High performance lithium/sulfur cells with sulfur-graphene oxide nanocomposite cathodes and ionic liquid-based electrolytes

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Current lithium-ion cells are projected to be incapable of providing the specific energy required to meet the ever-increasing demands of rapidly emerging technologies[1]. In this regard, lithium/sulfur cells are receiving significant attention as alternative power sources for zero-emission vehicles and advanced electronic devices[2-4]. Due to a high theoretical specific capacity of 1,675 mAh/g, sulfur has gained much attention as a promising positive electrode material for high energy rechargeable batteries. However, the insulating nature of sulfur has prevented the achievement of high utilization (or high specific capacity) and good rate capability.

We have developed nanostructured sulfur-graphene oxide (S-GO) nanocomposite cathodes and demonstrated much improved cycling performance via the reactive functional groups on GO to successfully immobilize sulfur and lithium polysulfides during operation[5]. In this report, while successfully increasing the sulfur loading in the electrode in order to improve the cell-level specific energy, we have optimized the synthesis conditions of S-GO nanocomposites by depositing uniform and thin (around tens of nanometers) sulfur coating on GO and using optimized heat-treatment conditions for molten sulfur to diffuse into nanopores of graphene oxide. We have also developed new electrolytes based on ionic liquids (PYR14TFSI), which led to excellent cell performance in terms of good reversibility ($S \leftrightarrow Li_2S$) as shown in Figure 1, and much improved high-rate capability as shown in Figure 2.

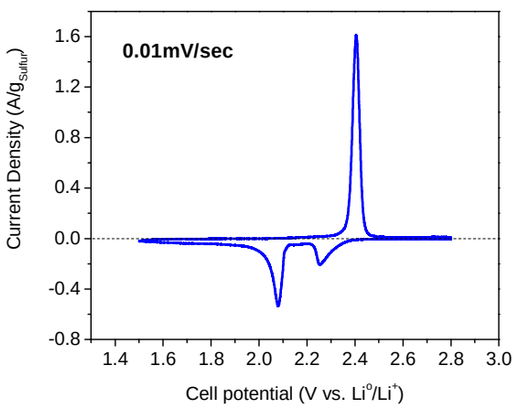

Figure 1. Typical cyclic voltammogram of a lithium/sulfur cell combining S-GO nanocomposite cathodes and ionic liquid-based electrolytes measured at the scan rate of 0.01mV/sec.

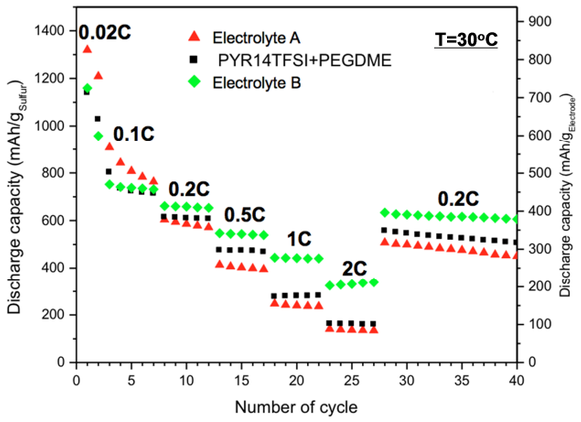

Figure 2. Rate capability of lithium/sulfur cells employing S-GO nanocomposite cathodes with different electrolytes containing LiTFSI (1M).

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References

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