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Magnetovolume effect in diluted magnetic semiconductors $CdGeAs_2$:Mn and$CdGeP_2$:Mn at high pressure

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The given work presents the experimental results on relative volume compressibility $\Delta V(P)/V_0$ from the pressure P≤7 GPa at room temperatures in diluted magnetic semiconductors $Cd_{1-x}Mn_xGeAs_2$ (x=0÷0.36) and p-$Cd_{1-x}Mn_xGeP_2$ (x=0.09 ≤x≤ 0.225). The measurements are carried out in a high pressure device of toroid type at the hydrostatic pressure up to P≤7 GPa in region room temperatures. A detailed description of a method of the experiment is given in work [1]. The synthesis of the samples and technological modes of their growth are described in work [2].

Compressibility is measured by the tensometric technique as in [3]. The measured samples have a cylinder shape of 1mm in a height and 3 mm in a diameter.

An extinction of ferromagnetic state under the pressure in $Cd_{1-x}Mn_xGeAs_2$ (x=0÷0.36) reveals as a sharp decrease in lattice compressibility and increase in bulk modulus beginning from P>4.5 GPa. The bulk modulus rises in wide pressure ranges above 4.5 GPa and gradually increases close to 7GPa, what indicates that the magnetic transition "ferromagnetic-paramagnetic" occurred at this pressure.

The anomalies of magnetic properties are found on the $\Delta V(P)/V_0$ dependences in $Cd_{1-x}Mn_xGeP_2$ (x=0.09 ≤x≤ 0.225) at P>3.5. In our pinion the obtained results show that magnetic phase transitions take place in all studied samples. A transition from the magnetic-ordered phase into the magnetic-disordered phase occurs near a critical pressure P_c>3.5GPa. High pressures significantly decrease the Curie temperature (T_c) in all researched polycrystals. The values for volume magnetostriction (coefficient of spontaneous magnetization) are determined from the $\Delta V(P)/V_0$ dependences. The calculations of bulk modulus B carried out by means of scaling expression allow to estimate the values of bulk modulus in magnetic-ordered and magnetic-disordered phases.

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Negative magnetoresistance in $CdGeP_2$:Mn induced by high pressure

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Three-component semiconductors of $A^{II}B^{IV}C^{V}_2$ group, in particular, $CdGeP_2$ on the base of which is firstly synthesized a high-temperature ferromagnetic [1], are conditioned by doping ability of diamond-like matrixes by transition elements (Mn, Fe, Cr, etc.) in rather wide intervals, high mobility of p-type carriers, high Currie temperatures. The baric dependences of negative magnetoresistance are measured in the polycrystalline samples of p-$Cd_{1-x}Mn_xGeP_2$ with (x=0.09 ≤x≤ 0.225) in a high pressure device of "Toroid" type at hydrostatic pressures up to P≤6GPa in a range of room temperatures, when pressure rises and falls. A detailed description of a method of the experiment is given in works [2].

In all studied samples of p-$Cd_{1-x}Mn_xGeP_2$ with (x=0.09 ≤x≤ 0.225) except the base CdGeP there is observed the transverse magnetoresistance induced by pressure, which is positive initially and becomes negative in a region of the magnetic phase transition (Fig. 1). Increase in pressure and magnetic field leads to rise magnetoresistance magnitude. The magnetic phase transitions are revealed in all samples of p-$Cd_{1-x}Mn_xGeP_2$ with (x=0.09 ≤x≤ 0.225) except the base $CdGeP_2$ at pressure rising. The experimental results on a behavior of impurities of transition metals allow assuming that Mn ions occupy the sites in Cd sublattice in CdGeP. The observed negative magnetoresistance confirms an interaction of carriers with magnetic moments of Mn ions. So we can conclude that a metamagnetic transition from low magnetization state to the high magnetization occurs in $Cd_{1-x}Mn_xGeP_2$ with (x=0.09 ≤x≤ 0.225) of chalcopyrite structure near the T_c.

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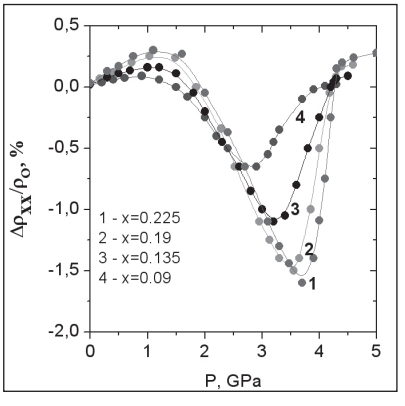

Fig.1. The baric dependence of transverse magnetoresistance ρ_{xx}/ρ_0 in a magnetic field H=5 kOe for $Cd_{1-x}Mn_xGeP_2$ with different level of Mn.