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# XVI МІЖНАРОДНА КОНФЕРЕНЦІЯ З ФІЗИКИ І ТЕХНОЛОГІЇ ТОНКИХ ПЛІВОК ТА НАНОСИСТЕМ

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# XVI INTERNATIONAL CONFERENCE ON PHYSICS AND TECHNOLOGY OF THIN FILMS AND NANOSYSTEMS

**(dedicated to memory Professor Dmytro Freik)**

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# Point Defects of Silver Doped Lead Telluride

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The issue of improving the efficiency of converting heat into electricity has gained a special importance in recent years in connection with the awareness of exhaustion of fossil fuels and significant emissions of harmful gases into the atmosphere during combustion that pollute the environment, damage the ozone layer and cause global climate changes.

Among all thermoelectric materials lead telluride (*PbTe*) should be noted, as its basic parameters can be changed effectively by doping and forming solid solutions. Especially promising impurity is silver.

In this work, silver doped lead telluride has been synthesized, and its defect structure and thermoelectric properties have been studied.

It has been found that the samples of undoped material and the samples containing impurity < 0.3 at. % are single-phase regardless of the annealing temperature, and at the impurity concentration > 0.5 at. % phase of pure lead (Pb) is presented in ***PbTe:Ag*** samples, which is caused by reaching the solubility limit of impurity.

The dependence of the Hall concentration and mobility of free charge carriers on the amount of introduced silver is characterized by non-monotonic dependence with a maximum, which position depends on the annealing temperature of samples. At annealing temperature 228 °C a maximum corresponds to concentration 0.5 at. % *Ag*, and at annealing temperature 300 °C it corresponds to 0.3 at. % .

Samples of undoped lead telluride obtained from the ingot with stoichiometric mixture by cold pressing with the annealing in air at 228 °C are characterized by ***n***-type conductivity. Silver doping leads to a significant decrease in conductivity, but there is no transition to ***p***-type.

To establish the causes of acceptor action of silver in ***PbTe***, crystal-quasichemical and quasichemical approaches to analysis of *PbTe:Ag* defect subsystem have been used. It has been concluded about the replacement of lead atoms by silver by way of their displacement into the interstices with the subsequent precipitation:

$$Ag^{S} + Pb_{Pb} = Ag_{Pb}^{-} + Pb_i^{2+} + e^{-}; \quad Pb_i^{2+} = Pb^{S} + 2h^{+}.$$

Since the interstitial atom of lead is a double-charged donor $Pb_i^{2+}$ and silver atom in cationic site is singly charged acceptor $Ag_{Pb}^{-}$, it could be an explanation of weak acceptor action of silver.

These assumptions about the mechanism of defect formation in silver doped lead telluride are confirmed by established increase of lattice constant with growth of *Ag* content and appearance of traces of phase of pure lead (*Pb*).