

### Synthesis of Hyper-Branched Macromonomer and Physical Property as Solid Polymer Electrolyte

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#### Introduction

To obtain the safety, reliability, and higher energy density of the lithium battery, great effort has been done for developing solid polymer electrolyte.

Recently, dry type polymer electrolyte having high ionic conductivity has been obtained by introducing branched short polyethyleneoxide side chain<sup>1,2</sup>. In these system the branched chain act as internal plasticizer and enhanced the ionic mobility in the system.

To realize higher ionic conductivity especially in low temperature region, we synthesized new macromonomers having hyper-branched structure. After cross-linking these macromonomers, we obtained solid polymer electrolytes having hyper-branched structure. The physical property as solid electrolyte of these polymers was examined.

#### Experimental

Hyper-branched macromonomers were synthesized from oxyrane, oxyrane-2-yl-methanol. Terminal hydroxyl group was partially capped with methyl group to prevent the reaction with lithium metal. Residual hydroxyl groups were converted to acrylic group to enable thermal or photochemical cross-linking.

The hyper-branched solid polymer electrolytes were obtained by cross-linking above macromonomers after dissolving electrolyte salt (LiTFSI).

#### Result

The viscosity, of the macromonomer was extremely lower at room temperature, and this property enables impregnation into porous material such as existing cathode.

The glass transition temperature ( $T_g$ ) of hyper-branched solid polymer electrolyte was lower than that of oxyrane-based polymer electrolyte ever obtained. The ionic conductivity reached  $10^{-4}$  S/cm at  $40^\circ\text{C}$ .

#### Reference

- 1) M. Kono, K. Furuta, S. Mori, M. Watanabe, and N. Ogata, *Polym. For Adv. Tech.*, **4**, 85 (1993).
- 2) M. Kono, E. Hayashi, and M. Watanabe, *J. Electrochem. Soc.*, **145**, 5, 1521 (1998).

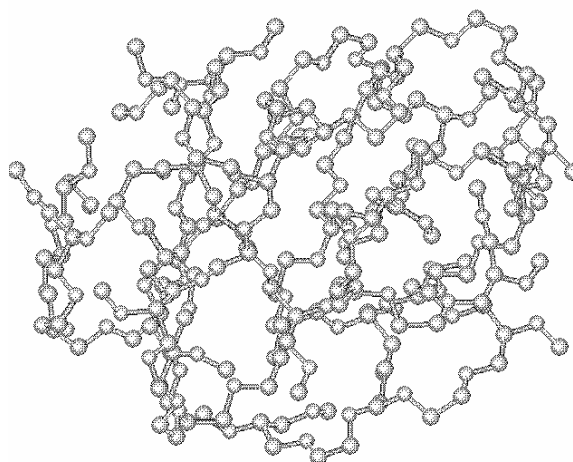


Figure-1. Structure of typical hyper-branched macromonomer molecule from MD calculation (hydrogen atom was hidden).

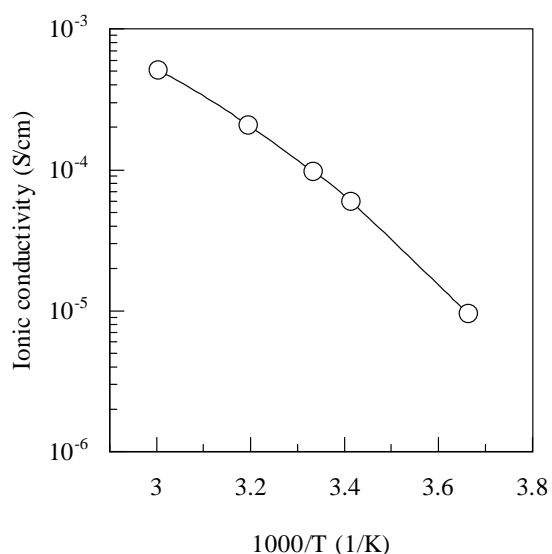


Figure-2. Arrhenius plots of ionic conductivity for solid polymer electrolyte from hyper-branched macromonomer with LiTFSI ( $[\text{Li}]/[\text{O}]=0.04$ ).