THz electron paramagnetic resonance ellipsometry for defect characterization in semiconductor materials: Bloch equations and superconvergence rules in the frequency-dependent magnetic susceptibility

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A new optical technique is presented to detect the signatures of electron paramagnetic resonances in semiconductor materials at terahertz frequencies and high magnetic fields using generalized spectroscopic ellipsometry. Measurements dispense with the need for modulation techniques and resonance cavities. The elements of the normalized Mueller matrix are determined, which contain hitherto undetected information about the polarization, frequency, and field response of unpaired electron spin moments including nuclear magnetic coupling. Approaches to model analysis of the frequency dependent magnetic susceptibility tensor are discussed, Bloch equations are revisited, and an analogue to the Lyddane-Sachs-Teller relationship is shown from theory and experiment. The approach permits new insights into the physics of defects in semiconductors and examples are discussed for wide and ultrawideband gap semiconductors such as SiC, GaN, and Ga_2O_3.