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Synchrotron radiation photoemission study of doped semiconductors valence band

B.A. Orlowski*, E. Guziewicz, B.J. Kowalski, A. Reszka

Institute of Physics, Polish Academy of Sciences, Al. Lotnikow 32/46, 02-668 Warsaw, Poland

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*e-mail: orbro@ifpan.edu.pl

The synchrotron radiation as a strong continuous radiation spectrum source in the wide photon energy range (from infrared, through visible light, ultraviolet, and up to the hard X-rays) was used to induce the Fano type resonant photoemission [1,2] spectra.

The 4f electrons shell contribution to the valence bands of selected semiconductors doped by rare earth atoms were studied. The impurity atoms were introduced to the crystal during technology process or sequentially deposited on the crystal clean surface. The sets of photoemission spectra were acquired for the photon energy range corresponding to 4d-4f Fano resonance. The data were collected after each sequential treatment of the sample. Measured spectra showed the contribution of the 4f electrons as an additional peaks of density of states in the valence band corresponding to rare earth 2+ and 3+ ions.

The presented results concern the change of the semiconductor valence band density of states caused due to contribution of 4f electrons states to the semiconductor valence band structure. It results in a new distribution of the valence band density of electronic states in semiconducting crystals, nanoelements and nanostructures. The interaction of electrons creating the structure of the valence band of a semiconducting material with the open-shell electrons of rare earth impurities strongly influences magnetic properties of systems with reduced dimensionality (like quantum dots or nanowires). Therefore revealing the contribution of such impurity states to the region of the valence band has become one of the important research problems in electronic band structure studies.

The results allowed to determine the rich structure of contribution of the 4f electrons to the valence band of the semiconductor crystals and to distinguish the contributions of 2+ and 3+ valence of it. The temperature annealing leads to the change of their valence in accordance with the value expected for the cation of the host lattice of semiconductor. The binding energies and the relative intensity of the correlated peaks were determined.

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P-02

The limit of CdTe solubility in PbTe and the phase diagram of (Pb,Cd)Te solid solutionR. Minikayev^{1*}, E. Dynowska¹, A. Szczerbakow¹, A. M. T. Bell², W. Szuskiewicz¹¹ *Institute of Physics, Polish Academy of Sciences, Al. Lotnikow 32/46, PL-02668 Warsaw, Poland*² *HASYLAB at DESY, Notkestr. 85, D- 22607 Hamburg, Germany*

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*e-mail: minik@ifpan.edu.pl

In search of new materials for developing of the mid-IR optoelectronic or the thermo-electric devices based on quantum dots an interesting system $Pb_{1-x}Cd_xTe$ solid solution attracted a lot of attention. Extremely low mutual solubility of both materials [1] results from the difference in their crystal structure – rock salt (RS) for PbTe and zinc-blende (ZB) for CdTe. The objects of present investigation are unique bulk, single $Pb_{1-x}Cd_xTe$ crystals (with $x \leq 0.11$) [2], which were obtained at the Institute of Physics of the Polish Academy of Sciences in Warsaw by SSVG method [3]. The goal of the present work was to study the structure properties and material stability of $Pb_{1-x}Cd_xTe$ solid solution at high temperatures and to get also new information on the temperature dependence of lattice parameters, and CdTe solubility limit in PbTe semiconductor compound.

In situ high-temperature X-ray diffraction measurements were performed at the B2 beamline (HASYLAB/DESY) [4], using the Debye–Scherrer geometry. The samples were prepared as a mixture of powdered $Pb_{1-x}Cd_xTe$ crystals and fine diamond powder (in the capacity of an internal standard [5]), and placed in a thin-wall quartz capillary, rotating inside a graphite heater during measurements. The Rietveld-method [6] was used for the structural analysis.

The experimental data [7-11] published previously in literature are mainly based on the results of DTA measurements performed on $Pb_{1-x}Cd_xTe$ solid solution with much worse crystal quality than that of present samples. The present results did not confirm the solubility limit known from the literature and suggested the necessity of some correction of the relevant phase diagram. The selected information on the $Pb_{1-x}Cd_xTe$ solid solution, such as a part of the phase diagram and CdTe solubility limit in PbTe for $x \leq 0.11$ up to $T \leq 1100$ K will be shown and discussed.

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