Hardening of (Pb,Cd)Te Crystal Lattice with an Increasing CdTe Content in the Solid Solution

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Lead telluride PbTe is among the chalcogenides the one, that has found much usefulness in the field of thermoelectricity and infrared detection. In a single PbTe bulk crystal grown by the Bridgman method, the microhardness maintains almost constant value of ~ 30 HV for various carrier concentrations [1]. Due to the relatively low microhardness value a layer of PbTe is so soft that it can be scratched easily. As a consequence, some devices consisting of PbTe layers are not robust enough to withstand damages possible in standard fabrication processing [2]. In order to avoid this problem, more robust materials are chosen typically as the outermost layers. However, there is another possibility by replacement of the PbTe by its solid solution containing another compound, e.g., GeTe [2].

The aim of present studies is to demonstrate the crystal lattice hardening resulting from noticeable CdTe content in the (Pb,Cd)Te solid solution. All single (Pb,Cd)Te crystals containing from 0 to 9% of the CdTe were grown at the Institute of Physics PAS by the self-selecting vapor growth (SSVG) method [3]. The room temperature data about microhardness and Young's modulus were determined by the nanoindentation method using an Ultra nano-hardness tester CSM UNHT/AFM and the Berkovich indenter tip. The maximum load equal to 1 mN was applied during 30 s, both the increase of the load during application and the removal of the load were performed in a linear manner with the same upload and download rate 0.033 mN. The average values and standard deviations of the hardness and Young's modulus were extracted from the determined load-displacement results. The composition-dependent modification of ultrasound velocity was estimated for the same set of solid solutions using the LA phonon dispersion data, obtained by inelastic neutron scattering (INS) measurements. Correlation between the composition of investigated crystals and their selected mechanical properties is given and discussed in comparison with available relevant data for (Pb,Ge)Te solid solution.

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