INVESTIGATION OF PHASE TRANSITION OF MONOCRYSTALLINE InAs AT HYDROSTATIC PRESSURE BY RESISTOMETRICAL METHOD

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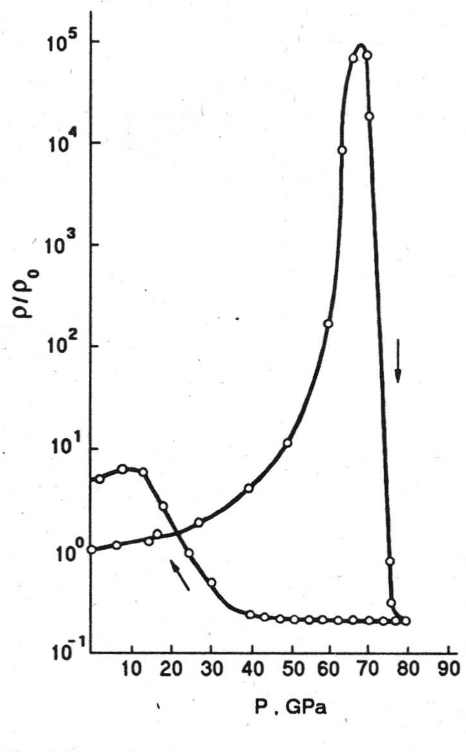
In "Toroid" device under pressure up to 9 GPa at room temperature the specific resistance of n-InAs crystals has been measured. Behaviour of material near phase transition is described using the heterophase structure-effective medium model.

In "Toroid" device for developing high pressures (up to 9 GPa) at room temperature the specific resistance ρ of *n*-InAs crystals has been measured. Gasoline B-70 is the quasi-hydrostatic enviroment, transmitting the pressure.

Fig. 1 is a suitable graph of specific resistance at room temperature against pressure for single crystal sample *n*-InAs with an electron density of 10^{16} cm^{-3}.

The available published data [1–3] are given in Fig. 2. Our results conform to Pitt and Vyas data [2].



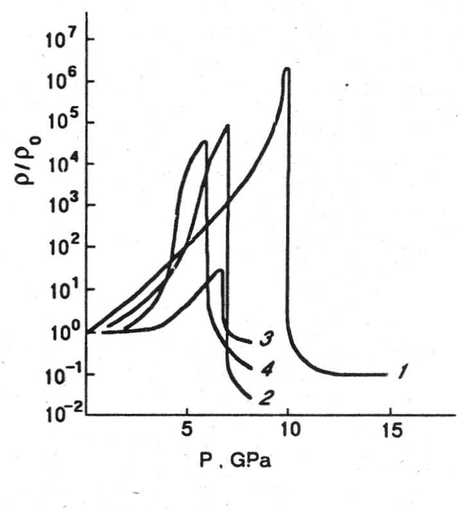


Fig. 1. Normalized dependence of electroresistance of monocrystalline *n*-InAs with an electron density of 10^{16} cm^{-3}

Fig. 2. Normalized dependence of electroresistance of monocrystalline *n*-InAs at room temperature. Curves: *1* — [1]; *2, 3* — [2] (electron density of 10^{16} cm^{-3} — *2* and 10^{17} cm^{-3} — *3*); *4* — [3]

To describe the behavior of solids in the vicinity of phase transition at high pressures different methods are used. In particular, structure and dynamics of real solid phase pressure is described on the basis of conception of heterophase structure formation [5–11]. On deflecting from the point of thermodynamic equilibrium F_0 of disturbing influence F (temperature, pressure) the nucleus of new phase 2 appears. The phase transition ends reaching the point F_E, where the volume shares of initial phase $C_1 = 0$ and that of final phase $C_2 = 1$. In the interval $F_E - F_B$ two-phase equilibrium is stated: at fixation of F in this interval the extreme degree of iso — F (thermal, baric) transmutation is reached quickly and remains constant at any duration of exposure.

Using consideration given above let's analyse the reverse transition 2→1. Evidently, the situation is analogous and we can distinguish the characteristic points F_0', F_B' and F_E' which correspond to points F_0, F_B and F_E. Thus, all solid properties depending on correlation of volumes shares of phase 1 and 2 in the model of sphere phase transition, are characterized by hysteresis. It is evident that at fixed value of disturbance C_2 in straight direction (2→1) is less than in the inverse one (2→1) and consequently here the hysteresis of solid properties takes place. The hysteresis of solid properties within the reverse phase transition allows to appreciate suitable interval of disturbing influence $F_B - F_0$, corresponding to minimal deflection from the point of thermodynamical equilibrium, after which the phase transition begins. In application to high pressure the interval $P_B - P_0$ is determined by substance properties, and in this sense it can serve like its characteristic parameter. Investigation of polymorphism is recommended to be carried out in conditions of pure hydrostatics.

In order to describe the behaviour of material near the phase transition point the region of uneven change of resistance — as a rational approach to the heterophase structure — effective medium approximation (HSEM) is used. It takes into account different configurations of phase inclusions and their dependence on pressure (from spherical form to isolated layers of high resistance phase perpendicular to and continuous chains of the high conduction phase parallel the electric field). Using HSEM model on the resistance curve of baric phase transition a point was discovered. There the channel of superconductivity phase parallel to the electric

Table. Electrical parameters and electrobaric characteristics for single crystalline samples of InSb under atmospheric pressure

n, cm^{-3}	ρ_0, Ω·cm	ρ_0'/ρ_0	ρ_m/ρ_0	ρ_E/ρ_0	P_B	P_E	P_B'	P_E'
						GPa		
$1.5\cdot10^{15}$	1.90	0.06	$5.0\cdot10^{3}$	$1.4\cdot10^{-3}$	7.0	8.2	4.5	1.3
$2.0\cdot10^{16}$	0.02	6.3	$6.6\cdot10^{4}$	$7.9\cdot10^{-2}$	6.5	8.2	4.0	1.0
$2.0\cdot10^{16}$	0.02	5.0	$1.0\cdot10^{5}$	$2.0\cdot10^{-1}$	6.7	8.2	4.2	1.0
$1.9\cdot10^{17}$	0.002	1.5	$3.3\cdot10^{2}$	$4.2\cdot10^{-1}$	7.0	8.2	4.5	1.8

field (electric breakdown) is formed, and we can identify this point as a point of real material phase transition [9–11].

Electrical parameters and electrobaric characteristics of single-crystals n-InAs at atmospheric pressure are shown in Table, where n — concentration of electrons, the indices: "O" is the atmospheric pressure, touch-decompression, "B" and "E" are the beginning and the end of transformation.

Fluctuational hysteresis $P_{HF} = P_E - P_B \approx 1.4$ GPa, thermodynamic hysteresis $P_{HT} = P_{OM} - P'_{OM} \approx 4.8$ GPa, pressure of metastable equilibrium $P_{OM} = 0.5(P_E + P_B) \approx 7.5$ GPa and $P'_{OM} = 0.5(P'_E - P'_B) \approx 2.7$ GPa, pressure of phase equilibrium $P_0 = P'_0 = 0.5(P_B + P'_B) = 0.5(P_E + P'_E) \approx 5.1$ GPa were obtained.

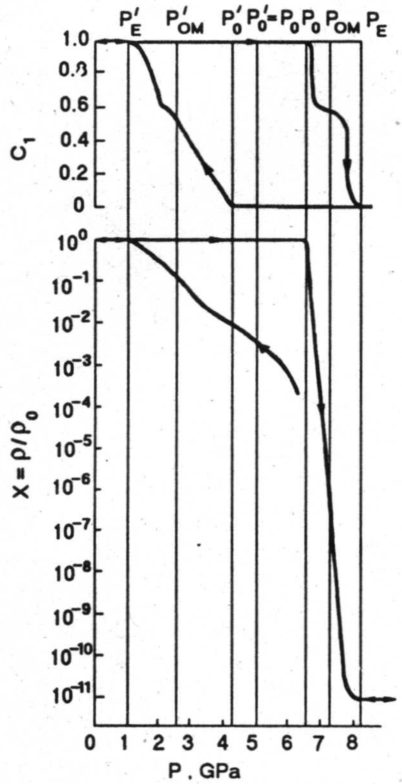


Fig. 3. Graphs of normalized resistivity X and calculated of volume share of low conductive phase C_1 at room temperature against pressure for InAs single crystal with an electron density of 10^{16} cm^{-3} (see Fig. 1)

In accordance with HSEM model the phase composition, the region of transformation (Fig. 3) and pressure of phase transition of real InAs ($P_{Ph} = 7$ GPa, $P'_{Ph} = 2.2$ GPa) have been calculated.

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