

Solid Polymer Electrolyte Membranes Based on Siloxane Matrix

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Abstract : Polymer electrolytes (PE) play an important part in electrochemical devices such as batteries and fuel cells. To achieve optimal performance, the PE must maintain a high ionic conductivity and mechanical stability at both high and low relative humidity. The polymer electrolyte also needs to have excellent chemical stability for long and robustness. According to the prevailing theory, ionic conduction in polymer electrolytes is facilitated by the large-scale segmental motion of the polymer backbone, and primarily occurs in the amorphous regions of the polymer electrolyte. Crystallinity restricts polymer backbone segmental motion and significantly reduces conductivity. Consequently, polymer electrolytes with high conductivity at room temperature have been sought through polymers which have highly flexible backbones and have largely amorphous morphology. The interest in polymer electrolytes was increased also by potential applications of solid polymer electrolytes in high energy density solid state batteries, gas sensors and electrochromic windows. Conductivity of 10⁻³ S/cm is commonly regarded as a necessary minimum value for practical applications in batteries. At present, polyethylene oxide (PEO)-based systems are most thoroughly investigated, reaching room temperature conductivities of 10⁻⁷ S/cm in some cross-linked salt in polymer systems based on amorphous PEO-polypropylene oxide copolymers.. It is widely accepted that amorphous polymers with low glass transition temperatures T_g and a high segmental mobility are important prerequisites for high ionic conductivities. Another necessary condition for high ionic conductivity is a high salt solubility in the polymer, which is most often achieved by donors such as ether oxygen or imide groups on the main chain or on the side groups of the PE. It is well established also that lithium ion coordination takes place predominantly in the amorphous domain, and that the segmental mobility of the polymer is an important factor in determining the ionic mobility. Great attention was pointed to PEO-based amorphous electrolyte obtained by synthesis of comb-like polymers, by attaching short ethylene oxide unit sequences to an existing amorphous polymer backbone. The aim of presented work is to obtain of solid polymer electrolyte membranes using PMHS as a matrix. For this purpose the hydrosilylation reactions of α,ω -bis(trimethylsiloxy)methyl-hydrosiloxane with allyl triethylene-glycol mono-methyl ether and vinyltriethoxysilane at 1:28:7 ratio of initial compounds in the presence of Karstedt's catalyst, platinum hydrochloric acid (0.1 M solution in THF) and platinum on the carbon catalyst in 50% solution of anhydrous toluene have been studied. The synthesized oligomers are vitreous liquid products, which are well soluble in organic solvents with specific viscosity $\eta_{sp} \approx 0.05 - 0.06$. The synthesized oligomers were analysed with FTIR, ¹H, ¹³C, ²⁹Si NMR spectroscopy. Synthesized polysiloxanes were investigated with wide-angle X-ray, gel-permeation chromatography, and DSC analyses. Via sol-gel processes of doped with lithium trifluoromethylsulfonate (triflate) or lithium bis-(trifluoromethylsulfonyl)-imide polymer systems solid polymer electrolyte membranes have been obtained. The dependence of ionic conductivity as a function of temperature and salt concentration was investigated and the activation energies of conductivity for all obtained compounds are calculated

Keywords : synthesis, PMHS, membrane, electrolyte

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