Effect of annealing on magnetic and kinetic properties of $Hg_{1-x-y}Cd_xDy_ySe$ crystals

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Magnetic and kinetic properties of diluted magnetic semiconductor solid solutions $Hg_{1-x-y}Cd_xDy_ySe$ (obtained by the Bridgman method), studied within the temperature rang T = 77 ÷ 300 K under magnetic field H = 0,25 ÷ 5 kOe.

Magnetic susceptibility's (χ) temperature dependence before and after annealing in selenium vapor have the typical form for paramagnets, χ decreases with the temperature increase. The growth of χ with the decrease of T results from the decrease of the disoriented action of atoms thermal vibrations in crystal lattice orientation of the magnetic moments 4f - atoms components in a magnetic field.

Positive (negative) Paramagnetic Curie temperature (θ) for straight-line plots $1/\chi_f = f(T)$ indicates that the "magnetic" atoms has ferromagnetic exchange interaction antiferromagnetic character. Kinks in the $1/\chi_f = f$ (T) dependence may be caused due to the presence of clusters [1] in $Hg_{1-x-y}Cd_xDy_ySe$ crystals or rather their transition from the paramagnetic state in magnetic at T_C.

Averaged in the high-temperature $1/\chi_f = f$ (T) dependences described by the Curie-Weiss law the extrapolation to zero gives value, θ by which we can determine the content of "magnetic" components (y_m) of $Hg_{1-x-y}Cd_xDy_ySe$ samples.

Heat treatment of the $Hg_{1-x-y}Cd_xDy_ySe$ samples in Se vapor leads to a change in the size of the clusters.

The features of the changes in kinetic coefficients with temperature for samples $Hg_{1-x-y}Cd_xDy_ySe$ suggests, that the vacancies in the sublattice Se and interstitial mercury mainly affect on transport phenomena in these crystals. It is known that mercury chalcogenides and solid solutions based on mercury interstitials and vacancies in the chalcogen sublattice are donors.

The temperature dependence of the electrical conductivity σ before and after annealing Se vapor for $Hg_{1-x-y}Cd_xDy_ySe$ crystals are metallic in character, that is σ decreases with increasing temperature due to decreasing mobility of electrons with the growth *T*.

The Hall coefficient $R_H = 1/(en)$ for crystals $Hg_{1-x-y}Cd_xDy_ySe$ is independent on temperature, indicating on the degeneracy of the electron gas. The heat treatment of the samples $Hg_{1-x-y}Cd_xDy_ySe$ in Se vapor leads to a decrease in the electron density. The reduction of the concentration of electrons can be explained by the decrease of the number of vacancies in the selenium sublattice (which are donors) due to their filling by diffusing Se atoms into the crystal from the vapor phase and the transition of the interstitial mercury atoms (which are also donors) from the crystal in vapor phase.

In crystals $Hg_{1-x-y}Cd_xDy_ySe$ electron mobility decreases with increasing temperature, indicating predominance of charge carriers in thermal vibrations of the crystal lattice.

Thermoelectric power for samples of $Hg_{1-x-y}Cd_xDy_ySe$ possesses negative values and increases in absolute value with the rise of temperature, that is reduction in the degree of degeneracy of the electron gas with the increase of *T*.

[1] P.D. Maryanchuk, E.V. Maistruk. *Inorganic Materials* **44** (5), p.475 (2008).