Substantial Difference in Selected Mechanical Properties of CdTe and PbTe Crystals Grown by Equilibrium and Non-Equilibrium Growth Techniques

Stanisław Adamiak [1], Piotr Adamski [1], Krzysztof Matracki [1], Dariusz Płoch [1], Elżbieta Dynowska [2], Piotr Dziawa [2], Andrzej Szczerbakow [2], Badri Talashvili [2], Maciej Wiater [2], Barbara Witkowska [2], Tomasz Wojtowicz [2], and Wojciech Szuszkiewicz [1,2]

[1] *Faculty of Mathematics and Natural Sciences, University of Rzeszów, ul. S. Pigonia 1, 35-310 Rzeszów, Poland*
[2] *Institute of Physics, Polish Academy of Sciences, al. Lotników 32/46, 02-668 Warsaw, Poland*

A range of physical properties of CdTe and PbTe, which can be found in many textbooks and databases, have been obtained long time ago with the use of bulk single crystals, i.e. materials grown by the equilibrium growth techniques. Due to development of non-equilibrium growth techniques, utilized for these group of semiconductors at least for the last 30 years the interest of the solid state physics shifted from 3D materials to low-dimensional objects such, as heterostructures, superlattices, nanowires or quantum dots. The same tendency is observed in the area of applications. The planar technology is today the basis of modern electronic industry, and the numerous semiconductor devices contain low-dimensional structures obtained by MBE or ALD. Under these circumstances the question arises: are the mechanical properties of these structures the same as those determined long time ago for the bulk materials or not? The small FWHM values of rocking curves determined by the X-ray diffraction measurements in MBE-grown layers, which demonstrate a much better crystal quality in comparison to that of corresponding bulk materials, suggests a negative answer to this question. To our knowledge, however, a difference in selected mechanical properties of the MBE-grown layer and the same material in the bulk form was not a subject of numerous, separated studies dedicated to this particular problem.

The aim of present studies is to compare the vales of mechanical properties of two types of crystals: bulk materials grown using the equilibrium growth technique and obtained by non-eqilibrium growth method – MBE. The cadmium telluride and the lead telluride, well known for a long time and widely investigated, typical semiconducting compounds of II-VI and IV-VI type, respectively, were chosen for this purpose. The investigated CdTe bulk crystal was grown by the Bridgman method, the bulk PbTe was obtained by the self-selecting vapor growth (SSVG) technique [1]. The 8 μm thick CdTe layer deposited onto GaAs substrate and 6 μm thick PbTe layer grown on BaF_2 were selected for the comparison. The room temperature data about microhardness and Young's modulus were determined for all samples by the nanoindentation method [2]. The parameters of the applied load were as follows: maximum load 1 mN, linear change of the load during application and removal of the load 0.033 mN, application time of the maximum load 30 s. The average values and standard deviations of the hardness and Young's modulus were extracted from the determined load-displacement results. Possible origins of observed, substantial difference in relevant values determined in MBE-grown layers and bulk materials are given and discussed.

This work was supported in part by National Science Centre (Poland) through grant UMO-2014/13/B/ST3/04393.

[1] A. Szczerbakow and K. Durose, *Prog. Cryst. Growth Charact. Mater.* **61**, 81 (2005).
[2] A.J. Crocker and M. Wilson, *J. Mater. Sci.* **13**, 833 (1970).