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An ultrathin inorganic-organic hybrid layer on commercial polymer separators for advanced lithium-ion batteries

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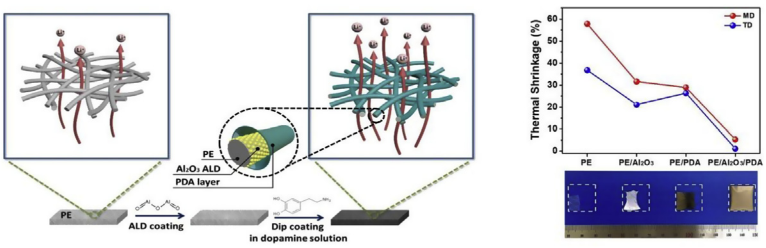
HIGHLIGHTS

- An ultrathin inorganic-organic hybrid separator is designed.
- Dual coating strategy enhances the thermal stability of battery separators.
- Enhanced electrolyte uptake induced superior electrochemical performances.

GRAPHICAL ABSTRACT



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ABSTRACT

As the secondary battery market expands to the electric vehicle and renewable energy fields and in particular as demand for high capacity and high safety lithium-ion batteries continues to grow, the function of the separator is becoming more important than ever. In this report, we propose an inorganic-organic hybrid coating strategy that enhances the thermal and dimensional stability of polymer battery separators without increasing the overall separator thickness. Ultrathin coating layers prepared using a combination of atomic layer deposition and polydopamine treatment cover fibrils of a porous polyethylene separator more uniformly and endow polyethylene separators with superior thermal properties compared to those coated with only one layer, which is linked to the safety of battery cells. In addition, dual coating enhances the electrolyte uptake and wettability of a conventional polyethylene separator, which ensures improved power capability and stable cycle performance. The dual coating strategy via organic/inorganic hybridization is an easy and effective way to overcome the inherent disadvantages of conventional polyethylene separators and can be a practical approach to safer and higher capacity batteries.

1. Introduction

The demand for lithium-ion batteries (LIBs) with higher energy densities and prolonged cyclability is rapidly increasing as their applications extend beyond mobile IT devices to electric vehicles (EVs) and energy storage systems (ESSs) [1–5]. In particular, the next generation of batteries requires higher safety and energy density; thus, the polymer separator, one of the most important components of LIBs, must be redesigned to meet these new higher-level requirements of advanced LIBs [6,7]. The separator in an LIB acts as an ion transport pathway between the cathode and anode, which prevents internal short-circuit by blocking the physical contact between the two electrodes and therefore prevents the batteries from exploding or catching fire. Hence, for commercialization, separators should have a porous structure, thermal stability and mechanical strength above a certain level [8,9]. Consequently, the current separators in commercial use are mostly based on

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