ANGLE-RESOLVED PHOTOEMISSION STUDY OF GeTe AND $Ge_{1-x}Mn_xTe$

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GeTe is a narrow-gap semiconductor which occurs in two crystalline structures: cubic (the rock salt structure) and rhombohedral (distorted NaCl structure). Its electronic structure was thoroughly studied for both structures by means of various calculation methods. In particular, the bonding character and its changes were considered. However, the set of related experimental data remains quite small.

Interest in GeTe has revived recently due to phenomena discovered in GeTe-based diluted magnetic semiconductors (DMS) (in view of emerging spintronic applications). $Ge_{1-x}Mn_xTe$ exhibits ferromagnetism with the Curie temperature which strongly depends on Mn concentration and can be as high as 140 K [1]. Such properties of this material inspired extensive investigations of GeTe-based DMSs but the set of experimental data concerning the electronic band structure of these materials still has to be markedly increased.

In this paper, we report an angle-resolved photoemission study of rhombohedral GeTe and $Ge_{1-x}Mn_xTe$ surface alloy prepared by *in situ* Mn deposition on the sample at elevated temperature. The GeTe epilayers were grown by MBE on BaF_2 substrates. The clean and ordered sample surface was prepared for photoemission experiments by cycles of Ar^+ ion sputtering and annealing under UHV conditions. In the experiments performed with use of the photoelectron spectrometer at BL41 in MAXlab synchrotron radiation laboratory of Lund University (Sweden) we acquired, for the first time, to our knowledge, the data revealing the valence band structure of GeTe along the Γ-T and T-W directions in the Brillouin zone. The bands along the Γ-T direction were mapped in the normal-emission mode with photon energy in the range of 20-35 eV, while for the T-W direction – in the off-normal mode (for the photon energy of 20 eV for $\theta = 0°$ and increased for higher angles in order to compensate changes in the normal component of the $\boldsymbol{k}$ vector). The dispersion of the main features in the spectra corresponded well to the band structure calculated by an empirical pseudopotential method [2].

For $Ge_{1-x}Mn_xTe$ surface alloy, the band structure was mapped along the T-W direction. By comparison of the data collected for GeTe and $Ge_{1-x}Mn_xTe$, we were able to reveal the contribution of Mn 3*d* states to the valence band of the system. It appeared in the deeper part of the valence band (1.5-6 eV with respect to the valence band edge) with a maximum intensity at about 3.5 eV. Such a result confirms the Mn 3*d* states distribution in $Ge_{1-x}Mn_xTe$, recently calculated with use of the density-functional theory [3].

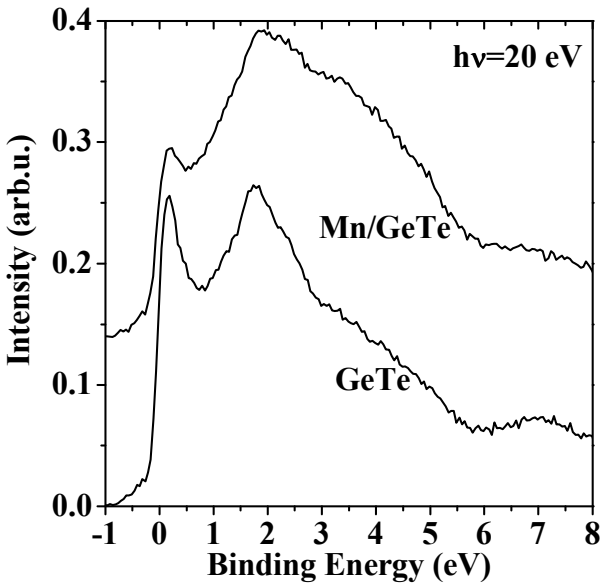

Figure 1. A comparison of the spectra taken from GeTe and Mn/GeMnTe for the T point in the Brillouin zone).

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