Supporting information

Development of the $\gamma$-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 $\approx 600 \text{ cm}^{-1}$ suggested that the PGA could be capable of forming chemical bonds with polysulfides.

![Graph](image)

**Fig. S2** The relationship between $Z_{re}$ 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:

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

where $R_{re}$ is the resistance of the electrolyte, $R_{ct}$ is the charge transfer resistance and $\omega$ is the angular frequency in the low frequency region and the $\sigma$ is the Warburg factor, which can be obtained from the slopes of lines in Figure S 2.

$$ D_{Li} = \frac{R^2 T^2}{2 A^2 n^4 F^4 C_{Li}^2 \sigma^2} $$  \hspace{1cm} (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
\[ \frac{D_{\text{PGA-Li}}}{D_{\text{LA132-Li}}} = \frac{\sigma_{\text{LA}}^2}{\sigma_{\text{PGA}}^2} \]  

(3)

where \( D_{\text{PGA-Li}} \) and \( D_{\text{LA132-Li}} \) 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: \( \frac{D_{\text{PGA-Li}}}{D_{\text{LA132-Li}}} = 1.7 \)

As confirmed by the diffusion coefficient, the PGA-70S cathode showed higher lithium ion conductivity.\(^1,2\)

References