Synthesis of *p* and *n*-type Gel Doped with Ionic Charge Carriers

E. Alveroglu Durucu, [1,*] Y. Yilmaz,[1]
[1]*Istanbul Technical University, Faculty of Science and Letters, Department of Physics, Maslak, 34469, Istanbul, TURKEY*

Organic electronics have become an active research area in recent years, because they are an alternative to the traditional semiconductor technology and challenges in design on a smaller scale from microscale to nanoscale. Organic based semiconductors, for example polymeric gels, may have superior properties due to their flexibility against to regulate some physical properties of the materials even after the production, e.g., by changing the volume of the gel. Due to great diversity and functionality of the polymers they may also be produced for specific requirements, like biocompatible semiconductors.

In this study, we synthesized new kinds of semiconductor polymeric gels having negative (*n*-type) and positive (*p*-type) counter ions as charge carriers. We have shown that the *pn* junction, formed by combining *p*-type and *n*-type gels together in very closed contact, rectifies the current as in Figure 1.

The polyacrylamide gel was doped with pyranine (8-hydroxypyrene-1,3,6-trisulfonic acid, trisodium salt), having SO_3^- ions as side groups and Na^+ as counter ions, so-called *p*-type semiconductor gel. In similar way, N-isopropylacrylamide gel was doped with methacrylamidopropyltrimethylammonium chloride (MAPTAC), having Cl^- as counter ions, so-called *n*-type semiconductor gel.

p-type gels were synthesized as free radical cross-linking co-polymerization of acrylamide and N,N´-methylene bisacrylamide as crosslink agent in the presence of pyranine in trace amount.[1] *n*-type gels were synthesized, similar to *p*-type, as free radical cross-linking co-polymerization of N-isopropylacrylamide and N,N´-methylene bisacrylamide as crosslink agent in the present of.[2,3,4] The pyranine and MAPTAC bind to the polymer chains chemically during the polymerization [4,5], thus they form stable charged sites doped with positive and negative counter ions, respectively.

In Figure 1, a representative example of I-U (current-voltage) character of polymeric diode is given for 4M polyacrylamide and 4M N-isopropylacrylamide gels including 10^{-4} M Pyranine and $3x10^{-4}$ M MAPTAC as doping agents, respectively.

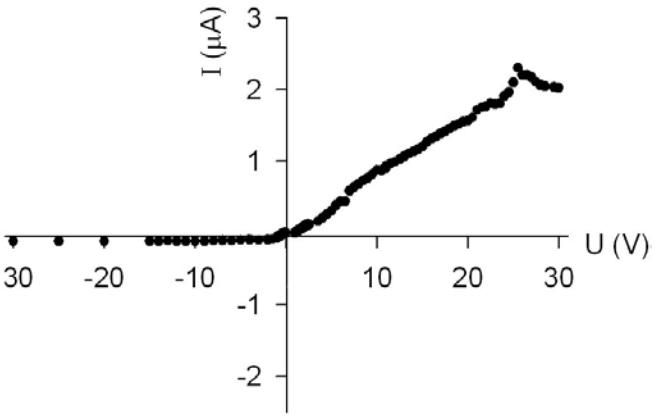

Fig. 1 Representative plot for I-U characteristic of polymeric *pn* junction for a certain swelling ratio.

Polyacrylamide is a water soluble polymer, therefore, both gels can swell in pure water. This fact can be used to regulate some physical parameters of the *pn* junction. We observed that changes in the swelling ratio causes considerable variations in the magnitude of the current of forward bias, in built-in voltage, and in rectification ratio.

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* Email: alveroglu@itu.edu.tr