SPECTROSCOPIC ELLIPSOMETRY FOR THE ANALYSIS OF ANISOTROPIC WIDE BAND GAP SEMICONDUCTORS

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Ellipsometry is used in many different applications fields from fundamental research to industrial applications in micro- and optoelectronics, photovoltaics, metal, and glass industry. We are presenting a selection of sophisticated R&D applications emphasizing the capability of spectroscopic ellipsometry analyzing the dielectric functions ε for selected anisotropic wide band gap semiconductors: wurtzite-ZnO, 6H-SiC, and β-Ga_2O_3.

The ellipsometric measurements were performed using a SENTECH SENresearch 4.0 SER850 DUV spectroscopic ellipsometer.

The (10-10) plane of a **wurtzite ZnO** crystal was measured parallel and perpendicular to the optical c-axis. The dispersion of ε_1, ε_2 of ZnO was parameterized using an oscillator model describing the bandgap structure as well as the excitonic structures in the band gap region (Fig. 1).

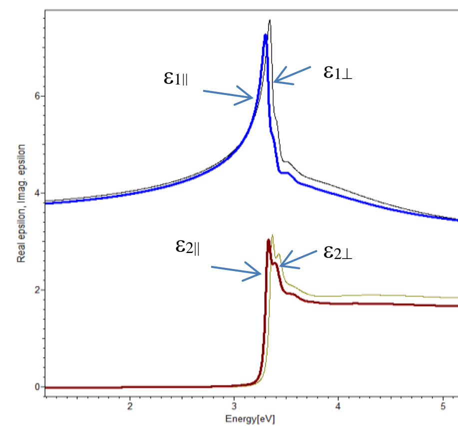

Fig. 1. ε_1, ε_2 of ZnO

The (000-1) plane of a double side polished **6H-SiC** sample was measured by Muller Matrix (MM) ellipsometry in the energy range from 0.5 to 3.0 eV. The beam, refracted into the wafer is split into two beams due to the anisotropy of the SiC wafer. When exiting the wafer after being reflected at the polished backside, both components show a phase shift due to different travel length. This causes interference fringes in the MM spectra. The superposition of these two interfering beams with the directly reflected beam is incoherent causing depolarization of the light. Muller matrix measurements must be applied for modeling anisotropy and depolarization simultaneously.

β-Ga_2O_3 shows a monoclinic crystalline structure. This causes biaxial anisotropic behavior. Here a simpler cubic crystal was modeled neglecting the xz component of the dielectric tensor. As a result, only three crystallographic directions a, b, c* can be measured. c* is the perpendicular component of the c-axis perpendicular to the crystallographic a-b-plane. An (010) β-Ga_2O_3 crystal was measured along the c*-axis and an (001) β-Ga_2O_3 crystal was measured along its a- and b-axes by Muller Matrix ellipsometry in the energy range from 1.2 to 6.5 eV. The resulting dielectric function is shown in Fig. 2.

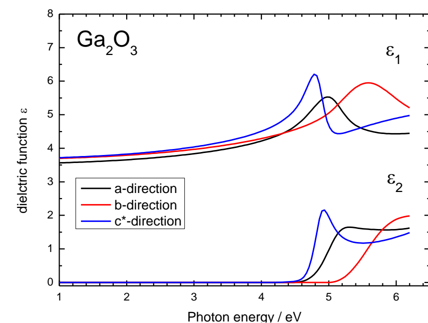

Fig. 2. ε_1, ε_2 of β-Ga_2O_3

Keywords: Ellipsometry, Muller Matrix, Anisotropy, Wide band gap, semiconductor, Ga_2O_3