Impurity band features formed by Mn in InSb

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It has been shown that transport and magnetic properties of the impurity band formed in InSb by nonmagnetic (Ge) and magnetic (Mn) acceptors radically differ within metal−insulator transition (MIT) at temperature below 4K on the insulator side of MIT while the critical concentration of MIT ($N_c = 2 * 10^{17} cm^{-3}$) is the same both in InSb(Ge) and InSb(Mn) crystals [1,2]. These findings were unexpected if we take into account the fact that both acceptors demonstrate the equal acceptor activation energy value E_c=9meV. The revealed in experiments Colossal Magnetoresistance, the Anomalouse Hall effect and especially uniaxial stress effects can be the evidence that Jahn−Teller distortions caused by Mn ions are responsible for the unusual magnetotransport and magnetic p−InSb(Mn) properties. Here, from the Hall constant and conductivity studies performed over the temperature range 0,3−280K, in the magnetic field up to 10 T for p−InSb(Mn) samples with $N_{Mn} = 5 * 10^{16}$-$2 * 10^{17} cm^{-3}$ it was revealed that inside the forbidden gap of InSb (E_g=0,23eV) the impurity band forms supernarrow gap semiconductor with the energy gap from 0 to 1meV depending on manganese concentration. In contrast to high mobility electrons in InSb ($1,5 * 10^4 cm^2/V sec$) both the mobility of electrons and holes in impurity band did not exceed $10 cm^2/V sec$. At $N_{Mn} > 2 * 10^{17} cm^{-3}$ the metal type conductivity and at $N_{Mn} < 5 * 10^{16} cm^{-3}$ the hopping type conductivity were observed. Thus, the formation of internal gap in impurity band is possible despite random distribution of manganese impurity in InSb single crystal.

References:

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