EJ9.

ARTIFICIAL MUSCLES WITH A POLYMER GEL ELECTROLYTE BASED ON POLYACRYLONITRILE (PAN)

KUMUDU PERERA, M.A.K.L. DISSANAYAKE, P.W.S.K. BANDARANAYAKE, STEEN SKAARUP* AND KELD WEST*

*Department of Physics, University of Peradeniya, Sri Lanka and *Department of Chemistry, Technical University of Denmark, Denmark*

Polymer gel electrolytes are formed by trapping a liquid electrolyte in a polymer matrix. They offer an approach to achieve high conductivity nearing that of the parent liquid electrolyte alongside good mechanical properties. Polymer networks found to be useful to form gel electrolytes include poly(acrylonitrile)(PAN), poly(methyl methacrylate) (PMMA), poly(vinyl chloride) (PVC) and poly(vinylidene fluoride) (PVDF). They have exhibited their potential capability in various applications. The most latest application of these gel electrolytes is in the artificial muscles which are defined as systems capable of converting chemical energy to mechanical energy. Different types of materials have been tested in artificial muscles. But, due to their practical difficulties such as requirement of high voltages and low displacements, the attention has diverted towards conducting polymers. Most studies have been done with conducting polymer based artificial muscles in liquid electrolytes. Recently, a keen interest has been put on dry artificial muscles where liquid electrolyte is replaced by a polymer electrolyte. Upon application of a potential, movements are registered as in a liquid electrolyte.

This report is based on a gel eletrolyte comprising PAN, ethylene carbonate (EC), propylene carbonate (PC) and lithium trifluoromethane sulfonate ($LiCF_3SO_3$) and its performance on artificial muscles prepared with conducting polymer polypyrrole (PPy).

The composition having the maximum room temeprature condcivity and the optimum mechanical properties was determined by varying the salt concentration and the PAN amount respectively. It was found that the highest room temperature can be obtained at the salt concentration, 0.87 $molkg^{-1}$ and good mechanical properties are available with a PAN amount corresponding to 1/10 of the amount of the liquid electrolyte (by weight). The highest room temeprature conductivity was 1.21×10^{-3} S cm^{-1} and the electrolyte composition was 15mol%PAN : 42mol%EC : 36mol%PC : 7mol%$LiCF_3SO_3$.

To fabricate the artificial muscle, two identical polypyrrole electrodes polymerized in the presence of sodium dodecylbenzene sulfonate (SDBS) and having thicknesses of 10 μm were used. The gel electrolyte was sandwiched in between two PPy electrodes. Movements were observed in different potential windows. To accelerate the motion, gel electrolytes of different thicknesses were used.

It could be noticed that thinner the gel electrolyte, faster the movements. But, using very thin electrolytes sometimes resulted short circuit effects. There are problems like evaporation of the solvents. Further studies are under way to overcome them.