Electrochemical properties of siloxane additives for lithium-ion battery

Byung Ryang Kim\textsuperscript{a}, Byung Hee Kim\textsuperscript{b}, Young Chan Kim\textsuperscript{b}, Honglae Sohn\textsuperscript{c} Young Kyu Hong\textsuperscript{a}\textsuperscript{*}

\textsuperscript{a}Nano-Convergence Research Center, Korea Electronics Technology Institute, Jeonju, Korea
\textsuperscript{b} DAMIPOLYCHEM co., LTD, Iksan, Korea
\textsuperscript{c} Department of Chemistry, Chosun University, Gwangju, Korea

E-mail: ykhong@keti.re.kr

In most of the commercial lithium-ion batteries, carbonate based liquid electrolytes are volatile and potentially combustible and therefore can lead to the thermal runaway at any abuse conditions \cite{1}. To improve the battery safety, an interest in nonflammable materials is greatly growing. Among these materials, siloxane have attracted attention recently \cite{2}. Siloxane shows higher flash point and lower glass transition temperature in comparison with carbonate based solvents, because the Si-O bond has higher bond energy and lower rotational barrier than the C-O bond. Hence, one can expect the enhanced thermal stability and ionic mobility at low temperature and of lithium-ion battery by using siloxanes.

In this study, we synthesized several kinds of siloxane including sila-crown-ether or polar functional group. The sila-crown-ether type siloxanes have binding pocket which expected to effectively bind a Li-ion. To evaluate electrochemical properties, we dissolved the siloxanes in base electrolyte (1M LiPF\textsubscript{6} in EC:DMC:DEC = 3:3:4, v/v) at a concentration of 5 wt\%. And we compared the results with that of base electrolyte.

Ionic conductivity was measured in the temperature range from 30 °C to -30 °C. The electrochemical stability was evaluated by linear sweep voltammetry (LSV), cyclic voltammetry (CV) and impedance spectroscopy.

The cycle-life performance of siloxane added electrolyte was investigated using 2032 coin-type full cell. The fabricated cells were cycled between 2.5 and 4.2 V at the rate of 1 C. The capacity retention rate of cells with siloxane added electrolyte were ~ 80% after 100 cycles as shown in Figure 1. In addition to the results of the cycle-life performance, the electrochemical properties will be discussed in relation to the molecular structure of siloxane.

![Figure 1. Cycle-life performance of the fabricated cell using siloxane added electrolyte](image)

References: