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Keywords: electric, magnetic, pressure

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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 δV(V)/V$_0$ from the pressure P≤7 GPa at room temperatures in diluted magnetic semiconductors Cd$_{1-x}$MnGeAs$_2$ (x=0÷0.36) and p-Cd$_{1-x}$MnGeP$_2$ (x=0.09 ≤x≤ 0.225). The measurements are carried out in a high pressure device of toroid type at room temperatures in diluted magnetic semiconductors Cd$_{1-x}$MnGeAs$_2$ (x=0÷0.36) and p-Cd$_{1-x}$MnGeP$_2$ (x=0.09 ≤x≤ 0.225). 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 1 mm in a height and 3 mm in a diameter.

An extinction of ferromagnetic state under the pressure in Cd$_{1-x}$MnGeAs$_2$ (x=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 δV(V)/V$_0$ dependences in Cd$_{1-x}$MnGeP$_2$ (x=0.09 ≤x≤ 0.225) at P=3.5. In our paper 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 δV(V)/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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Keywords: Magnetic, Pressure, Tensometry

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Negative magnetoresistance in CdGeP$_2$:Mn induced by high pressure

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Three-component semiconductors of A$^3$B$^7$C$^4$V 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$_{1-x}$MnGeP$_2$ 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$_{1-x}$MnGeP$_2$ with (x=0.09 ≤x≤ 0.225) the base CdGeP$_2$ 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$_{1-x}$MnGeP$_2$ 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$_2$. 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$_x$GeP$_2$ 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 $\rho_{xx}/\rho_0$ in a magnetic field H=5 kOe for Cd$_{1-x}$Mn$_x$GeP$_2$ with different level of Mn.
MS19.P10

Crystal structure refinement of Pt-base perovskite

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AA’_2B_3O_11-type perovskites have been extensively investigated because of their intriguing structural and physical properties. In CaCu_3O_4 (B = Mn^4+ and Fe^3+)) perovskites, electron carrier doping by substitution of an aloivalent cation La^3+ for Ca^2+ at A-site induces drastic changes in structural and physical properties [1], [2], [3], [4]. However, CaCu_TiO_3 does not accept effective electron carriers by this type of substitution because of high stability of Ti^4+ valence state in oxide. The resulting compound contains 1/3 deficiency at A-site, having a chemical formula of La_2CuTiO_3 [5].

A novel Pt-based perovskite CaCu_PtO_3 (CCPO) has been reported [6]. CCPO is an antiferromagnetic insulator with T_N = 40 K. In the course of electron carrier doping for CCPO, we successfully obtained an AA’_2B_3O_11-type perovskite phase from a nominal starting composition of LaCu_PtO_3 (LCPO). LCPO exhibited a spin-glass-like behavior below 4 K, whereas it remains an electrical insulator, suggesting that the possibility of B-site cation deficiency should be considered in the structural analysis of AA’_2B_3O_11-type perovskite in some cases.


Keywords: platinum perovskite, vacancy, high-pressure synthesis

MS19.P12

Novel high-pressure van der Waals compound in solid hydrogen-krypton mixtures

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Bonding interactions in molecular systems can be dramatically changed upon compression; atomic rare gases, diatomic (N_2, O_2, H_2, etc.) and even full-shell molecules (CH_4, SiH_4, etc.) can interact with each other in solid form under high pressure; novel stoichiometric van der Waals compounds have been synthesised, for example in the systems He-Ne [1], Ar-H_2 [2], CH_4-H_2 [3], and more recently Xe-H [4], [5].

The study of binary mixtures of hydrogen is of particular interest because they are relevant to the study of the interior of the giant planets and are of technological relevance for hydrogen storage.

Here we present a study of the binary system krypton-hydrogen. A diamond-anvil cell was loaded with a mixture of 8% in volume high purity Kr and H_2. Kr and H_2 are miscible in the liquid phase. A solid phase with stoichiometry Kr(H_2)_x was observed to form at a pressure of 5.3 GPa.

The structure of this novel van der Waals compound has been determined by single crystal diffraction at beamline I15, Diamond Light Source. Krypton atoms assemble in a face-centred cubic structure forming octahedral clusters with Kr-Kr bond distances comparable to the Kr bond distance in pure Kr solid. Complementary Raman spectroscopic measurements were performed to better characterize the environment of the H_2 molecule. Three intramolecular H-H vibrions are observed at higher frequencies than those of pure, solid H_2 at the same pressure.