Bandgap study of MBE grown {CdO/MgO} superlattices

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The development of superlattice structures (SLs), using molecular beam epitaxy (MBE) technique is challenging but meaningful work for technological advancement in semiconductor industries. Here, in this work, short-period SLs composed of alternate CdO and MgO layers were grown on sapphire and MgO substrate using plasma-assisted MBE technique. The structural properties of the SLs were investigated by high-resolution X-ray diffraction (HR-XRD) and the sublayer thickness of individual CdO and MgO layers were determined. High-resolution transmission electron microscopy (HR-TEM) image confirmed the separation of Mg and Cd elements and a distinct interface between CdO and MgO layers. The optical investigation was carried out using UV-Vis spectroscopy at room temperature and the corresponding bandgap was found to be 2.76 eV. It is found that the bandgap of SLs can be varied from 2.6 eV to 6 eV by changing the CdO sublayer thickness at a constant MgO layer thickness [1]. The pressure dependence of fundamental bandgap has been studied using a diamond anvil cell technique. It has been found that the band-to-band transition shifts toward higher energy with applied pressure. The bandgap of SLs was varied from 2.76 to 2.87 eV with applied pressure varied from 0 to 5.9 GPa. The pressure coefficient for the direct bandgap of SLs was found to be 26 meV/GPa [2]. The obtained experimental result was supported by theoretical results obtained using density functional theory calculations. The volume deformation potential was estimated using the empirical rule. We believe that our findings may provide valuable insight for a better understanding of {CdO/MgO} SLs toward their future applications in optoelectronics.

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[2] A. Adhikari, P. Strak, P. Dluzewski, A. Kaminska, and E. Przezdziecka. Pressure-dependent bandgap study of MBE grown {CdO/MgO} short period SLs using diamond anvil cell. Appl. Phys. Lett. 2022; 121: 242103.