Safety-Enhanced Lithium-Ion Batteries Emplyoing a Thermally Stable Cross-linked Composite Separator

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Lithium-ion batteries are rapidly becoming the preferred choice for powering portable electronic devices, electric vehicles and energy storage systems. In these batteries, the separator is an essential component that prevents electronic contact between the positive and negative electrodes while allowing ionic transport. Polyolefin separators currently used in commercialized lithium-ion batteries have some drawbacks. Their low porosity and poor wettability lead to increases in cell resistance [1]. In addition, they suffer from significant thermal shrinkage at elevated temperatures, which has raised serious safety concerns over their ability to prevent internal short circuits occurring at high temperatures [2]. Therefore, it is desirable to develop new separators with good wettability and improved thermal stability to enable high performance lithium-ion batteries with enhanced safety. In our study, reactive silica particles and tri(ethylene glycol) diacrylate (TEGDA) were coated onto the fibrous membrane. A cross-linked fibrous composite separator was then prepared by inducing thermal cross-linking between reactive silica particles and TEGDA, as illustrated in Fig.1. It showed excellent thermal stability and high ionic conductivity when soaked with liquid electrolyte. The cross-linked fibrous composite separator was applied to fabricate the cell composed of a graphite negative electrode and a $LiNi_{0.6}Co_{0.6}Mn_{0.2}O_2$ positive electrode. The cycling performance of the lithium-ion cell was evaluated and compared to those of cells employing a conventional polyolefin separator.

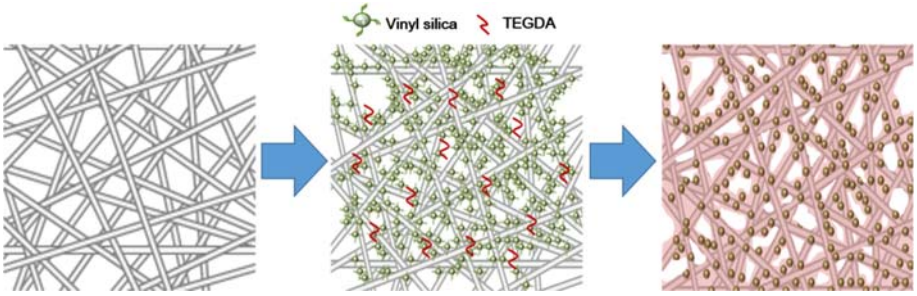

Figure 1. Schematic illustration of the preparation of the cross-linked fibrous composite.

References:

[1] K.M. Abraham, M. Alamgir, J. Electrochem. Soc. 142 (1995) 683–687.

[2] I. Uchida, H. Ishikawa, M. Mohamedi, M. Umeda, J. Power Sources 119–121 (2003) 821–825.