Electrochemical properties of siloxane additives for lithium-ion battery

Byung Ryang Kim[a], Byung Hee Kim[b], Young Chan Kim[b], Honglae Sohn[c] Young Kyu Hong[a*]
[a]*Nano-Convergence Research Center, Korea Electronics Technology Institute, Jeonju, Korea*
[b] *DAMIPOLYCHEM co., LTD, Iksan, Korea*
[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 [1]. To improve the battery safety, an interest in nonflammable materials is greatly growing. Among these materials, siloxane have attracted attention recently [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 $LiPF_6$ 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 ℃ to -30 ℃. 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.

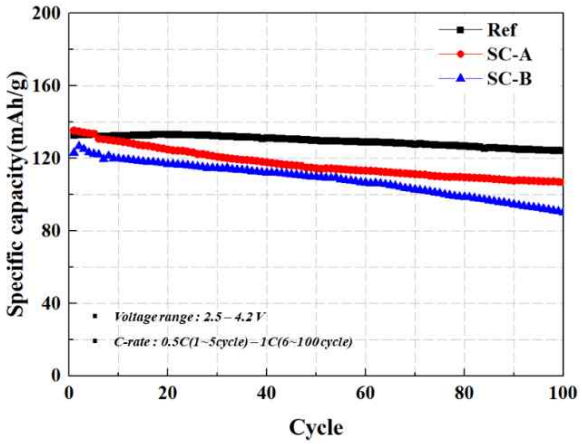

Figure 1. Cycle-life performance of the fabricated cell using siloxane added electrolyte

References:

[1] Nam-soon Choi, et al., J. Korean Electrochem. Soc. 12 (2009) 203-218.
[2] Nicholas AA Rossi and Robert West, Polym. Int. 58 (2009) 267-272.