Low-Temperature Neutron Diffraction in PbTe and (Pb,Cd)Te Solid Solution

Rafał Kuna[1], **Xavier Fabreges**[2], **Roman Minikayev**[1], **Jędrzej Korczak**[1], **Andrzej Szczerbakow**[1] **and Wojciech Szuszkiewicz**[1,3]*

[1] *Institute of Physics, Polish Academy of Sciences, Aleja Lotników 32/46, PL-02668 Warsaw, Poland*
[2] *Laboratoire Léon Brillouin, CEA Saclay, F-91191 Gif-sur Yvette, Cedex France*
[3] *Faculty of Mathematics and Natural Sciences, University of Rzeszów, ul. Pigonia 1, PL-35310 Rzeszów, Poland*

PbTe is a well-known IV-VI type semiconductor, serving e.g. for thermoelectric applications or infrared detection. Its phonon dispersion was determined more than fifty years ago [1], the softening of TO-mode with decreasing temperature in this compound was also reported a long time ago [2]. In the last few years studies devoted to PbTe lattice dynamics attract again a lot of attention due to a strong anharmonicity of this compound [3, 4]. This semiconductor is an incipient ferroelectic which can easily be transformed into a real one by a small PbTe doping with Ge. The aim of the present paper was to check a possibility of similar transformation by crystal doping with Cd and the neutron diffraction was selected as an experimental method for this purpose.

The bulk PbTe and (Pb,Cd)Te samples were grown by the self-selecting vapor growth (SSVG) method [5, 6] and characterized at the Institute of Physics PAS. All samples exhibited a rock salt type crystal structure at room temperature. The solid solution crystals contained a small amount of CdTe (up to a few percent), their exact Cd content was determined by XRD using the composition dependence of (Pb,Cd)Te lattice parameter given in [6]. The neutron diffraction was measured at Laboratoire Léon Brillouin in Saclay taking advantage of the hot neutron beam from Orphée nuclear reactor and 5C2 spectrometer. The single crystals with a volume equal to about 10 mm^3 used for the experiment were placed inside a helium cryostat, the neutron diffraction patterns were collected at several temperatures between 6 K and 295 K. The values resulting from present measurements were compared with those given by a few existing experimental data, resulting from both neutron and X-ray low-temperature diffraction, taken for PbTe and other compounds or solid solutions exhibiting the same type of crystal structure.

This work was partly supported by National Science Centre (Poland) through grant No. DEC-2014/13/B/ST3/04393.

---

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

[1] W. Cochran et al., *Proc. R. Soc. Lond. A* **293**, 433 (1966).
[2] H.A. Alperin et al., *Phys. Lett. A* **40**, 295 (1972).
[3] E.S. Božin et al., *Science* **330**, 660 (2010).
[4] O. Delaire et al., *Nature Materials* **10**, 614 (2011).
[5] A. Szczerbakow and K. Durose, *Prog. Cryst. Growth Charact. Mater.* **51**, 81 (2005).
[6] M. Szot et al., *Acta Phys. Pol. A* **116**, 959 (2009).