good electrochemical performance. Unless a high sulfur-loading electrode with reasonable dead weight is achieved, the obtainable specific energy of the Li/S cell will not be commercially attractive, even though a high specific capacity (by weight of sulfur) can be achieved.

We have developed a cetyltrimethylammonium bromide modified sulfur-graphene oxide (S-GO) electrode (the S content: 70 %) using a 3-dimensional (3-D) aluminum foam as current collector with a sulfur loading of up to 11.9 mg S/cm^2 and evaluated in type 2032 coin cells. The 3-D current collector provides for the active sulfur particles to be supplied with both electrons and Li ions efficiently during cycling due to its continuous and porous structure. As shown in Figure 1, high areal discharge capacities of 4.5, 7.7 and 12.8 mAh/cm^2 (corresponding to 1132, 1092 and 1076 mAh/gS, respectively) depending on the sulfur loading were achieved at a current density of 0.2 mA/cm^2 for the first cycles. The specific capacity of 411 mAh/g of electrode was achieved with a high S loading of 11.9 mg/cm^2.

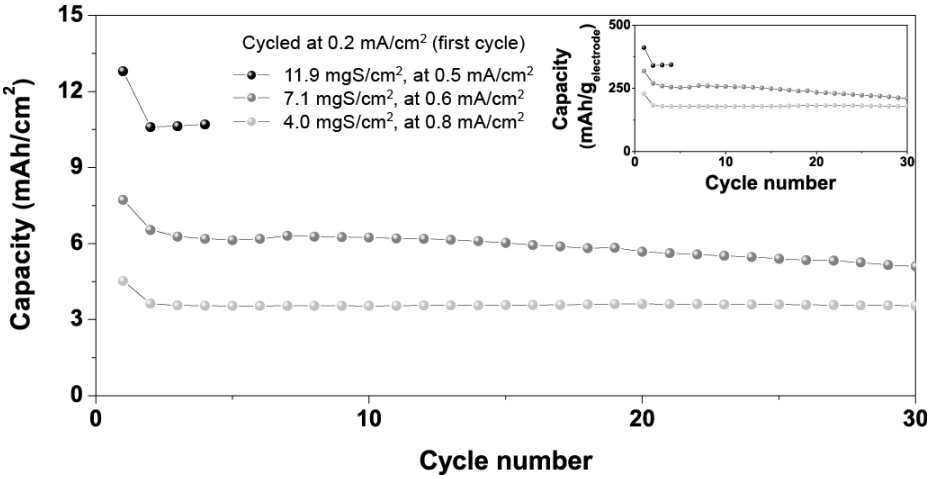

Figure 1. Cycle performance of the high-loading S-GO electrodes. The electrolyte:sulfur weight ratios were about 21, 12 and 7.2 where the sulfur loadings were 4.0, 7.1 and 11.9 mgS/cm^2, respectively. (Inset: cycle performance of the S-GO electrodes with specific capacities normalized by the weight of the electrodes including that of the current collector)