Heteroatom-doped Graphene as Cathode Materials for Lithium-oxygen Batterie

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Introduction

Lithium-oxygen (Li/O_2) batteries become more and more attractive energy storage systems due to their extremely high energy density. During the discharge process, the anode material Li reacts with O_2 which is absorbed from the environment, making these systems serious contenders to meet the rapid growing requirements of electric vehicles. Although the theoretical energy density of Li/O_2 batteries is large, the practical discharge capacity is limited by the cathode performance. The cathode reaction products are not soluble in the electrolyte but deposited in the pores of the electrode (usually on the surface of carbon or catalyst) which will eventually block the diffusion paths of oxygen, and reduce the activity of catalyst, resulting in dramatically capacity reduced. Therefore, novel cathode materials with good porosity, high conductivity, large surface area, and good catalytic activity are desired.

Graphene nanosheets (GNSs) have attracted great attention for energy storage applications, such as fuel cells, biosensors, supercapacitors, due to their unique physical and chemical properties. It is reported that chemical doping with nitrogen atoms to GNSs can modify the electronic property, provide more active sites, and enhance the interaction between carbon structure and other molecules, thus improves the performance in various applications.

In this presentation, we will report nitrogen-, sulphur-doped GNSs as cathode materials for lithium oxygen batteries, and the performance of the battery and the mechanism will be discussed as well.

Experimental

GNSs were synthesized by modified Hummers' method and the nitrogen- and sulphur- doped graphene were obtained by further treatment. The morphologies were examined using a SEM and a TEM. Li/oxygen cells with the synthesized samples were test by Arbin BT-2000 battery station.

Results

The nitrogen-doped samples deliver higher discharge capacities than pristine ones at various current densities (Fig 1a). In addition, the particle size of the discharge products was much smaller due to the introduction of nitrogen into the carbon framework (Fig 1c and d).

For sulphur-doped graphene, the discharge capacity of the first cycle is lower but the charge capacity is higher while it is seldom shown for pristine graphene (Fig 1b). The reason is the morphology of the products change from particle-shape to nanorods (Fig. 1e).

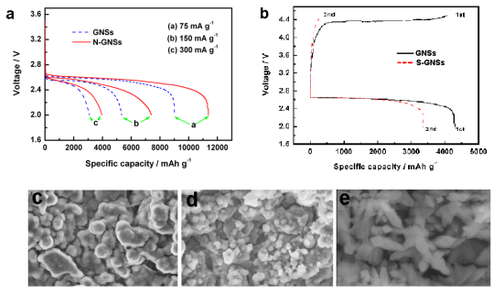

Fig. 1 (a, and b) Discharge/charge curves of pristine, nitrogen- and sulphur-doped graphene electrodes; SEM image of discharge products on pristine (c), nitrogen- (d) and sulphur-doped (e) graphene.

References

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