Improved lithium-sulfur batteries with a conductive coating on the separator to prevent the accumulation of inactive S-related species at the cathode-separator interface

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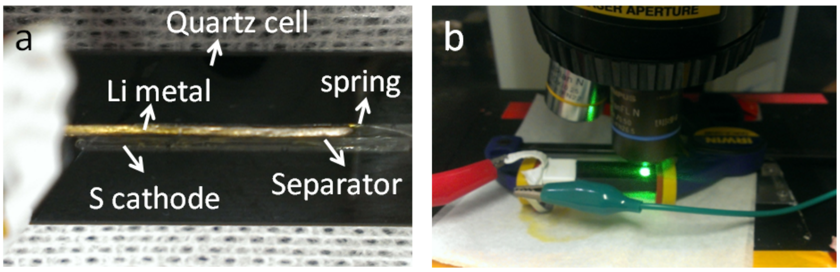

Fig.S1 (a) photograph of the cross section of Li-S battery fabricated in a quartz cell. (b) photographs of *In situ* scanning Raman setup.

Calculation of the amount of polysulfides accommodated in the separator. The thickness of the separator is 25 μm. The porosity of the separator is 50%. Thus, the empty space in one piece of the 1 cm^2 separator is: $25\ \mu m * 1cm^2 * 0.5 = 1.25\ \mu l$. The highest dissolution concentration of Li_2S_8 in electrolyte (1:1, DOL:DME) is ~8 M (the molar concentration was calculated based on sulfur). If the polysulfide (Li_2S_8) diffused into the electrolyte during discharging is 5 M, then the amount of polysulfide accommodated in the separator is: $1.25\ \mu l * 5\ mol/L * 32\ g/\text{mol} = 0.2$ mg.

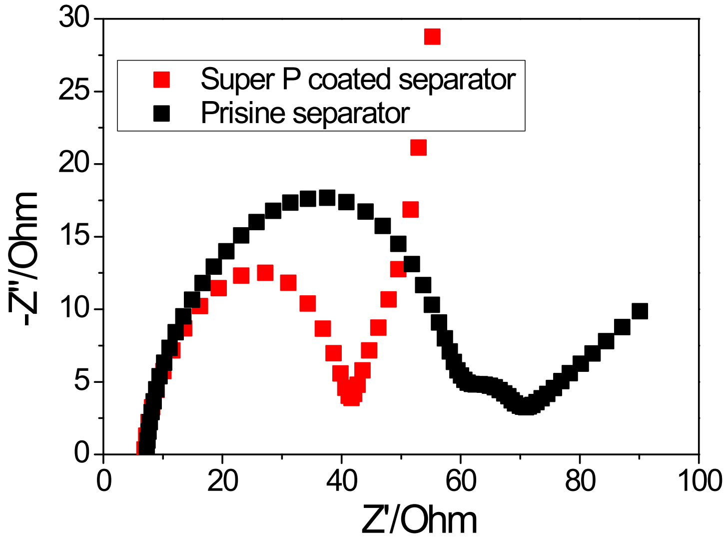

Fig.S2 Electrochemical impedance spectroscopy plots of Li–S cells with pristine separator (50 wt.% cathode) and super P coated separator (60 wt.% cathode), respectively.

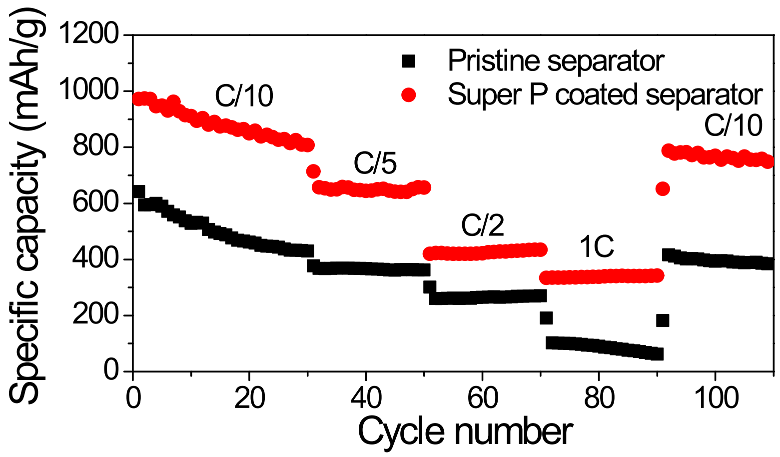

Fig.S3 Rate capability of Li-S cells with pristine separator (50 wt.% cathode) and super P modified separator (60 wt.% cathode), respectively.

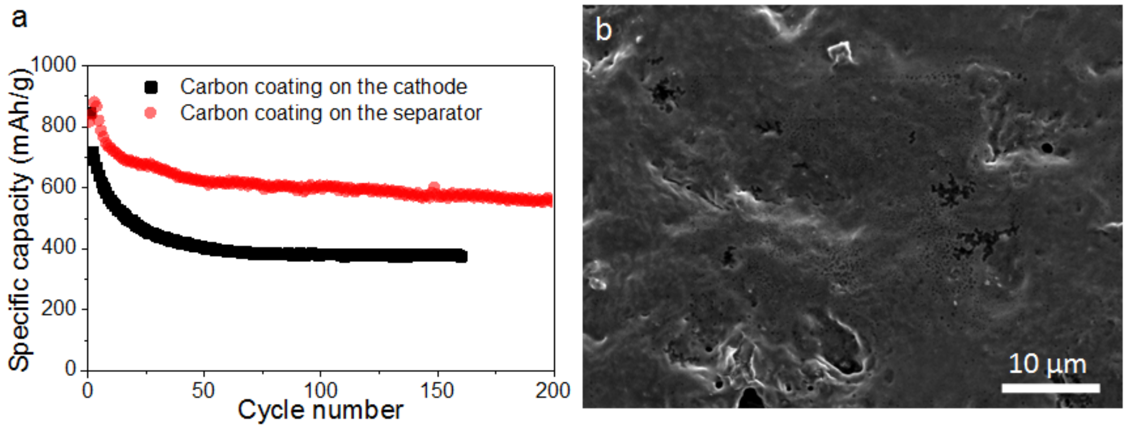

Fig.S4 (a) cycling performance of 70 wt.% sulfur cathode with super P carbon coating on the separator and the cathode, respectively. C/10. (b) SEM image of the surface of super P carbon coating on the cathode at the discharge status (1.7V) after 50 cycles.

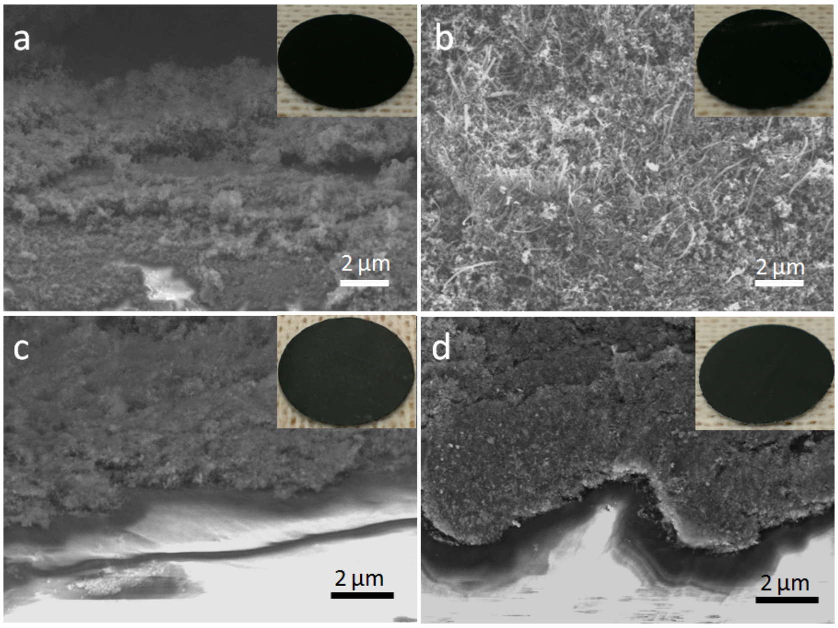

Fig.S5 (a-d) SEM images of ketjen black carbon coated separator, multi wall carbon nanotube coated separator, TiO_2 nanoparticles-super P coated separator, and Al_2O_3 nanoparticles-super P coated separator, respectively. Insets are corresponding photos, respectively.

Table S1. The summary of sheet resistance of different coating layers on the surface of the separator.

Coating materials	Multi-wall CNTs	Ketjenblack carbon	Super P carbon	Al_2O_3 NPs Super P	TiO_2 NPs Super P
Sheet resistance (Ω/□)	472±86	514±92	1065±104	2780±157	2375±143