Facile introduction of polyether chains onto polypropylene separators and its application in lithium ion batteries

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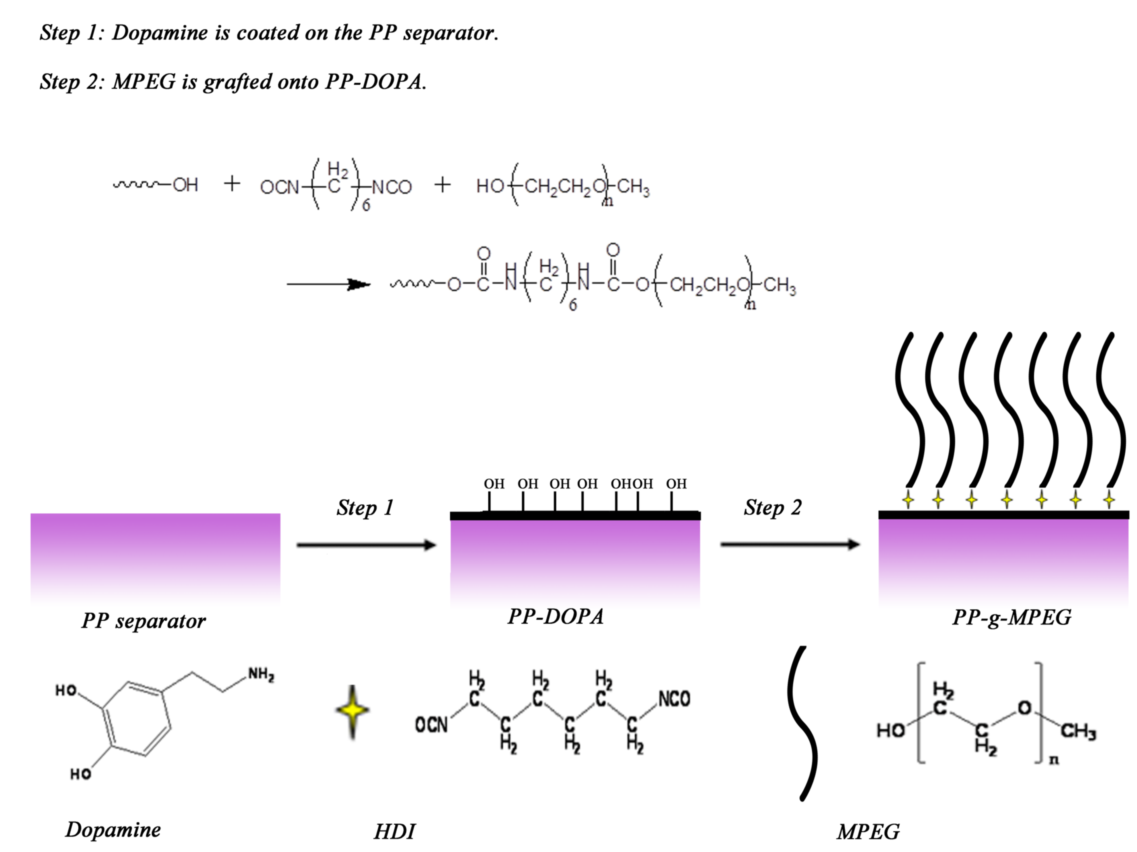
Introduction

Polypropylene (PP) is one of the most dominant materials used for separators in lithium ion batteries for its low price, chemical resistance and thermal stability, etc. However, the major drawbacks of this kind separator lie in its intrinsically low polarity and low surface energy, which would result in poor compatibility between separators with liquid electrolyte and electrodes in the batteries. To this point, modification of PP separators is of great importance for the preparation of high performance LIBs.

In this work, we propose a facile approach to introduce PEG chains onto the surfaces of PP separators via covalent bonds basing on mussel-inspired dopamine coating.

Experimental



Results and Discussion

1. Preparation of the modified separators

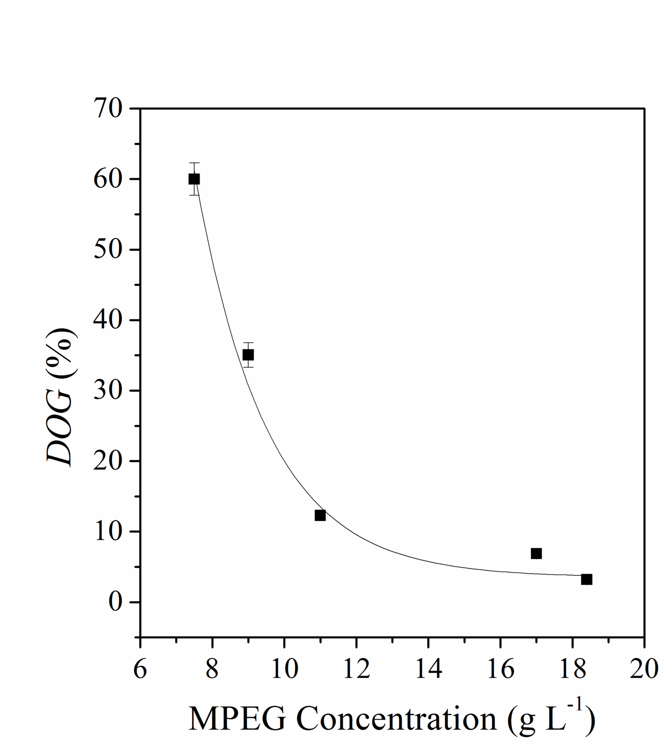


Fig. 1. The *DOG* at different MPEG concentrations with the same HDI concentration.

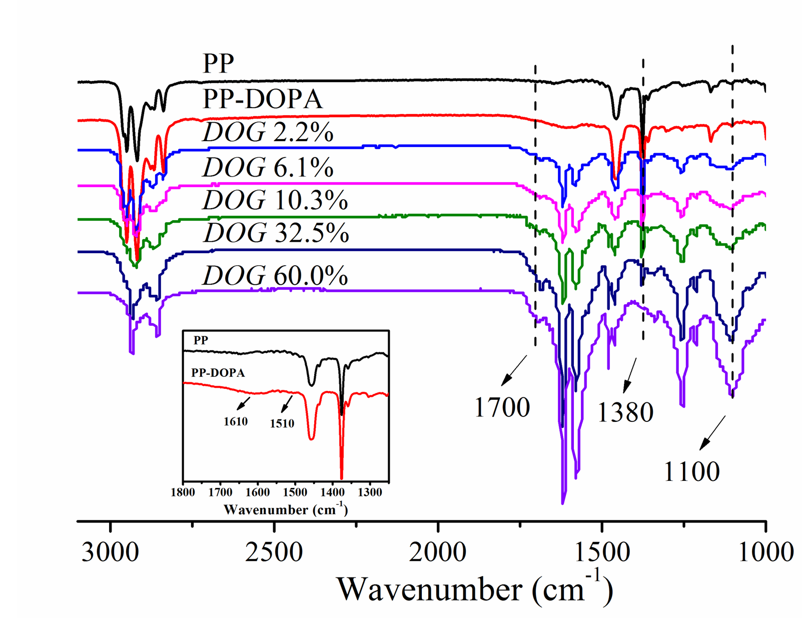


Fig. 2. ATR-FTIR spectra of PP, PP-DOPA and PP-*g*-MPEG based on *DOG*.

2. Morphology of membranes

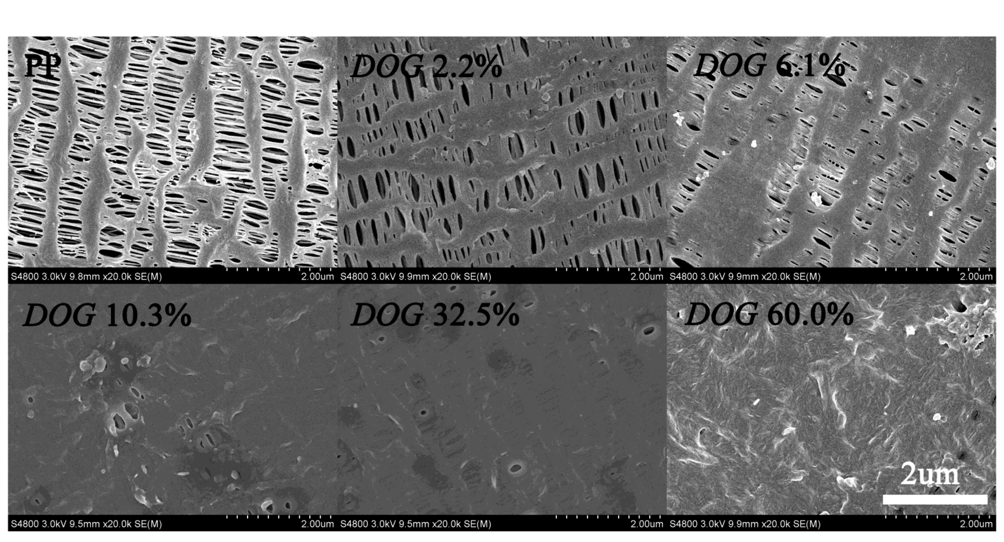


Fig. 3. Surface morphologies of PP separator and PP-*g*-MPEG with different *DOG*.

Table 1 Surface porosity of PP separator and PP-*g*-MPEG with different *DOG*

Separator ID	PP	DOG 2.2%	DOG 6.1%	DOG 10.3%	DOG 32.5%	DOG 60.0%
Surface porosity (%)*	16.3±0.8	9.3±0.4	3.5±0.7	<1.0	<1.0	<1.0

* Calculated by Image-Pro Plus 5.0.

The pores on separator surface are **gradually covered** by PEG chains with increasing *DOG*.

3. Pore structure of the separators

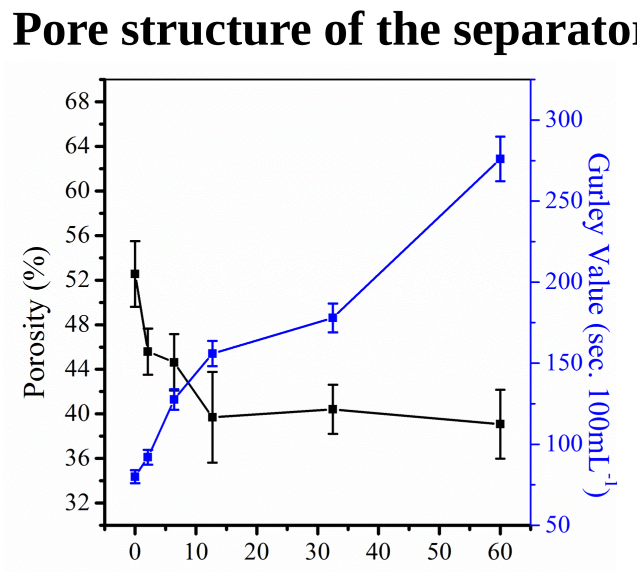


Fig. 4. The porosity and Gurley value of the separators with different *DOG*.

4. The wettability and liquid electrolyte uptake of the separators

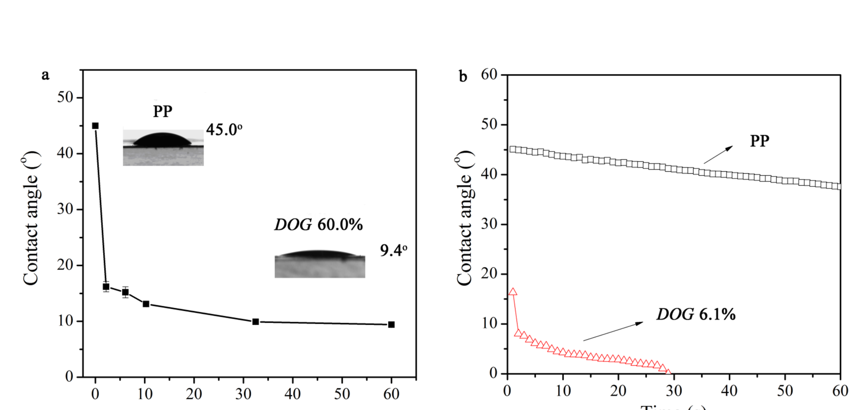


Fig. 5. The static (a) and time dependent (b) LECA on PP separators and PP-*g*-MPEG separators.

5. The electrochemical performances of separators for LIBs

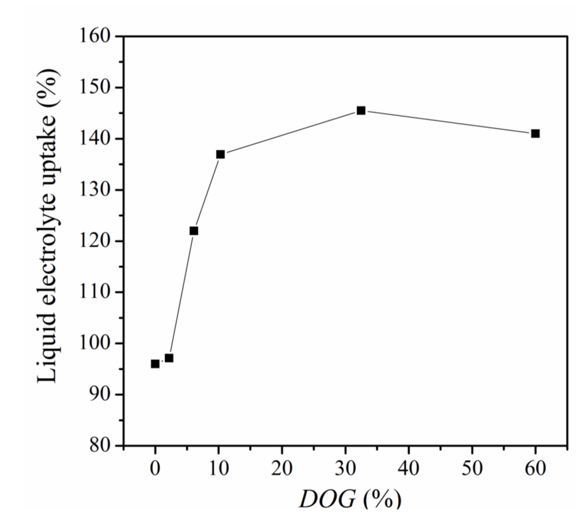


Fig. 6. Liquid electrolyte uptake changes with *DOG*.

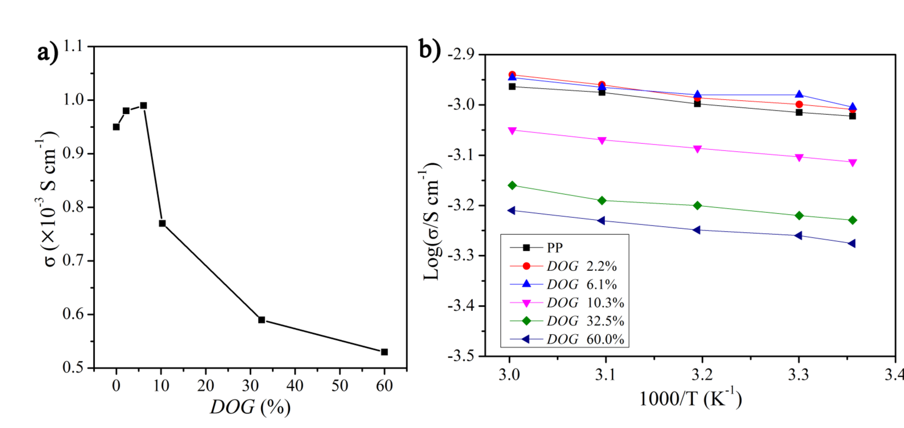


Fig. 7. a) Ionic conductivity at 25 °C with different *DOG*, b) Relationship between ionic conductivity and temperature.

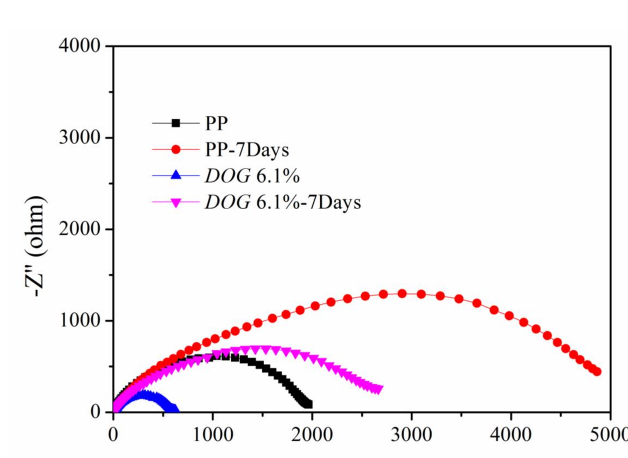


Fig. 8. Interface resistance of the test cells before and after stored 7 days.

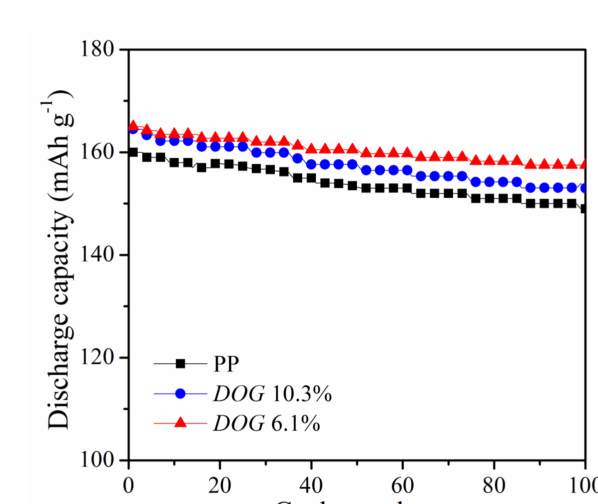


Fig. 9. The discharge capacities of the cells assembled with virgin PP separator and PP-*g*-MPEG (*DOG*: 6.1%, *DOG*: 10.3%) as a function of the cycle number.

Conclusion

Polyether chains, such as PEG chains, were successfully grafted onto PP separators based on mussel-inspired dopamine coating. The introduction of PEG chains onto the surface of PP separators enhanced the compatibility between the separator and liquid electrolyte, as well as the electrodes.

Acknowledgements

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References

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