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Crystal lattice deformation in (001)-oriented CdTe/SnTe/CdTe trilayers MBE-grown on 2° offcut GaAs

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Keywords: high resolution X-ray diffraction, SnTe, CdTe, crystal lattice deformation

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SnTe is known as a topological crystalline insulator [1, 2]. Topological crystalline insulators constitute a new class of materials with many interesting properties, important especially for electronics and spintronics [3], thus they are currently investigated [4-6].

The aim of our research was to perform a crystallographic study on the lattice deformation in (001)-oriented CdTe/SnTe/CdTe trilayers. Samples were MBE grown on GaAs substrate. Each of them had a 4 μm CdTe buffer layer, ca. 1 μm SnTe layer and a 50 nm CdTe cap. The substrate was (001) oriented with 2° off-cut toward [100] direction allowing for growth of good quality CdTe film comparable with literature data [7].

As an experimental technique the high-resolution X-ray diffraction (Philips X'Pert MRD diffractometer with $CuK_{\alpha 1}$ radiation) was used. To evaluate lattice parameters and structural quality of samples, we measured rocking curves, $2\theta/\omega$ scans and reciprocal space maps for both, symmetrical and asymmetrical Bragg reflections. Atomic force microscopy (AFM) was used as a complementary technique applied for sample surface assessment.

The main part of work consisted in checking, how the conditions of MBE growth determine the lattice parameters of CdTe and SnTe layers. We investigated the samples which had been grown mainly at 310°C and at a variable Te/SnTe molecular streams ratio.

The experimental results indicate that for all studied samples the CdTe cubic crystal structure undergoes a tetragonal distortion. According to the data from literature, it is attributed to the lattice mismatch and the difference of the thermal expansion coefficients between CdTe and GaAs [8]. Next, the strains are relaxed by formation of misfit dislocations at the interface [9] and another mechanism, which cause significant (001) plane inclination together with twist of adequate in-plane directions. It is observed that the SnTe layer lattice also is tetragonally distorted and next relaxed.

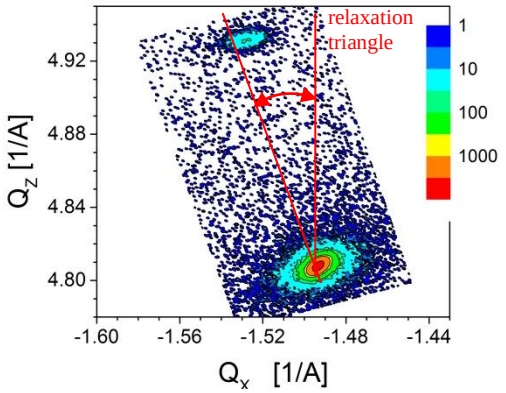

Figure 1. Reciprocal space map of CdTe (lower node) and SnTe (upper node) lattices for -1-15 Bragg reflection. The shift of nodes towards the horizontal Q_x axis shows almost full relaxation of SnTe layer.

Acknowledgments: This work has been supported by the research project No 2014/13/B/ST3/04489 financed through the National Science Centre (Poland).

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