Magneto-Optics of Molecular and Polymeric Materials

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Michael Faraday provided the first evidence that light has a magnetic component in 1845. The effect is known as the Faraday effect wherein plane polarized light is rotated when propagating through a material along the direction of an applied magnetic field. The rotation is linearly dependent upon the thickness and applied magnetic field and the magneto-optical (MO)response is proportional to the Verdet (V) constant. All materials display this MO property, and the theory for molecular systems has been understood for decades. Current MO devices use inorganic crystals with $V \approx 10^4$ deg T^{-1} m^{-1}, however organic materials are known to have values 1-2 orders of magnitude higher. New applications await discovery if new generations of optical films can be produced that can display easily measurable rotations in thin films. In this lecture I will describe designs of molecules with high symmetries and electronic degeneracies that that display MO activity and their assembly into optical films. The translation from molecular properties to create superior MO materials is critical and we seek to create new materials with V that exceed 10^7 deg T^{-1} m^{-1}. The alignment of a material's electronic and magnetic transition dipoles with the optical path is critical and is improved through the use of liquid crystalline organization as shown in the accompanying graphic. Intermolecular and interpolymer associations are also of interest and we have found large increases in V that would not be expected based on simple molecular models. I will discuss our recent results in creating extended aromatic molecules and polymers in our quest to expand the scope of MO materials with large Vs and the ongoing development of structure property correlations.