Superconductivity of Surface Layers of PbTe Crystals Grown From Melt by a Bridgman Technique

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Superconductivity of surface layers of *PbTe* crystals was firstly detected in the study of ingots grown from the melt with low initial concentration of the doping impurity of *Eu*, which is entirely pushed out onto the lateral surface of the ingot during the process of growth of the doped crystal [1]. Recently the same effect was detected in the study of surface layers of undoped *PbTe* crystals too [2]. It was suggested that the observed superconductivity is caused by a mixture of the superconducting inclusions of *Pb* as type-I superconductor and the normal phase. Here we present the results of in-depth study of this phenomenon by method of magnetic measurements in undoped *PbTe* crystals, grown from melt by a Bridgman technique. High purity (99.9999 %) *Pb* and *Te* were used for the growth of crystals, which were afterwards additionally purified. The crystals had hole conductivity with typical for *PbTe* hole concentration of the order of $3 \cdot 10^{18}$ cm^{-3}.

The magnetization and magnetic susceptibility of the surface layers were investigated. Since only powder samples could have been manufactured out of surface layers of crystalline ingots, powder samples were used for the study. Particular reference was done on extra-low temperature range up to 1.7 K and low magnetic fields. Meissner effect was used as an indicator of the appearance of superconductivity. As grown and annealed in the atmosphere of oxygen samples were studied.

It is shown that the probability of occurrence of surface superconductivity of *PbTe* crystals correlates with their total magnetic susceptibility. The sample is weak diamagnetic or paramagnetic at high temperature the probability of its superconducting state at low temperature is higher. Superconductivity of *PbTe* surface layers has characteristic features of non-uniform type-II superconductor, such as temperature hysteresis of magnetic susceptibility upon transition to superconducting state, field hysteresis of magnetization and preservation of features of intermediate state in magnetic fields exceeding critical field of type-I superconductor *Pb* at $T \rightarrow 0$ K. Annealing in the atmosphere of oxygen destroys the superconducting state of the samples.

1. Zayachuk D.M., Mikityuk V.I., Shlemkevych V.V., Kaczorowski D., and Ilyina O.S. *Physica C* **483,** (2012), 1.
2. Zayachuk D.M., Ilyina O.S., Mikityuk V.I., Shlemkevych V.V., and Kaczorowski D. *Solid State Sciences*, **38,** (2014), 30.