Nanoindentation Studies of the MBE-Grown, Zero-Gap (Cd,Hg)Te Layers

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The (Cd,Hg)Te solid solution is a II-VI semiconductor crystallizing in the zinc blende structure. The crystals containing up to about 30% of CdTe belong to the group of narrow-gap semiconductors. For a low CdTe content these crystals exhibit an inverted band structure, and the exact zero-energy gap at helium temperature is achieved in (Cd,Hg)Te containing about 15% of CdTe. The (Cd,Hg)Te was intensively investigated from sixties of the last century and found several important applications, in particular in optical devices used in the infrared spectral range of radiation. Over the last years (Cd,Hg)Te with an inverted band structure have again attracted a lot of attention due to its possible transition from a normal to a topological insulator phase and the observation of the Quantum Spin Hall effect.

Recently, it was demonstrated that selected mechanical properties of PbTe bulk crystals and MBE-grown layers differ substantially [1]. On the other hand analogous difference seems to be much smaller in the case of GaAs [2]. Therefore the question arises if this effect exists also in II-VI mercury containing semiconductors.

The aim of present study is to determine the nanohardness and Young's modulus of (Cd,Hg)Te solid solution by the method of nanoindentation. About 1 μm thick layers of material containing 15% of CdTe were grown by MBE technique using the Double RIBER COMPACT 21 system. The (001)-oriented GaAs wafers with CdTe buffer layer were used as a substrates. For details of the technology see Ref. [3]. Prior to the nanoindentation measurements the chemical composition of all crystals was determined by XRD and EDX techniques and all samples were also characterized by Raman scattering. For the nanoindentation measurements the Ultra Nanohardness Tester CSM UNHT/AFM was used. The average values and standard deviations of the nanohardness and Young's modulus were extracted from the determined load-displacement results. The values of both parameters were compared with these collected for bulk crystals and those known from the literature. Possible reasons of the observed differences are discussed.

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