Measurement of the Dynamics of Nonlinear Refraction and Absorption via Nonlinear Beam Deflection

D. J. Hagan[1], P. Zhao[1], S. Benis[1], and E. W. Van Stryland[1]

[1] CREOL, The College of Optics and Photonics, University of Central Florida, Orlando, FL 32816, USA

Abstract – max of 100 words

Nonlinear Beam Deflection (BD) allows sensitive time-resolved measurement of nonlinear refraction (NLR) and absorption (NLA) by using an excitation beam to create an index gradient deflecting a probe beam onto a quad-cell detector. The method is broadly applicable, having been applied to solid, liquid and gaseous samples. It also is superior to other methods in its ability to resolve NLR in the presence of strong NLA. We have used this method to characterize the full impulse response for third-order nonlinearities in many organic solvents.

Abstract – max of 250 words

Many materials exhibit nonlinear refraction (NLR) and absorption (NLA) that has multifaceted temporal dynamics. As a result, measurements at one laser pulse width may not be fully predictive of the behavior at other pulse widths. We have recently developed a method, Nonlinear Beam Deflection, (BD) that allows sensitive time-resolved measurement of nonlinear refraction (NLR) and absorption (NLA) by using an excitation beam to create an index gradient deflecting a probe beam onto a quad-cell detector. The method has a demonstrated sensitivity to induced phase changes as small as 1/20,000 of a wavelength, which is sensitive enough to measure NLR in gases. By changing the relative polarization of the beams we can separate the bound-electronic response from the slower and different-symmetry nuclear contributions. In gases and liquids where reorientational nonlinearities are important, measurements at the magic angle allow isolation of the ultrafast nonlinearities. In isotropic solids the bound-electronic symmetry dictates a ratio of 1/3 for parallel to perpendicular polarizations which measurements confirm. This method also allows for measurements of nonlinearities using very different wavelengths for the excitation and probe. We have used this method to characterize the impulse response function for third-order nonlinearities in many transparent organic solvents. This allows accurate prediction of the nonlinear refraction for any pulse width longer than that used for the BD characterization. The method proves to be very useful in organic materials that may show strong nonlinear absorption, as it is able to resolve NLR in the presence of strong NLA better than other methods, such as Z-scan.