Characterization of Hydrogel-Conductive Polymer Recognitive Interpenetrating Networks

Carolyn L. Bayer[1], Nicholas A. Peppas[1,2]
[1]Department of Biomedical Engineering, [2]Department of Chemical Engineering
The University of Texas at Austin, Austin, TX 78712, USA

Statement of Purpose:

Recognitive hydrogels which respond to environmental changes such as pH, temperature, or the presence of biomolecules have been extensively researched. Hydrogels have been utilized to develop molecularly imprinted polymers (MIPs), which recognize a specific biomolecule of interest, called the template, which has been associated with the material prior to polymerization. MIPs have the potential to act as artificial antibodies, thus providing future applications in medical research and diagnostics.

Molecularly imprinted polymers are not responsive devices on their own, and must be incorporated into a device for transduction of the molecular binding event. To accomplish this, we have developed co-polymers of conductive and recognitive polymers. Specifically, we are incorporating a conductive polymer, polyaniline, into our hydrogel networks. Polyaniline (PANI) is a conjugated polymer which is conductive in its protonated emeraldine salt form. PANI can be synthesized on a polymer acid, poly(2-acrylamido-2-methyl-1-propane-sulfonic acid) (PAAMPSA) to generate a complex which demonstrates improved solubility[1]. The PAAMPSA in this complex acts both as a dopant and a stabilizer. Water-soluble PANI-PAAMPSA has been used to show a simple patterning technique on glass which allows it to be used in microdevices[2].

Methods:

Preparation of glass substrates was accomplished by first cleaning the substrates with solvent, followed by a Pirhana clean, then exposing the glass to a solution of 3-methacryloxypropyltrimethoxysilane (γ-MPS) in acetone. After exposure to γ-MPS, the slides were rinsed in acetone, then in methanol, and then dried with nitrogen.

PANI-PAAMPSA was obtained as a dry powder from Dr. Yueh-Lin Loo at UT Austin. Synthesis methods for PANI-PAAMPSA have been previously reported [2]. To form the interpenetrating hydrogel-CP network, the PANI-PAAMPSA was first prepared by weight percentage in deionized water. A solution of the monomer acrylamide and the crosslinker poly(ethylene glycol)dimethacrylate was prepared, and the PANI-PAAMPSA solution was added. 1-hydroxycyclohexyl phenyl ketone was added as the UV free radical initiator for the polymerization and the entire solution was sonicated. The solution was then spun coat onto a functionalized glass substrate, covered with a cover slip, then exposed to UV to initiate the reaction.

In addition, thin films of PANI-PAAMPSA alone were obtained by spin coating the PANI-PAAMPSA in a water solution onto cleaned glass substrates at 500RPM for 60 seconds. In this case, the water is allowed to evaporate, leaving a thin conductive film of PANI-PAAMPSA on the glass substrate.

The resulting thin films were characterized. Conductivity of the hydrogel-conductive polymer composites was verified using a 4-point probe and an Agilent 4145B Semiconductor Parameter Analyzer. Voltage was swept from -1V to +1V and the conductance was calculated. A Dektak II profilometer was used to measure the thickness of the film.

Results/Discussion:

Homogenous thin films of hydrogel-CP were successfully prepared for PANI-PAAMPSA concentrations up to 10 wt%. The hydrogel significantly decreases the conductivity of the PANI-PAAMPSA material. Thin films of 2.5% PANI-PAAMPSA alone were found to be conductive as demonstrated by a linear current response with changing voltage, as shown in Figure 1.

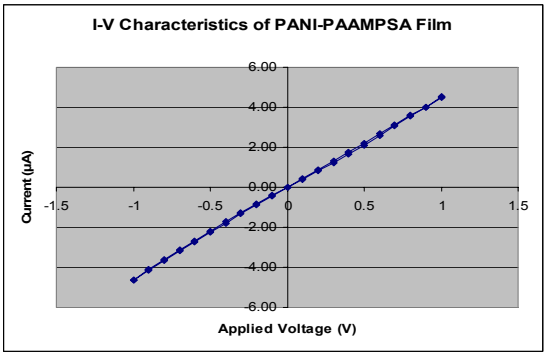

Figure 1: Conductivity of PANI-PAAMPSA film.

Conclusions:

Hydrogel-CP films were fabricated which have the potential to introduce novel transduction properties into recognitive hydrogels. The fabrication and characterization techniques will be applied in the future towards the generation of a MIP which will both recognize and respond to the template molecule of interest.

References:

1. Sun, L., Synthetic Met, 1997, 84: p. 67-68.
2. Lee, K.S., App Phys Lett, 2005, 86(7): p. 074102

Acknowledgments:

This work was supported by the National Science Foundation Integrative Graduate Education and Research Traineeship (IGERT) Fellowship (to C.L.B.), DGE-03-33080. The conductivity and profilometry were performed at The Center for Nano- and Molecular Science and Technology at The University of Texas at Austin. We thank Joung Eun Yoo and Dr. Yueh-Lin Loo for providing the PANI-PAAMPSA for this work.