TEMPERATURE DEPENDENCE OF ZINC Δ_{101} ENERGY GAP

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We present experimental results of spectroscopic ellipsometry (SE) and modulation spectroscopy study of the (001) single-crystal zinc in the 10-500 K temperature range.

The clean (001) optical surfaces of Zn samples were disclosed by cleaving crystals. The SE measurements, in the 0.73–6 eV spectral range, were performed with a dual rotating compensators ellipsometer RC2 (J. A. Woollam Co., Inc.) equipped with the standard heat stage HTC-100 (incident angle of 70°) for high-temperature measurements and the closed-cycle cryostat CTI-Cryogenics (incident angle of 45°) for low-temperature measurements. The dielectric functions of zinc were determined from SE data by an iteration procedure [1]. A theoretical analysis of the obtained dielectric function spectra allowed for a determination of the temperature dependence of the interband optical transitions across the Δ_{101} energy gap. Alternatively, to follow the low-temperature dependence of the gap, the λ-modulated reflectance measurements were carried out, making use of a Δ_{101}-related minimum of Zn reflectance spectrum (at $\boldsymbol{E} \perp \boldsymbol{c}$).

The temperature dependence of the zinc energy gap Δ_{101} (presented by dots in Fig. 1) is similar to that of band-gaps of semiconductors. In the present work we succeeded to show that the *T*-dependence of Zn Δ_{101}-gap is solely due to the Debye–Waller factor. Indeed, making use of literature data [2] for Zn mean-square displacements and having calculated the Debye–Waller factor for the $\boldsymbol{g}_{101}$ reciprocal lattice vector, we obtained an excellent agreement between the experimental $\Delta_{101}(T)$ dependence and the temperature dependence of the Debye–Waller factor (Fig. 1).

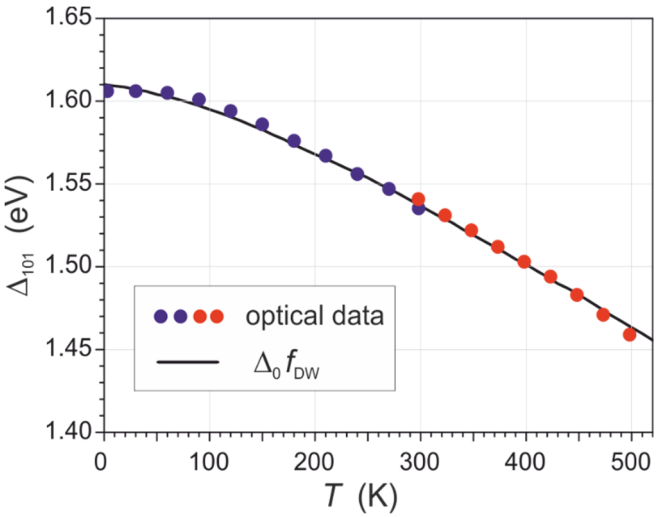

Fig. 1 Temperature dependence of the Zn Δ_{101} energy gap. Dots present experimental optical data and curve corresponds to *T*-dependence of the Debye–Waller factor f_{DW} (at Δ_0 = 1.63 eV).

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Keywords: Zinc; Spectroscopic Ellipsometry

References

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