Molecular Crystals and Liquid Crystals Incorporating Nonlinear Optics

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Preface

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PREFACE

The Third Brookhaven Symposium on Electroresponsive Molecular and Polymeric Systems demonstrated the extraordinary diversity of research efforts in the design, synthesis and applications of electrically and optically active organic materials.

The intent of this symposium series, which provides its unique flavor, is to bring together leading researchers from various related fields, such as electronically and ionically conducting polymers, redox polymers, nonlinear optical systems, molecular and biomolecular electronics, and organic superconductors.

The developments in this area continue at a rapid pace. In the field of conjugated polymers, the fabrication of highly oriented fibers has resulted in materials with simultaneously high mechanical strength and high conductivity. Fibers with a modulus approaching high strength industrial fibers have already been demonstrated. What has become clear, is that high conductivity and high mechanical strength are both a function of the high degree of orientation, and will, therefore, increase simultaneously.

Applications of conjugated polymers are beginning to appear in a variety of different systems, such as batteries, capacitors, and transparent speakers.

The Langmuir-Blodgett technique is emerging as a central materials fabrication method for producing ordered, highly anisotropic structures, with applications in nonlinear optics and molecular electronics, such as in the design of organic quantum well structures. These mono- and multilayer structures can also be used to study the basic properties of the materials themselves. The high degree of orientation and the possibility of producing noncentrosymmetric structures is of particular interest for fabricating nonlinear optical systems for second harmonic generation.

Ion conducting polymers represent a separate class of materials which have shown promise as thin film solid electrolytes in a number of electrochemical devices, such as high energy density rechargeable lithium batteries. In this case, high performance is associated with amorphous, liquid-like materials with low glass transition temperatures. Materials based on highly flexible polysiloxane and polyphosphazene backbones have shown particular promise. The latest developments have focussed on synthesizing ion conductors which are specific for transport of only one ionic species, either cations or anions, where the counterion is covalently attached to the polymer backbone.

Redox polymers have moieties capable of undergoing reduction/oxidation covalently attached to the polymer backbone and can become electrically conducting in the presence of a solvent, e.g. water, which allows the introduction of counterions. With partial oxidation, a mixed valence system is produced which allows electronic conduction via electron hopping, or self-exchange. These materials can be tailored to have specific redox properties. One particularly intriguing application of this class of materials is to "electrically wire" redox enzymes for applications such as biosensors.

The field of electroresponsive molecular and polymeric systems has clearly matured, and many of the major hurdles against producing commercially viable materials have fallen in several areas. At the same time, this vibrant field continues to develop new concepts and new applications. The Brookhaven Symposium has become a forum for bringing together researchers from the various subfields, to provide cross fertilization to open yet new areas of research in this highly dynamic field.