

Supplementary Information

Title : High Capacity Cathode Materials for Li/S Battery

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Fig. X1 shows the schematic diagram of sulfur (S) deposition into nanopores of activated carbon (AC) under the experimental condition. We prepared a saturated solution of sulfur in DMSO at 90°C. By addition of AC in the solution, the solution penetrates into nanopores of AC (Fig. X1(a)). The phenomenon is applied to adsorption of metal ion and creation of nano material into nano pore etc. [S1, S2] By cooling of the solution to room temperature, nano sulfur would be deposited into nano pore and surface of AC due to solubility difference.

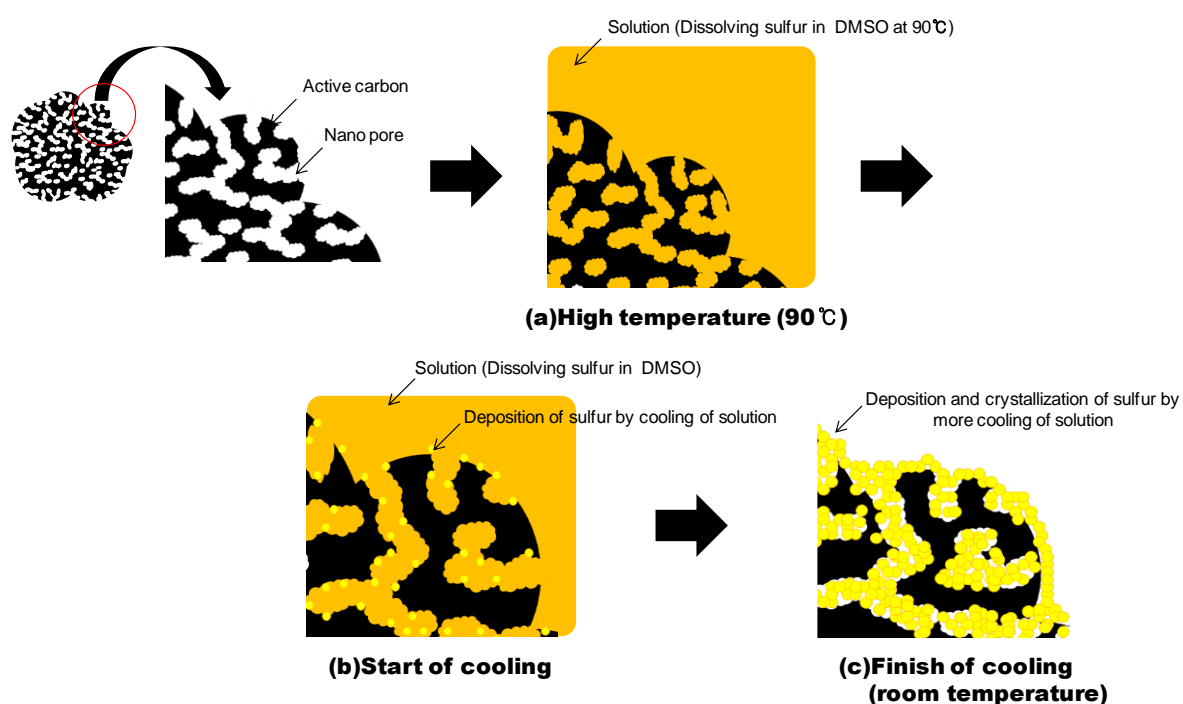


Fig. X1. The schematic diagram of sulfur deposition into nanopores of AC under the experimental condition.

Fig. X2 shows the XRD patterns of the S, AC, S-AC and S-AC with heat treatment at 300°C for 10min. All diffraction peaks of sulfur in the Fig. X2 (a) match very well with the standard of orthorhombic phase sulfur (JCPDS card No. 08-0247). The XRD diffraction peak of AC shows a broad diffraction peak in the Fig. X2 (b). The XRD pattern of the S-AC composite in the Fig. X2(c) consists of a broad diffraction peak and low diffraction peaks of crystal sulfur. For clear view of the structure of S-AC composite, sulfur of S-AC composite surface removed by heating at 300°C for 10 min. Fig. X2(d) shows the XRD patterns of the sulfur-active carbon (S-AC) composites with heat treatment at 300°C for 10min. In the S-AC composite sample with heat treatment, the XRD pattern consists of a broad diffraction peak without traces of crystal sulfur peaks.

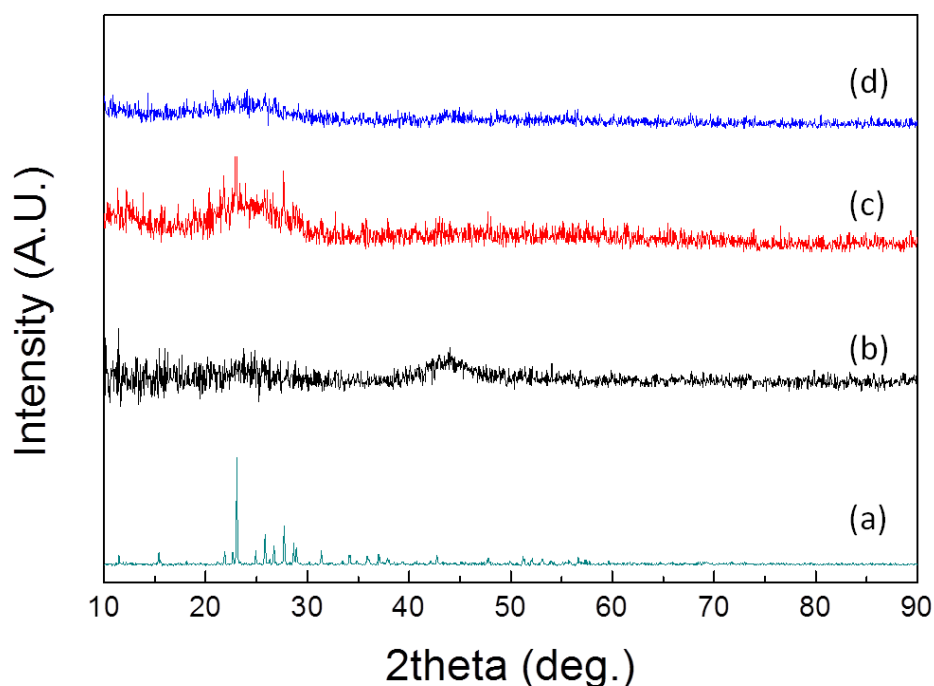


Fig. X2. XRD patterns of materials as (a) S (b) AC, (c) S-AC composite and (d) S-AC composite with heat treatment at 300°C for 10min

Fig. X3 shows the DSC curves of sulfur, S-AC composite and S-AC composite with heat treatment. The original sulfur (a) had two endothermic peaks at 109°C and 120°C which might come from the phase transition and melting of elemental sulfur. Also, the S-AC composite had one endothermic peak at 113°C which could relate the melting of elemental nano sulfur. However, we could not find out any traces of endothermic peaks in the DSC curves of S-AC composite with heat treatment at 300°C for 10min. The results are similar to XRD result (Fig X2).

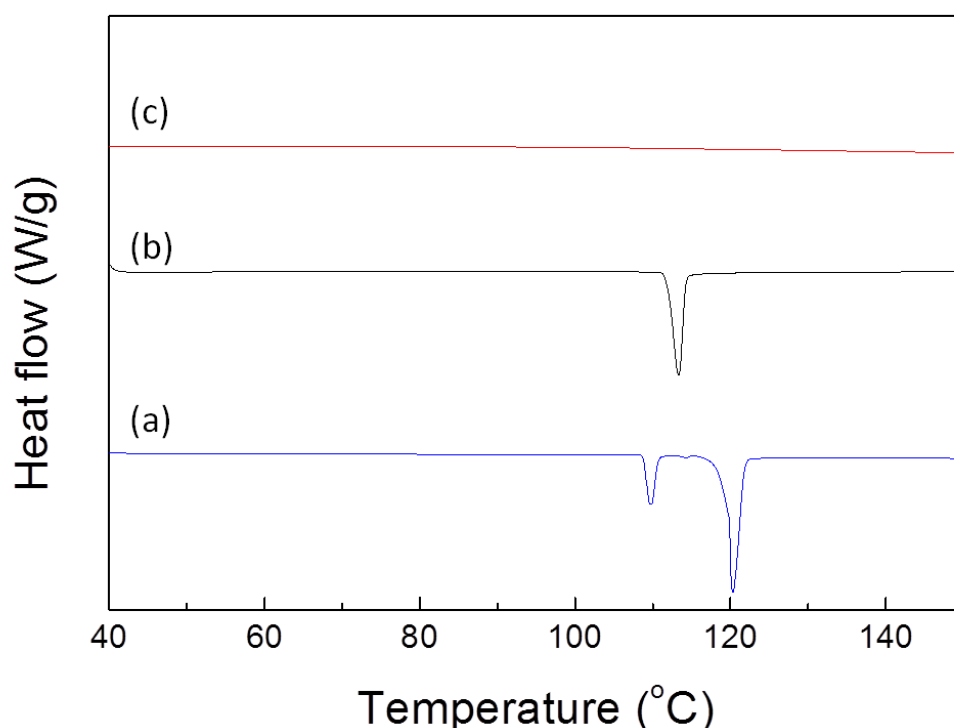


Fig. X3. DSC curves of (a) S, (b) S-AC composite and (c) S-AC composite with heat treatment at 300°C for 10min.

The content of sulfur in S-AC composites was determined by thermal gravimetric analysis (TGA). Fig. X4 shows the TGA curve of pristine (a) sulfur, (b) the S-AC composites, and (c) S-AC composite with heat treatment. Weight loss of pristine sulfur powders started over 180°C and completely decreasing all evaporation of sulfur at 317°C. However, the weight of the S-AC composite decreased from 180°C to 480°C. Above 480°C, there was no weight change. The S-AC composite contains 54.27 wt.% sulfur. For the practically content of sulfur inner AC in S-AC composite, the S-AC composite with heat treatment was analyzed by thermal gravimetric analysis (TGA). The weight of the material decreased from 250°C to 480°C. Above 480°C, there was no weight change. The S-AC composite after heat treatment contains 45.59 wt % sulfur.

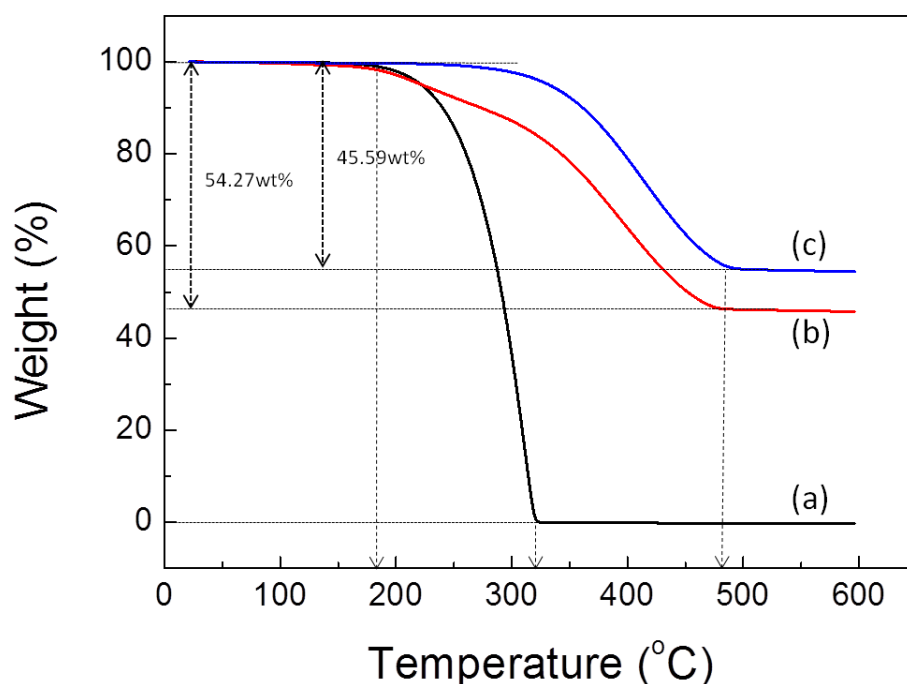


Fig. X4. TGA curves of (a) sulfur, (b) S-AC composite and (c) S-AC composite with heat treatment

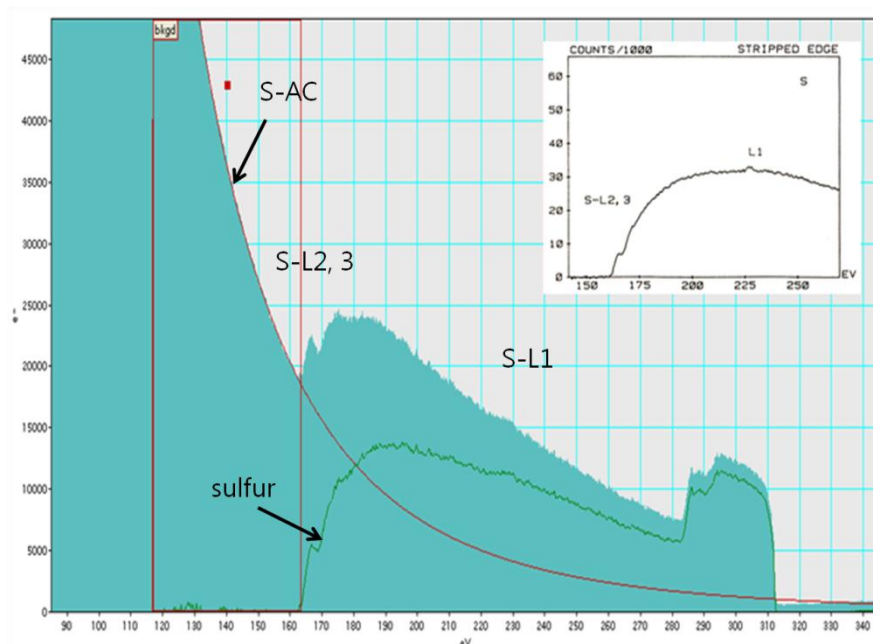


Fig. X5. EELS result of S-AC composite with heat treatment (300°C for 10min) and reference of sulfur

An electron energy loss spectroscopy (EELS) was performed in order to investigate the sulfur state inside nano pore in AC of S-AC composite with heat treatment. Figure X5 shows the EELS curves of sulfur (green line) and S-AC composite (filled green) with heat treatment. The EELS curve of the S-AC composite is similar to sulfur results with S-S bonding (peaks of S-L1, 2 and 3). From the results sulfur and S-AC composite with heat treatment, sulfur inside nano pore of AC has S-S bonding in the S-AC composite with heat treatment.

Reference

- [S1] Osamu Sawai, Yoshito Oshim, *The Journal of Supercritical Fluids*, 2008, **47(2)**, 240
- [S2] Harry Marsh, Francisco Rodríguez-Reinoso, *Activated Carbon*, 2006, 383, Elsevier