The Effect of Electrolytes on the Discharge Properties of Sulfur Electrode for Li/S cells

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Introduction

The Li/S battery is a very attractive candidate for rechargeable lithium batteries due to its high theoretical specific capacity of 1672 mAh/g and theoretical energy density of 2600 Wh/kg based on sulfur active material. Moreover, utilization of sulfur is advantageous because of its low cost and nontoxicity.[1,2]

The reduction process of Li/S battery with ether-based electrolyte could be divided into two regions based on the voltage profile;[3,4] these are the first discharge region in the range of 2.4-2.1 V and the second discharge region in the range of 2.1-1.5 V. The discharge curve of cell was similar as that using tetrohydrofuran (THF)-based electrolyte[5].
Most of Li-ion battery used carbonate-based electrolytes such as mixed ethylene carbonate(EC) and dimethylene carbonate (DMC) or propylene carbonate (PC) and DMC. However, electrochemical properties of Li/S cell and change of sulfur electrode with carbonate-based electrolyte have not been studied.

In order to study electrochemical properties of Li/S batteries with various electrolytes such as ether-based system and carbonate-based system, we investigated the discharge curves, cycle properties and changes of sulfur electrode.

Experiment

Sulfur electrodes were prepared by mixing sulfur, carbon black and PEO powders. The composition of electrode is 70wt% sulfur, 15wt% electric conductor, and 15wt% PEO. The slurry was mixed by attrition ball milling for 2h, and then cast on the Al current collector.

Electrolytes were organic solutions of 0.5M $LiCF_3SO_3$. Organic solutions were ether-based such as tetraethylene glycol dimethylether (Tetraglyme, TEGDME) and carbonate–based such as PC, EC and DMC.

The configuration of the Li/S cells was Li(350 ㎛ thick, Aldrich)/celgard with electrolyte/sulfur electrode. All assemblies of the cells were carried out in argon-filled glove box. Cell tests were conducted under galvanostatic conditions using a WBCS3000 to 1.5V with electrolytes at room temperature.

We investigated the discharge and cycle properties of Li/S batteries with various electrolytes. The change of cathode during discharge was investigated by means of SEM, AC impedance, XRD, DSC, SEM, and EDS techniques.

Results

Figure 1 shows the first discharge capacities of Li/S batteries with various electrolytes.

The sulfur electrode using TEGDME electrolyte shows higher discharge capacity of 1271mAh/g-S compared with that of the carbonate-based electrolytes.

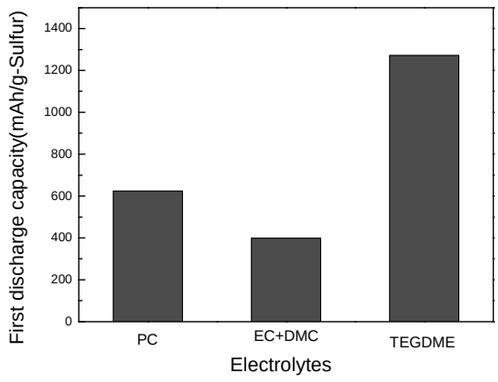

Fig. 1. The first discharge capacity of Li/S batteries with various electrolytes

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