Temperature Dependent Dielectric Functions and Critical Points of β-InSe

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2D layered materials have attracted extensive interest due to their unique optical, electronic, and mechanical properties. Among the mono-chalcogenides, InSe exhibit promising properties in the field of microelectronic, optical, and optoelectronic applications [1]. For the device application of InSe, knowledge of its optical properties, such as the dielectric function, is necessary. Although there are a few studies on the dielectric functions [2], systematic study on temperature dependence of critical points (CPs) of InSe has not been reported yet.

In this work, we present the dielectric function on cleavage plane of β-InSe from 0.74 to 6.42 eV at temperatures from 27 to 300 K using dual rotating compensator spectroscopic ellipsometry. The sample was a bulk β-phase InSe single crystal grown by the temperature gradient method. We confirmed the quality and phase of our InSe sample through X-ray diffraction (XRD), high-resolution transmission electron microscopy (HRTEM), selected area diffraction (SAD), Raman spectroscopy, and photoluminescence (PL). The sample was positioned to align its cleavage plane with the in-plane direction. It was then promptly placed into the cryostat following cleaving to minimize surface oxidation or contamination. The ellipsometric measurements was performed under ~10^{-8} Torr vacuum condition to prevent surface condensation. Figure 1 shows the imaginary parts of pseudodielectric functions of InSe at 27, 150, and 300 K. The CP energies were determined by standard lineshape analysis of numerically calculated second derivatives of dielectric function (ε) with respect to energy. Many new CPs are observed at low temperature where the CPs are blue shifted and sharpened because of the reduced lattice constant and electron-phonon interaction. These results will be useful for physical understanding and application for the device based on InSe.

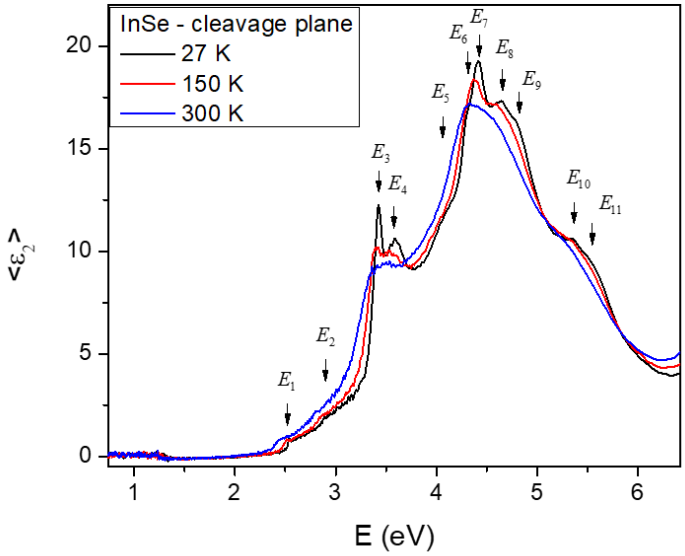

Fig.1. The imaginary parts of pseudodielectric functions of β-InSe

References

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