Tannic acid/Fe (III) coated polypropylene separator for high-performance lithium-ion battery

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Introduction

Here, we demonstrate a fast and effective method to fabricate chemically active separator with improved hydrophilicity, using tannic acid (TA) and Fe (III) as organic ligand and inorganic cross-linker, respectively. The simple TA/Fe coating process improves a variety of critical properties of separators such as the electrolyte wetting, the electrolyte uptake, and the ionic conductivity, which could be directly linked to LIB performance, particularly the power performance. These improved properties are very meaningful because the treatment is fully compatible with the most widely adapted PP separators without sacrificing their original advantageous properties. Finally, we expect that this tannin-inspired treatment is quite versatile and thus is immediately applicable to other separators with similar surface property issues.

Method

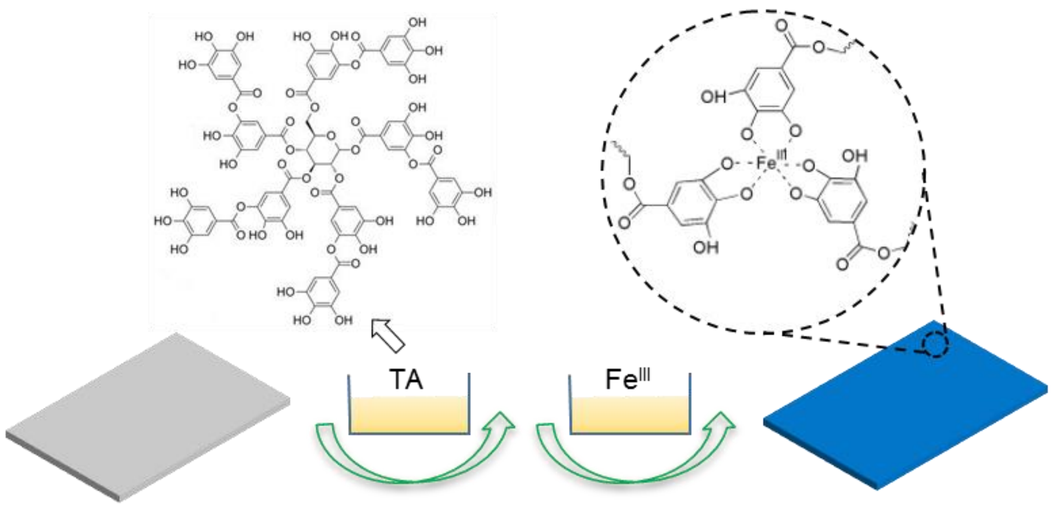

Figure 1. Schematic description of the preparation of the TA/Fe modified PP separator.

Results and Discussions

1. Chemical composition and surface morphology

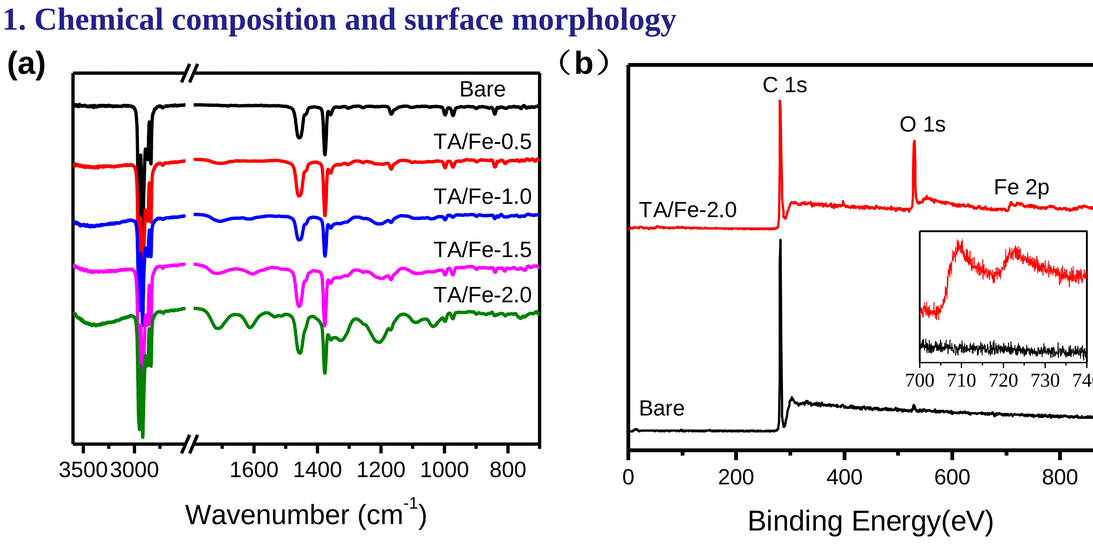

Figure 2. Spectra of (a) ATR-IR and (b) XPS for the bare and TA/Fe coated separators.

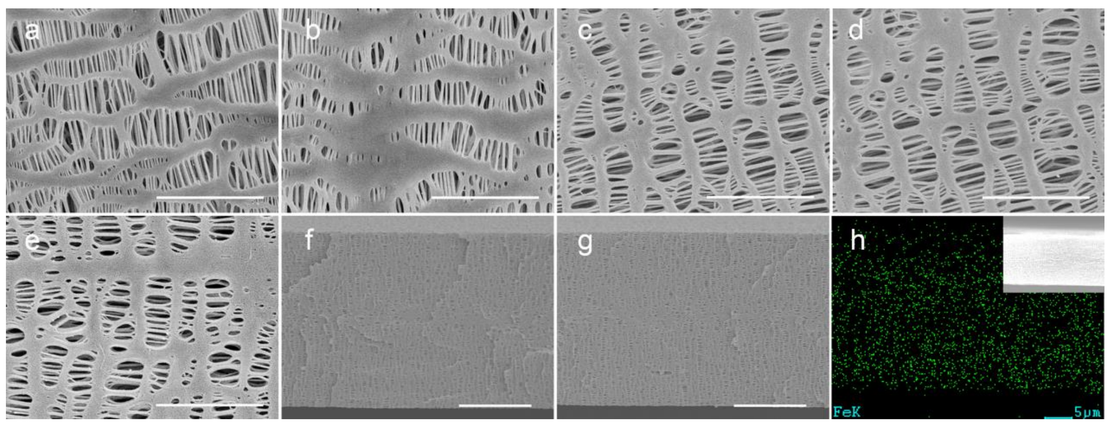

Figure 3. SEM images for (a-e) the surfaces of the bare and TA/Fe modified separators with the TA concentrations of 0.5 mg/ml, 1.0 mg/ml, 1.5 mg/ml and 2.0 mg/ml, respectively, and (f-g) cross section of the bare and TA/Fe-2.0 separators. (h) EDX mapping of the Fe element on the cross section of TA/Fe-2.0 separator.

2. Electrolyte wettability and uptake

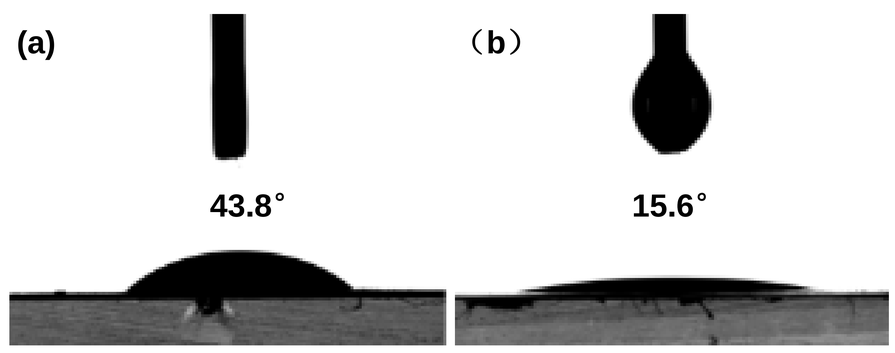

Figure 4. Liquid electrolyte contact angles for (a) the bare and (b) TA/Fe-2.0 separators.

3. Electrochemical properties

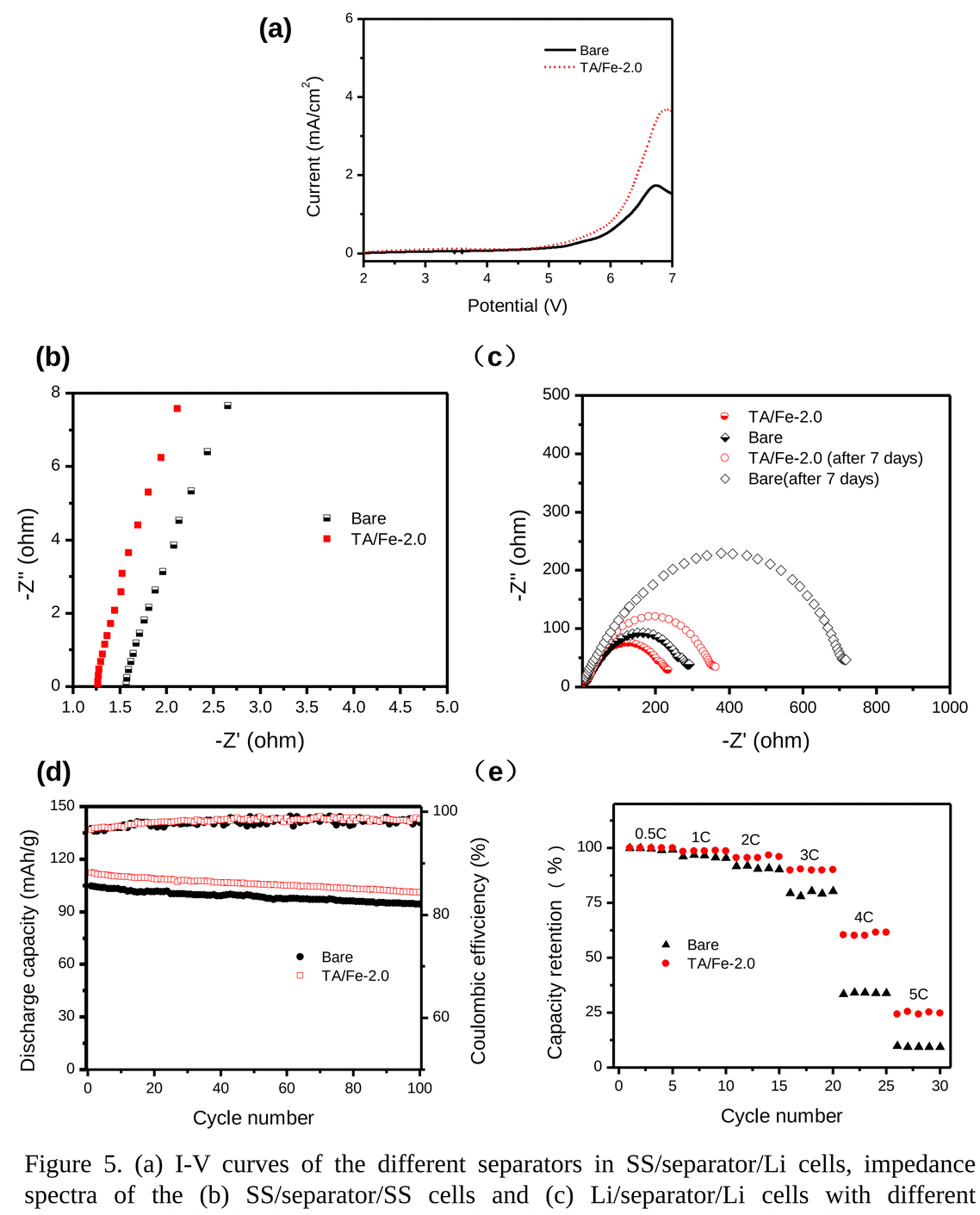

Figure 5. (a) I-V curves of the different separators in SS/separator/Li cells, impedance spectra of the (b) SS/separator/SS cells and (c) Li/separator/Li cells with different separators, (d) the discharge capacities and coulombic efficiencies of the cells as function of cycle number at 0.5 C and (e) rate capacities of the cells.

Conclusion

In summary, we demonstrated that the simple TA/Fe coatings make the surface of PP separators more hydrophilic, which then increases the liquid electrolyte wettaility and ionic conductivity of the separators. The coin cells assembled with the TA/Fe coated separator exhibit improved cycle performnace and rate capability.

References

1. Advanced materials, 2011, 23(27): 3066-70.