

Characteristics of Complexes of Poly(ethylene oxide) with Lithium Salts

Yu-Chuan Liu^{*}, Li-Huei Lin, Chenh-Jung Tsai and Yu-Sheng Liang

Department of Chemical Engineering, Van Nung Institute of Technology, 1 Van Nung Road, Shuei-Wei Li, Chung-Li City, Tao-Yuan, Taiwan, R.O.C.

Due to polymer batteries applying polymers-based electrolytes, these polymer electrolytes can act as media for ions transference and isolation films, their reactivity with lithium is low and their chemical stability is high, they aren't subjected to the problem of liquid leakage as liquid organic electrolytes are, these characteristics make polymer electrolytes can reach the demands of safety and miniature for excellent batteries.¹⁻⁵ Therefore, lithium polymer batteries are recently widely studied. Generally, polymer electrolytes own higher viscosity than liquid electrolytes do, it results in poor conductivity accompanied with polymer electrolytes.⁶⁻⁹ However, this shortage can be overcome by adding organic solvents, like propylene carbonate, with low molecular weights and high dielectric constants served as plasticizers,¹⁰ or adding nanoparticles, like Al₂O₃, into the polymer electrolytes. Furthermore, the mechanical strength of polymer electrolytes can be improved via blending inert polymers to form composite polymer electrolytes.

In polymer electrolytes, the interactions between polymers and lithium salts and new interactions forming owing to additions of plasticizers, nanoparticles or inert polymers in the polymer electrolytes matrix, are significantly related to the mechanism of ions transference in electrolytes and to their corresponding increase in chemical strength. However, less efforts had been made on these interactions. In this study, the complexes of polyethylene oxide (PEO, MW=600000) with lithium perchlorate with various EO/Li molar ratios were prepared. The crystallization and surface morphology of PEO electrolytes were examined via differential scanning calorimeter (DSC) and scanning electron microscopy (SEM). The results indicate that the conductivity and the crystallization of electrolyte increases and decreases, respectively, with decreasing the EO/Li molar ratio. Furthermore, the melting point of electrolyte disappears at the EO/Li molar ratio of 1/10. The complex PEO electrolyte demonstrates a soft property and shows thin cleavage on its surface. The results investigated via x-ray photoelectron spectroscopy (XPS) the binding energies of both C and O atoms in PEO electrolyte shift to lower energy side due to the existence of lithium ions. The interaction between PEO and lithium ion was measured via surface-enhanced Raman scattering (SERS). The results reveals that the relative intensities of two pairs peaks, showing at ca. 1230 and 1285 cm⁻¹, and 1401 and 1423 cm⁻¹, respectively, change with changing the EO/Li molar ratio. Furthermore, a new peak shows at ca. 1423 cm⁻¹ in the complex of PEO and lithium salt. It confirms that Li⁺ ion interacts with the PEO in the complex electrolyte.

Acknowledgments

The author thanks the National Science Council of the Republic of China (NSC-89-2214-E-238-001) and Van Nung Institute of Technology for their financial support.

References

1. H. Akashi, K. Tanaka, and K. Sekai, *J. Electrochem. Soc.*, **145**, 881 (1998).
2. A. Wendsjo, J. O. Thomas, and J. Lindgren, *Polymer*, **34**, 2243 (1993).
3. P. Birke, W. F. Chu, and W. Weppner, *Solid State Ionics*, **93**, 1 (1997).
4. S. D. Jones, and J. R. Akridge, *J. Power Sources*, **54**, 63, (1995).
5. S. W. Smoot, *Solid State Ionics*, **18/19**, 306 (1986).
6. B. L. Papke, M. A. Ratner, and D. F. Shriver, *J. Electrochem. Soc.*, **129**, 1434 (1982).
7. R. G. Linford, and S. Hackwood, *Chem. Rev.*, **81**, 327 (1981).
8. M. B. Armand, *Solid State Ionics*, **9/10**, 745 (1983).
9. M. A. Ratner, and D. F. Shriver, *Chem. Rev.*, **88**, 109 (1988).
10. M. Alanmgir, R. D. Moulton, and K. M. Abraham, *Electrochim. Acta*, **36**, 773 (1991).