# An Effective Method for Confining Polysulfide by Using Polyimide Separator together with Ionic Liquid-based Electrolytes in Lithium-Sulfur Battery

Yanqing Wang[a, b], Yongcheng Jin[a, *]

a *CAS Key Laboratory of Biobased Materials, Qingdao Institute of Bioenergy and Bioprocess Technology, Chinese Academy of Sciences, Qingdao 266101, P. R. China.*

*b University of Chinese Academy of Sciences, 19A Yuquanlu Road, Beijing 100049, P. R. China.*

E-mail: jinyc@qibebt.ac.cn

In this research, we demonstrate a new method for reducing the shuttle effect by confining polysulfide in separator area through the use of polyimide (PI) separator with reversible adsorption functions in lithium-sulfur batteries. As a comparison, the cells with polypropylene (PP) separators which have no function to adsorb dissoluble polysulfide show a result that the content of sulfur on lithium anode surface is increased up to 63.94% after 100th cycles with the content of N-methyl-N-butylpiperidinium bis-(trifluoromethylsulfonyl) imide ($PP_{14}TFSI$) in the mixture electrolyte increasing. This result illustrates that the migration and reaction between dissolved polysulfide in $PP_{14}TFSI$ and lithium cannot be neglected although the solubility of polysulfide is slight in $PP_{14}TFSI$ solvent. However, when PI separators are introduced, besides improving the wettability with $PP_{14}TFSI$-based electrolytes, experimental results also show that the PI separator has a reversible adsorption function to dissoluble polysulfide which is used to confining polysulfide in separator area to a certain extent due to the abundant nitrogen-, oxygen-containing functional groups in PI skeleton. What's more, PI separator can decreases the sulfur content on lithium surface after cycling to 17.92% which decreases greatly than that with PP separator and improves its electrochemical performance.

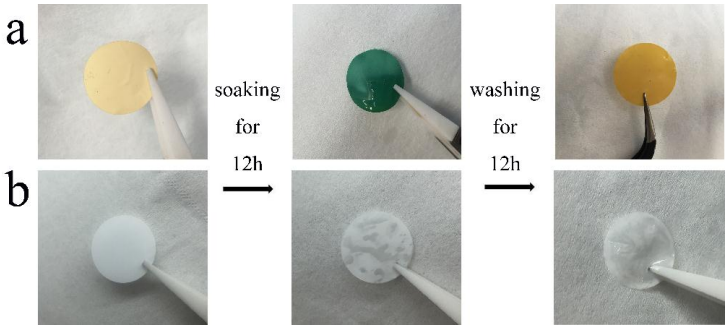


Figure 1. The color change of (a) PP and (b) PI after soaking in solution containing polysulfide for 12h and washing in solution without polysulfide for 12h.

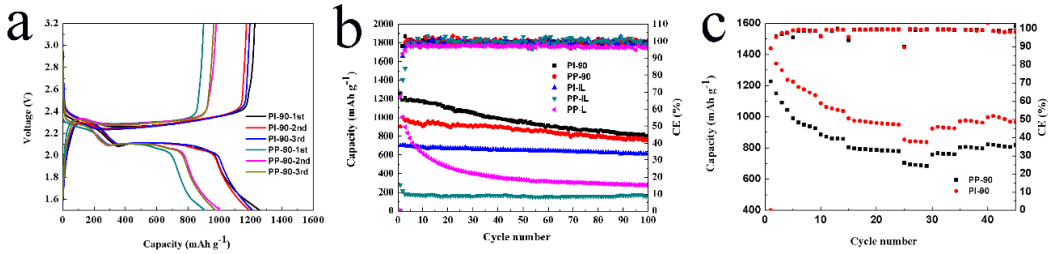


Figure 2. Charge-discharge voltage curves of the 1st, 2nd, 3rd cycles with (a) PI-90 and PP-90,. (b) Cycle performance with PI-90, PP-90, PI-IL, PP-IL and PP-L at 0.1 C. (c) Rate performance with PI-90, PP-90 at a current rate of 0.1 C, 0.5C, 1C, 2C, 5C at 60 ℃.

**References:**

[1] L. Wang, J. Liu, S. Yuan, Y. Wang, Y. Xia, Energ. Environ. Sci., 9 (2016) 224-231.

[2] H. Munakata, D. Yamamoto, K. Kanamura, J. Power Sources, 178 (2008) 596-602.

[3] Y. Maeyoshi, S. Miyamoto, H. Munakata, K. Kanamura, J. Power Sources, 350 (2017) 103-108.