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Chiral Phenomena in Nonlinear Optic

GARTH SIMPSON, Purdue University

Frequency doubling (second harmonic generation, SHG) and frequency mixing (sum frequency generation, SFG) are remarkably sensitive probes of interfacial structure. The application of these techniques in studies of biological systems and interfaces is particularly exciting, given their high sensitivity to chirality. Whereas absorbance measurements yield circular dichroic (CD) ratios of a few fractions of a percent, these same molecular systems can easily produce CD ratios approaching 100% in thin films. In order for these emerging techniques to successfully undergo the transformation from academic curiosities to practical instrumental tools for biological characterization, experimental and theoretical advances are required. Novel ellipsometric approaches for polarization analysis have been developed to yield greater information content with simpler instrumentation. As a complement to these experimental studies, new and relatively simple theories have been proposed for interpreting the relationships between the detected signals and the molecular/macromolecular structures at the interfaces. Applications of these combined experimental and theoretical techniques include the demonstration of label-free methods for real-time biosensing, chiral-specific detection and analysis with ultra-high sensitivity, and the quantification of changes in protein secondary structure from polarization analysis.