Supporting information

Development of the γ-polyglutamic acid binder for cathodes with high mass fraction of sulfur

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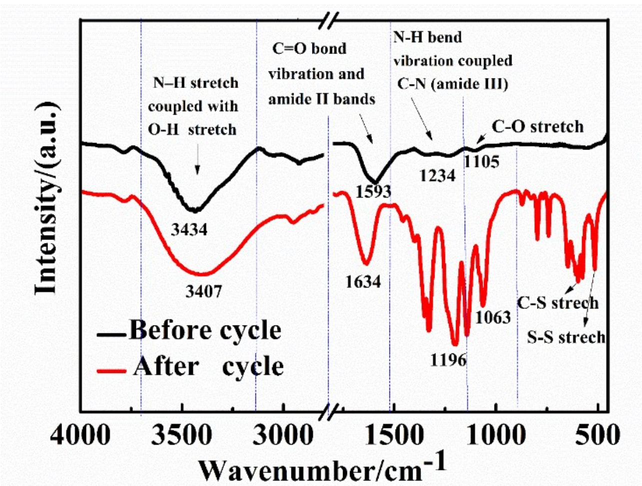

Fig.S1. FTIR of the PGA-70S cathode before cycle and after cycle.

The PGA-70S cathode after cycle was obtained through cycling the PGA-70S cathode for several times and stopping it at the upper discharge flat where high-order lithium polysulfides generated. For the PGA-70S cathode after cycle, the emergence of C−S bond at ≈600 cm^{-1} suggested that the PGA could be capable of forming chemical bonds with polysulfides.

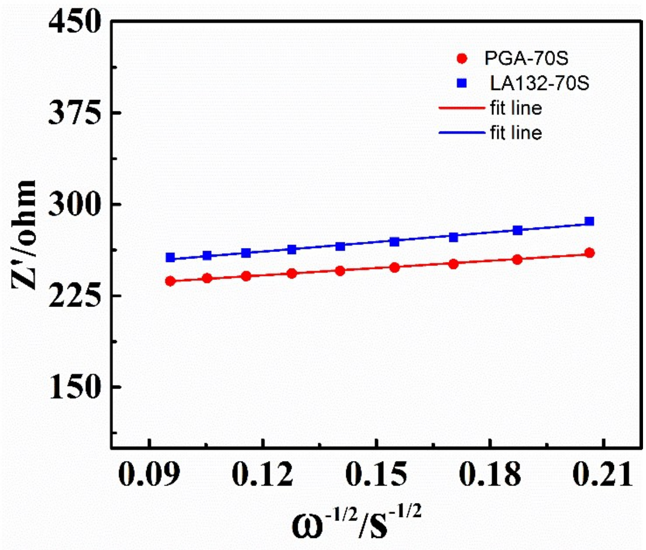

Fig. S2 The relationship between Zre and $\omega^{-1/2}$ at low frequencies for PGA-70S cathode and LA132-70 cathode before cycle.

The lithium diffusion coefficient was calculated by using the following equations:

$$Z_{re} = R_{ct} + R_s + \sigma\omega^{-1/2} \qquad (1)$$

where Re is the resistance of the electrolyte, Rct is the charge transfer resistance and ω is the angular frequency in the low frequency region and the σ is the Warburg factor, which can be obtained from the slopes of lines in Figure S 2.

$$D_{\mathrm{Li}} = \frac{R^2T^2}{2A^2n^4F^4C_{\mathrm{Li}}^2\sigma^2} \qquad (2)$$

where D_{Li} is the diffusion coefficient, R is the gas constant, T means the temperature, A is area of the electrode, n is the number of electrons involved, F is the Faraday constant, C_{Li} is the concentration of lithium ion in electrolyte.

Therefore, for the PGA-70S cathode and LA132 cathode

$D_{PGA-Li} : D_{LA132-Li} = \sigma_{LA}^{2}/\sigma_{PGA}^{2}$ (3)

where D_{PGA-Li} and $D_{LA132-Li}$ is the diffusion coefficient of PGA-70 cathode and LA132-70 cathode, and is the Warburg factor of PGA-70 cathode and LA132-70 cathode.

Thus: $D_{PGA-Li} : D_{LA132-Li} = 1.7$

As confirmed by the diffusion coefficient, the PGA-70S cathode showed higher lithium ion conductivity. [1, 2]

References

1. H. Wang, V. Sencadas, G. Gao, H. Gao, A. Du, H. Liu and Z. Guo, *Nano Energy*, 2016, **26**, 722–728.
2. Y. Cui, X. Zhao and R. Guo, *Electrochimica Acta*, 2010, **55**, 922-926.