Colloquium on Polymer Science and Molecular Engineering Zhejiang University and the University of Chicago
12-16 April 2017

Fast assemble of polyphenol derived coatings on polypropylene separator for high performance lithium-ion batteries

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Abstract: **Improving the wettability of liquid electrolyte to polyolefin separators plays a significant role in the fabrication of high performance lithium-ion batteries. Herein, we report a facile surface coating method to enhance the wetting capacity of commercially available polypropylene (PP) separator. Natural polyphenol tannic acid (TA) and sodium periodate were chosen as the coating precursor and inorganic trigger, respectively. After being modified, wettability of the separator can be significantly enhanced without damaging its original advantage properties, which accordingly resulted in higher electrolyte uptake and better interfacial compatibility. Furthermore, the $LiCoO_2$/graphite full cells assembled with the modified separator displayed an excellent cycle stability with coulombic efficiency exceeding 99.9% and superior rate performance.**

Introduction

Polyolefin-based microporous separators, such as PP and PE, are the dominant products in current LIBs market, thanks to their low cost, excellent mechanical strength, high electrochemical stability, appropriate microporous structure, and smart thermal shutdown properties. However, the lack of polar groups leads to low surface energy and endows the separators with highly hydrophobic surface. Consequently, these inert substrates exhibit poor compatibility with the commonly used electrolyte solvents such as ethylene carbonate and ethylmethyl carbonate, thus hampers the absorption and diffusion of the liquid electrolyte within the porous polymeric membrane and ultimately results in a reduced cell performance. To address this problem, a number of surface modification approaches have been reported to improve the wettability of commercial polyolefin membrane separators..However, the rapid oxidization of nature polyphenol with sodium periodate to generate the corresponding coatings has not been reported.

Resluts and discussion

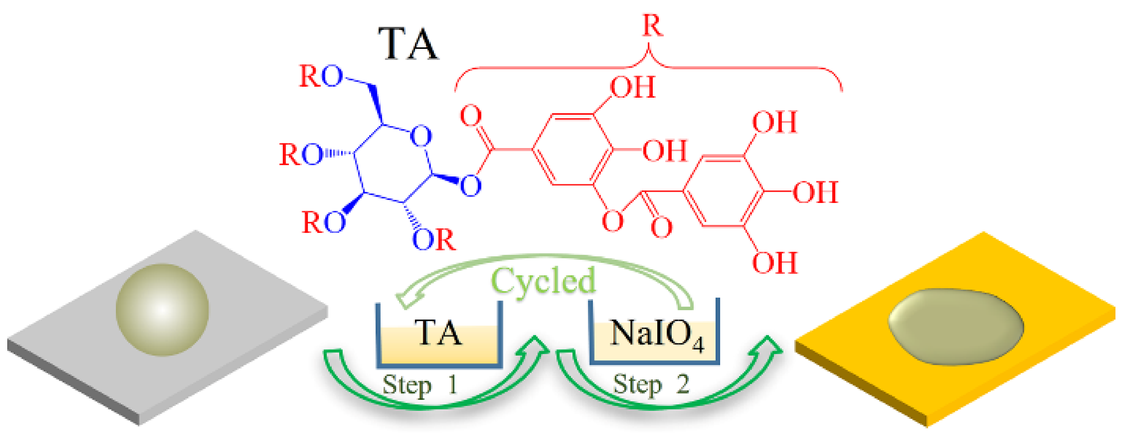

Fig. 1. Schematic illustration of the coating process and the chemical structure of TA.

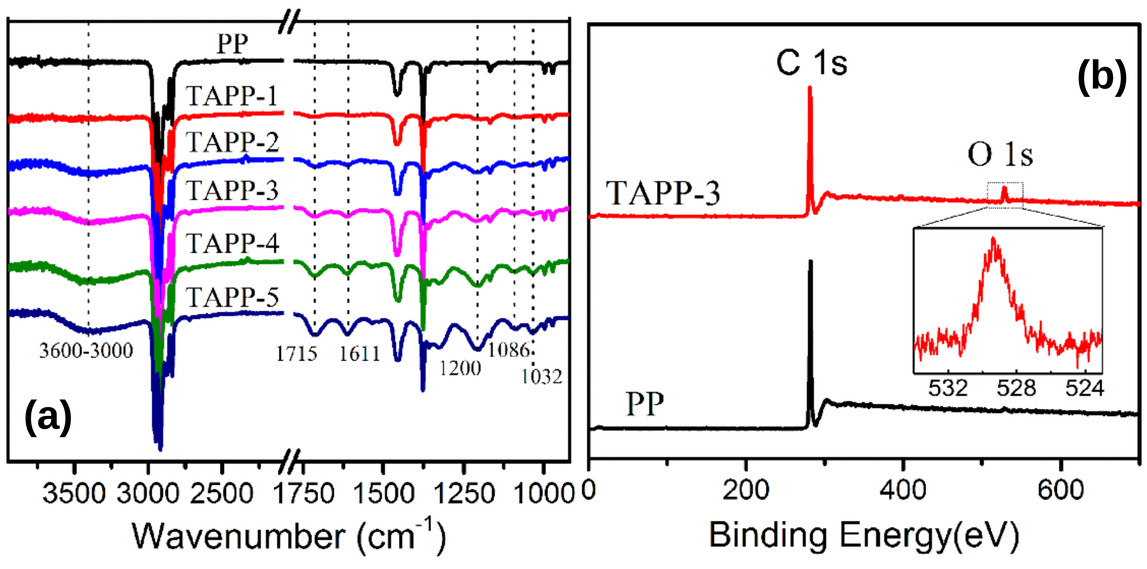

Fig.2. (a) ATR-FTIR spectra of PP separators with different number of coating cycles. (b) XPS spectra of the bare PP and TAPP-3 separators. The inset shows the high-resolution XPS O1s spectrum of the TAPP-3 separator.

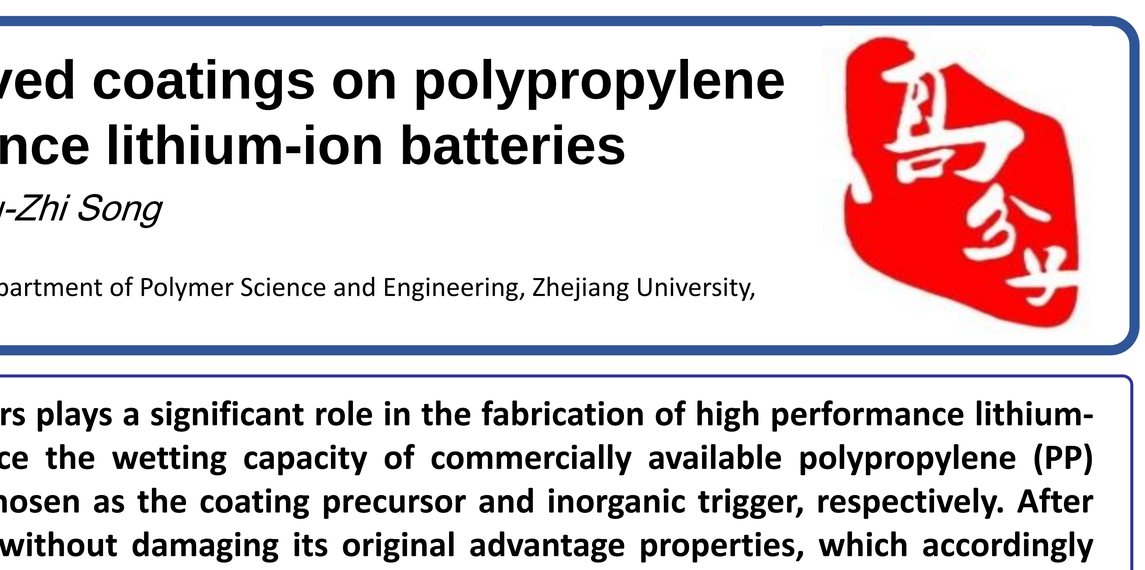

Fig. 3. SEM images of the bare and modified PP separators with different number of coating cycles.

Fig. 4. (a) The influence of coating cycles on the water contact angle of the separators. The inset is a digital image (taken within 30s) for the PP and TAPP-3 separators each with a drop of liquid electrolyte (10 μL). (b) Nyquist plots of the Li/separator/Li cells with the bare and modified separators.

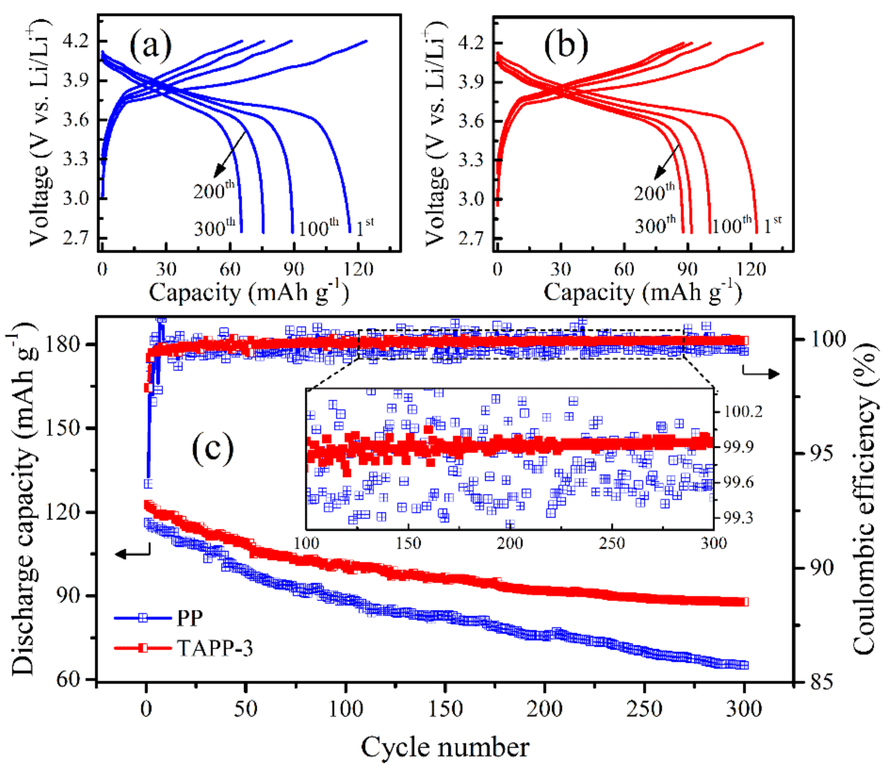

Fig. 5. Capacity of the 1st, 100th, 200th, and 300th charge/discharge cycle for the cells assembled with (a) the bare PP separator and (b) TAPP-3 separator. (c) Cycle performance and coulombic efficiency of the cells with different separators. The cells were tested with the rate of 1C/1C.

Conclusions

In summary, a nature polyphenol derived coatings were facilely assembled on the PP separator triggered by sodium periodate. The wettability of the as-prepared separators were optimized via simply repeating the coating steps without sacrificing its original pore structures. Compared with the bare PP separator with poor wetting capacity, the modified separator exhibited better wettability, higher electrolyte uptake, and better interfacial compatibility. This approach is expected to be also effective in the case of other substrates for various applications.

Acknowledgement

The 863 Program of China (2012AA03A602), the 973 Program of China (2009CB623402), the Nature Science Foundation Committee of China (20974094) and Zhejiang Provincial Collaborative Innovation Center Program 2011 (G1504126001900).

References

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