

# ELECTROCHEMICAL PROPERTIES OF NANO FILLER ADDED PEO SOLID ELECTROLYTE

KWANG-SUN JI, HEE-SOO MOON, JONG-WOOK KIM,  
JONG-WAN PARK

DIVISION OF MATERIALS SCIENCE  
AND ENGINEERING,  
HANYANG UNIVERSITY  
17, HAENGDANG-DONG, SEONGDONG-KU,  
SEOUL 133-791, KOREA

## INTRODUCTION

PEO(polyethylene oxide) has been studied for a long time as an electrolyte since introduced by Wright and Armand et al in 1979 at first. However, PEO-LiX polymer electrolytes are affected by some problems, namely

- i) a reactivity towards the lithium metal electrode,
- ii) a low conductivity at ambient temperature( $<10^{-8}$ S/cm)
- iii) poor mechanical properties

Composite electrolytes are among the most promising candidates for use in rechargeable lithium batteries.[1,2]

These are obtained by dispersing inorganic particles (eg, TiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, MgO) in a polymer matrix.[3]

In this study, we fabricated nanocomposite electrolytes with fumed silica(~11nm) and focusing their surface groups which may provide secondary pathway for Li cation migration.

## EXPERIMENTAL

PEO(Aldrich,  $M_w=4 \times 10^5$ ) and LiClO<sub>4</sub>(Aldrich) were prepared as a base polymer materials and lithium salt. Nano-sized fumed silica(Degussa) which have octyl(C<sub>8</sub>H<sub>17</sub>) and silanol(OH) surface groups was added followed by PEO solved slurry in Acetonitrile. The slurry was casted on Teflon plates after enough stirring for homogeneous solution. The film samples were made thorough vacuum drying at 50 °C for 48h and its average thickness of 100 μm. The impedance spectroscopy was worked for conductivity measurement using sus/CPE/sus sandwich type cells with EG&G M6310 in the 1Hz~100kHz range. WBCS 3000 cycle tester was used for cycleability with LiMn<sub>2</sub>O<sub>4</sub>/CPE/Li cell. All procedure was carried out in dry box filled with Ar gas.

## RESULTS AND DISCUSSION

Figure 1 shows the impedance response of SiO<sub>2</sub>-added nano composite PEO-LiClO<sub>4</sub> based electrolyte in comparison with that of varies SiO<sub>2</sub> concentration and times. The conductivity enhanced about 2~3 orders of magnitude from 10<sup>-8</sup>S/cm to 2.4 x 10<sup>-6</sup>S/cm at room temperature. Before measuring the conductivity, all samples were annealed at 90 °C over 24h.

Figure 2 represents surface groups of added silica simply. The octyl group (C<sub>8</sub>H<sub>17</sub>) is hydrophobic (=organophilic) and the other one is hydrophilic. The homogeneous solution was obtained by this partially organophilic properties. XRD and FT-IR analysis were performed for making clearly the relations between the crystallinity and conductivity. We knew that nano-sized filler and annealing treatment may decrease crystallinity of PEO. On other hand, it means increase of free volumes in which Li cations can be conducting. We confirm that nano-sized filler performed a work prevents or retards recrystallization of PEO such like "solid plasticizer" and its silano group(OH) provides secondary path way for Li ion migration.

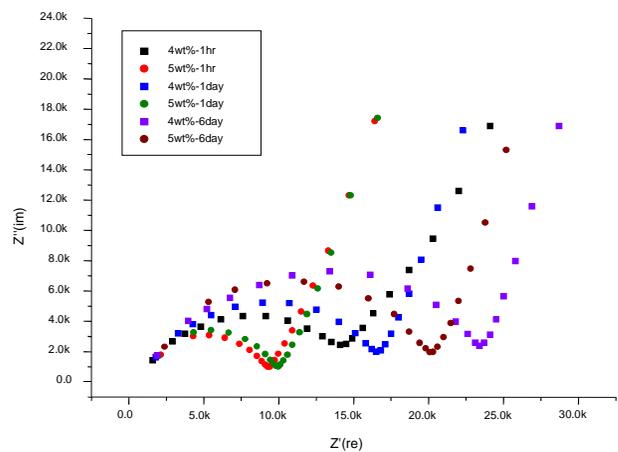


Figure1. Impedance response of composite electrolytes

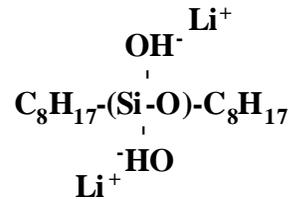


Figure2. Surface group of nano-sized silica

## References

- [1] J.E.Weston and B.C.H.Steel. Solid state Ionics, **7**, 75 (1982)
- [2] F.Croce and B.Scrosati, J. Electrochem. Soc, **138**, 1918 (1991)
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