Surface Characterization of Zincblende and Wurtzite Semiconductors Using Nonlinear Optics

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Abstract : Current progress in the field of nonlinear optics has enabled precise surface characterization in semiconductor materials. Nonlinear optical techniques are favorable due to their nondestructive measurement and ability to work in nonvacuum and ambient conditions. The advance of the bond hyperpolarizability models opens a wide range of nanoscale surface investigation including the possibility to detect molecular orientation at the surface of silicon and zincblende semiconductors, investigation of electric field induced second harmonic fields at the semiconductor interface, detection of surface impurities, and very recently, study surface defects such as twin boundary in wurtzite semiconductors. In this work, we show using nonlinear optical techniques, e.g. nonlinear bond models how arbitrary polarization of the incoming electric field in Rotational Anisotropy Spectroscopy experiments can provide more information regarding the origin of the nonlinear sources in zincblende and wurtzite semiconductor structure. In addition, using hyperpolarizability consideration, we describe how the nonlinear susceptibility tensor describing SHG can be well modelled using only few parameter because of the symmetry of the bonds. We also show how the third harmonic intensity feature shows considerable changes when the incoming field polarization angle is changed from s-polarized to p-polarized. We also propose a method how to investigate surface reconstruction and defects in wurtzite and zincblende structure at the nanoscale level.

Keywords : surface characterization, bond model, rotational anisotropy spectroscopy, effective hyperpolarizability
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