Young's Modulus Anisotropy in Semiconductors Crystallizing in the Rock Salt Structure: (Pb,Cd)Te and (Pb,Sn)Se Solid Solutions

Elżbieta Łusakowska[1], Stanisław Adamiak[2], Piotr Adamski[2], Rafał Kuna[1], Roman Minikayev[1], Paweł Skupiński[1], Andrzej Szczerbakow[1] and Wojciech Szuszkiewicz[1,2]*

[1] *Institute of Physics, Polish Academy of Sciences, Aleja Lotników 32/46, PL-02668 Warsaw, Poland*
[2] *Faculty of Mathematics and Natural Sciences, University of Rzeszów, ul. Pigonia 1, PL-35310 Rzeszów, Poland*

The Si, GaAs and few other semiconductor crystals of III-V type serving as a basis of several devices found a lot of commercial applications. The mechanical properties of these materials have been determined long time ago and they are relatively well-known today. On the contrary, similar properties of IV-VI compounds and solid solutions obtained on the basis of these semiconductors have not yet been a topic for systematic studies and these properties are much less explored.

Among the group of IV-VI semiconductors those which have served for thermoelectric applications or infrared detection are considered particularly interesting. In the last few years one may easily observed a 'renaissance' of topics of studies devoted to the lattice dynamics in these compounds. Recently, it was discovered that some from these materials under well selected conditions exhibit the properties of topological crystalline insulators. All studies devoted to new topological states of matter attract a lot of attention. Taking into account all circumstances mentioned above we decided to investigate the anisotropy of Young's modulus for two well selected single crystals of solid solutions of IV-VI type. The first one is the (Pb,Cd)Te crystal containing 5% of CdTe. Quite recently, we examined the mechanical properties of this particular solid solution. What we have found out is an important increase of the crystal microhardness with an increasing CdTe content [1]. The second, (Pb,Sn)Se sample with 23% of SnSe has a chemical composition corresponding to a topological crystalline insulator, reported a few years ago [2].

Both samples were grown at the Institute of Physics PAS by the self-selecting vapor growth (SSVG) method [3] and characterized by XRD. The microhardness and Young's modulus for (001), (011) and (111) planes of each crystal were determined by the nanoindentation method. The anisotropy of Young's modulus value determined by the measurements was compared with theoretical predictions and a few existing experimental data taken for other compounds or solid solutions exhibiting the same type of crystal structure.

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* Corresponding author. E-mail address: szusz@ifpan.edu.pl.

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