

Novel Microporous Gelling Separator Membrane for Lithium Ion Polymer Battery

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A rechargeable battery with higher energy density is necessary for compact portable electronics. The lithium polymer battery is highlighted due to its thin, light, and safe characteristics. The difference between the conventional lithium ion battery and polymer one lies in whether it uses the polymer material as a part of electrolyte system. A polymer battery utilizes polymer as either an ion-conducting medium by itself or at least a matrix to immobilize the liquid electrolyte. It improves the safety and dimensional stability over long time and temperature range by reducing the vapor pressure of reactive liquid system. There have been several suggestions on the polymer separators for lithium polymer battery [1,2,3,4], such as gel polymer coated on polyolefin separators. However, problems, such as increase in the interfacial resistance between separator and electrodes due to delamination or dissolution of the polymer layer after swelling by the liquid electrolyte, should be resolved to make good battery application [2].

We have developed a novel polymer separator membrane that has functionally-graded layered structure. Each layer is assigned to fulfill its own functions such as to give mechanical strength or to enable separator adhere to electrode surface as well as to retain liquid electrolyte. The attractiveness of this approach lies in the fact that it is possible to have the system composed of as many functional layers as needed in a body. Different from the conventional polymer coated membrane, this system has no distinct interface between the layers, as shown in Figure 1. The preparation of microporous gelling membrane is composed of following procedures: (1) the gelling polymer is coated on the nonporous polyolefin film; (2) the film is stretched in the machine direction at room temperature; (3) the film is stretched in the machine direction at increased temperature; (4) under stretched state, the film is annealed for certain period of time.

The increased affinity between the layers is expected to prevent the increase in the interfacial resistance between the gelling polymer layer and the electrode by maintaining the membrane structure after swelling with the liquid electrolyte. Furthermore, one can create the micropores in the gelling polymer layer by choosing the material having a crystalline phase in its structure and the melting temperature similar to that of polyolefin layer (Figure 2). The created micropores may facilitate the ionic transport by providing the convective passage in a liquid electrolyte. Another advantage to have micropores in the membrane lies in the shortened gellation time of polymer matrix with liquid electrolyte in the battery manufacturing process.

The novel microporous gelling membrane is used for the assembly of the lithium ion polymer battery of LG Chemical Ltd. The structure of the battery is disclosed elsewhere [5]. As shown in Figure 3, the battery has excellent discharge performance with retaining over 95% of the cell capacity by discharging at 2 C rate. The test results of cell performance will be further discussed.

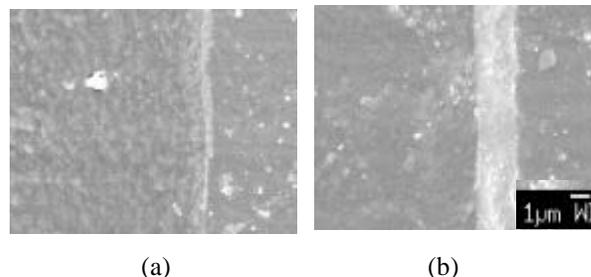


Figure 1. Cross-sectional morphology of (a) novel microporous gelling membrane and (b) conventional polymer coated separator

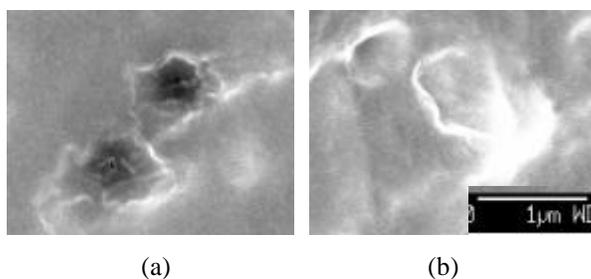


Figure 2. Surface morphology of (a) novel microporous gelling membrane and (b) conventional polymer coated separator

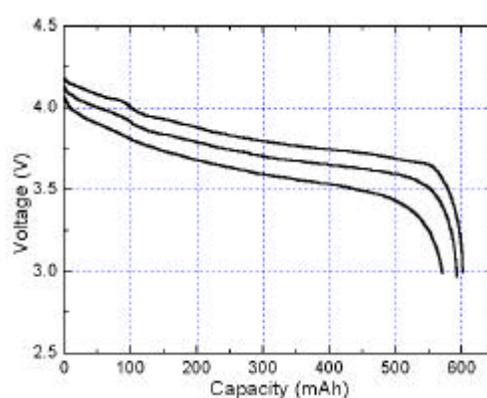


Figure 3. Performance of LG Lithium ion polymer battery made with the novel Microporous Gelling Membrane: the discharged capacity by C-rate of 0.2C, 1C, and 2C.

REFERENCE

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- [4] US Patent 5631103
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