Selected Mechanical Properties of MBE-Grown (Pb,Cd)Se Layers

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The possibility of forming ternary alloys between the narrow-gap IV-VI semiconductors crystallizing in the rock-salt structure and wide-gap II-VI compounds exhibiting the tetrahedral coordination is an attractive idea because of some new perspectives for application of such alloys that have recently emerged. For instance, it has been demonstrated that this material can serve as a basis for making infrared detector devices [1].

The principal aim of present study is to determine the composition-dependent, selected mechanical properties of (Pb,Cd)Se solid solution. The determination of the nanohardness and Young's modulus by the nanoindentation was selected for this purpose. Two types of samples with different buffers were grown by the MBE technique. The (001)-oriented GaAs substrates were first overgrown by either 3 μm thick CdSe or by 5 μm ZnTe buffer layers. Next, the 2 μm thick (Pb,Cd)Se layers were grown on the semiconductor wafers prepared in such a manner. The samples containing 0, 2.5%, 5% and 10% of Cd were prepared. Prior to the nanoindentation measurements all structures were characterized by XRD and AFM techniques.

The data on nanohardness and Young's modulus were collected for all samples at room temperature. For the measurements the Ultra Nanohardness Tester CSM UNHT/AFM with a several values of maximum load from 0.2 to 10 mN was used. The average values and standard deviations of the hardness and Young's modulus were extracted from the determined load-displacement results.

Recent experiments on PbTe crystals demonstrated a huge difference in the nanohardness determined for MBE-grown layer and bulk material [2]. Therefore, the additional aim of present study was to compare the vales of mechanical properties of two types of PbSe crystals: bulk material grown using the equilibrium growth technique (self-selecting vapor growth) and thick layer obtained by MBE method. The (001)-oriented 2 mm thick slab was prepared from bulk PbSe for the nanoindentation measurements, and the natural, (001)-oriented crystal surface served for these studies. The possible reasons of observed differences in mechanical properties of both types of crystals are provided and thoroughly discussed.

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