

## **Tunable Polarizers: +359° to -359° Using a Single Macromolecule**

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Why do we care about polarized light? In addition, to filters, lenses, and displays, every light pulse sent down an optical cable develops polarization and this leads to distortion that must be periodically adjusted. Optical rotations and wavelength absorptions (circular dichroism) are known to vary with temperature, solvent and wavelength of light. The variations in polarizations in small molecules are usually on the order of  $\pm 5-15^\circ$ . We herein report a family of chiral macromolecules that can exhibit reversible, specific optical rotations over a wide range and changes in sign ( $+950^\circ \leftrightarrow -650^\circ$ ) depending on solvent, temperature, or AC current. The polymers of topic are non-symmetric, helical aryl polycarbodiimides that are polymerized using chiral catalysts that preferentially select for one screw-sense over the other. The preparation of these materials and the mechanisms responsible for their unusual optical switching properties will be discussed.

Restricting the conformational degrees of freedom within a polymer's backbone can have the effect of extending the chain and endows the material with a number of interesting properties including helicity, chirality and liquid crystallinity. Moving from achiral to homochiral materials can induce further alteration and improvement of properties. The helix motif is a versatile structure that has applications in a number of important technological areas which include optical devices, piezoelectric materials, electromechanical actuators, pyroelectric materials, ferroelectric materials, chiral separations and sensors and biomimetic polymers. Single screw-sense polymers have properties vastly different than their racemic analogues. In order to form single screw-sense polymers from achiral monomers (carbodiimides), we have been investigating their polymerization with chiral catalysts. We recently discovered that titanium binaphthol complexes will catalyze these reactions to give polymers displaying a predominance of a single screw-sense. The resulting polymers with polyaromatic side chains (naphthalene, anthracene) have very unusual properties that include a facile and pronounced chiroptical switching (e.g.,  $+300^\circ$  to  $-200^\circ$ ) near body temperature. Analysis indicates that the switching behavior is related to the reorientation of the anthracene ring relative to the helix director. Switching can be driven by temperature, polarity and electric fields. The synthesis and utility of these chiral polymers will be discussed.