Lead Telluride: Atypical Paramagnetism of Native Defects

Zayachuk D.M.

Lviv Polytechnic National University, Lviv, Ukraine

This report is devoted to atypical paramagnetic centers in solid recently the first experimentally revealed in lead telluride, which can be attributed to the native defects of *PbTe* crystal matrix. Atypical paramagnetism of the centers manifests itself in an unusual combination of temperature and magnetic field behavior of their magnetic susceptibility, which doesn't depend on temperature but drastically decreases when the applied magnetic field increases. Just this combination of temperature and magnetic-field behavior of the magnetic susceptibility allows asserting about a new type of paramagnetic centers in solid.

There are orientation and polarization paramagnetism in solid. Only one of them, namely van Vleck polarization paramagnetism is temperature-independent. It emerges when electronic shells of weakly interacting centers do not have spherical symmetry. Herewith magnetic susceptibility of the standard van Vleck paramagnetic non-spherical centers is independent of magnetic field too that is not the case for *PbTe*.

Magnetic investigations of *PbTe* samples show the existence of two different types of paramagnetic centers there. One of them is the typical paramagnetic centers, which create the temperature-dependent Curie-like component of the total magnetic susceptibility, $\chi \sim 1/T$. The concentration of such paramagnetic centers is rather low, about $(3\div4)\cdot 10^{18}$ см$^{-3}$, namely the same order as a typical hole concentration for undoped *PbTe* crystals grown from melt by a Bridgman technique. Other one is the atypical paramagnetic centers, which create the temperature-independent component of the total magnetic susceptibility, which drastically depend on the applied magnetic field. The bulk and surface of crystal ingots strongly differ in concentration of the atypical paramagnetic centers. Towards the surface their concentration might increase so dramatically that it leads to the transition of *PbTe* from diamagnetic to paramagnetic state in quite broad range of low magnetic fields.

The nature of both types of paramagnetic centers in undoped *PbTe* is not entirely clear. Here we discuss the possibility to explain their by different native defects of crystal matrix. We believe that the typical paramagnetic centers can be formed by *Pb* vacancies, which are the source of free holes in *PbTe*. Creating a free hole, *Pb* vacancy binds an electron, which might lead to the emergence of orientation paramagnetism. A *Pb* atom shifted into interstitial site of *PbTe* lattice could be suggested as the atypical polarization paramagnetic center since polarization paramagnetism can arise from the breaking of spherical symmetry of outer electron shell when full magnetic moment of an atom is zero, $J = 0$, but spin and orbital moments are both non-zero, $L = S \neq 0$, what is consistent with configuration of the outer electron shell $6s^2 6p^2$ of *Pb*.