Design and Deposition of Electroactive Polymers for Light-emitting Diodes and Photovoltaics: DMR-0208786

Mary Galvin, University of Delaware and Lewis Rothberg, University of Rochester

Goals: The primary goal of this research is to correlate the structure of a polymer to its performance in electroactive devices including light-emitting diodes (PLEDs) (Figure 1) and photovoltaic cells. This is accomplished by combining the synthesis of new materials with characterization, device fabrication and theoretical modeling.

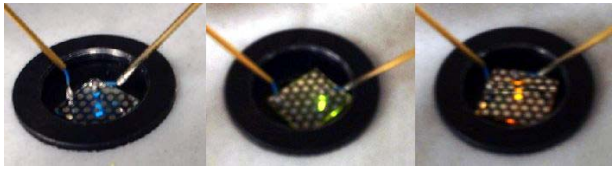
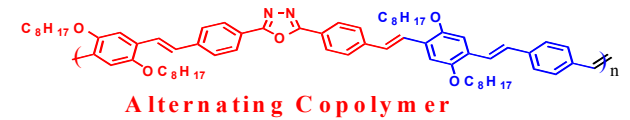
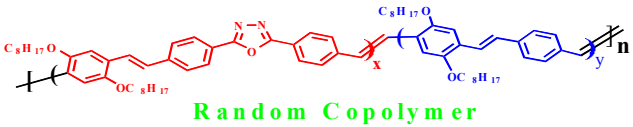


Figure 1: PLEDs made with an active organic layer in the Galvin lab. Organic structure affects color and light output.

Research: **Energetic Disorder -** Galvin and Rothberg discovered that energetic disorder, that is a mixture of chains of varying length, can decrease the efficiency of a PLED by 2 orders of magnitude. To understand this phenomena, Steve Konezny, a student at Rochester, has worked with Darryl Smith from Los Alamos to develop a predictive model. This model is being tested with devices made from oligomers and polymers synthesized in the Galvin group. **Sequence Distribution -** In addition to chain length, the arrangement or sequence, of two chemically distinct groups can be varied in a polymer chain. In our research these groups are oxadiazole, because it transports electrons, and phenylenevinylene (PV) because it transports holes. Three polymers with an over all composition of 50% PV were synthesized. In these copolymers the PV and oxadiazole were connected to form alternating, random and block copolymers (Figure 2). The random copolymer produced a much brighter PLED than the other two copolymers, 10 times more efficient than the block and 50% more efficient than the random. This difference is being correlated to the energy levels and morphology of the polymers. A random copolymer with 30% PV is being used to fabricate bright green PLEDs on plastic.





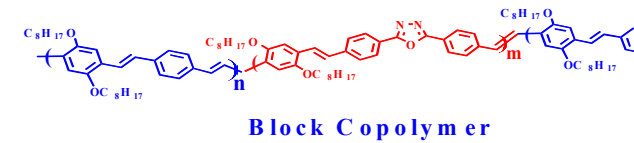


Figure 2: All 3 polymers have an identical chemical composition, 50% **oxadiazole** and 50% **PV.** The sequence of the these 2 groups does, however, vary in the 3 polymers.

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Education

During the last year 2 students (Jane Wesley and Steve Konezny) and one Postdoctoral fellow (Zhenjia Wang) received some financial support from this grant at the University of Rochester. Two students at the University of Delaware were also supported on this grant (Subramanian Vaidyanathan and Yashpal Bhandari). Subramanian received a Ph.D. from Delaware in May 2003 and is now at Bell Laboratories, Lucent Technologies. As part of their professional development all of the students were encouraged to present their research at national meetings. Subramanian gave an oral presentation at the Materials Research Society meeting in Boston. Steve and Jane gave talks at the American Physical Society meeting last March. Zhenjia presented a talk at the Materials Research Society meeting in the spring. The PIs gave several invited talks at national and international meetings. In addition to the graduate students supported by the project, 1 high school teacher who worked in Rothberg's lab co-authored a paper on research done under this grant.

Outreach

The Galvin group took part in a program run by Engineering Outreach in the College of Engineering at the University of Delaware. In June 30 girl scouts, predominately of middle school age, spent time in the Galvin lab learning how PLEDs were made and tested. The students were thrilled to see light coming from a plastic film (Figure 1).

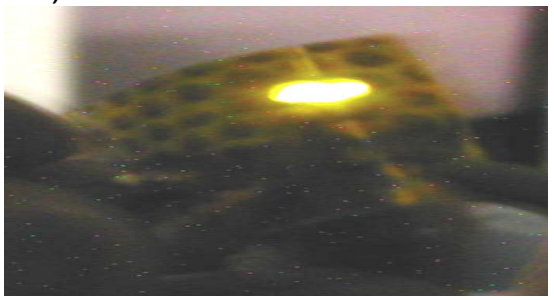

Figure 1: PLED made on a plastic substrate used to demonstrate fabrication and testing to 30 girl scouts this summer.