Introduction of the dopant Cr into HgSe leads to an increase in specimen paramagnetism, and it is not possible to describe the behavior of Cr in a diamagnetic matrix using the point model or the point model with consideration of covalence effects.

LITERATURE CITED


MAGNETIC SUSCEPTIBILITY OF MERCURY SELENIDE DOPED WITH IRON

N. P. Gavaleshko, S. Yu. Paranchich, L. D. Paranchich, and M. F. Rybak

The electrical and magnetic properties of mercury selenide single-crystals doped with iron are studied over the temperature range 80-400 K in magnetic fields of 0-8 kOe. The Fe distribution coefficient in HgSe is determined using the isotopic solution method. It is found that the Fe impurity in the mercury selenide lattice is electrically inactive. With growth in Fe concentration the paramagnetism of the specimens studied increases. The results of the magnetic susceptibility study are evaluated within the framework of crystalline field theory.

Introduction of magnetic impurities into a diamagnetic matrix or "spin doping" is an effective method for studying the electron structure of semiconductors [1].

Solid solutions based on gapless (HgTe, HgSe) semiconductors containing f- or d-element as a component form a class of semimagnetic semiconductors with specific properties [2]. Mercury selenide, doped with iron group impurities, or solid solutions of the type Hg_{1-x}Fe_xSe, Cr_xHg_{1-x}Se, etc. are practically unstudied representatives of the semimagnetic semiconductor class. In [3] studies of IR-magneto-absorption in Fe_xHg_{1-x}Se (x = 0.01) found a new type of optical effect analogous to the Shubnikov-de Haas effect. As for magnetic studies, such are practically unknown.

The present study will investigate electrical and magnetic properties of HgSe doped with Fe over the temperature interval 80-400 K. The HgSe doping was carried out by simultaneous fusion of HgSe with the dopant additive with subsequent crystallization by the Bridgman method. Electrical studies were done with direct current and magnetic susceptibility...
Fig. 1. Fe distribution over length of HgSe ingot.

Fig. 2. Temperature dependence of Hall mobility in HgSe specimens and HgSe:Fe, n$_{Fe}$, cm$^{-3}$: 2) 5×10$^{18}$; 3) 5×10$^{19}$; 4) 1×10$^{20}$; 1) HgSe.

Fig. 3. Temperature dependence of HgSe and HgSe:Fe magnetic susceptibility, n$_{Fe}$, cm$^{-3}$: 1) 0; 2) 5×10$^{18}$; 3) 5×10$^{19}$; 4) 1×10$^{20}$.

Fig. 4. Experimental data, n$_{Fe}$, cm$^{-3}$: 1) 5×10$^{18}$; 2) 5×10$^{19}$; 3) 1×10$^{20}$, and theoretically calculated dependences of magnetic susceptibility of Fe ions in HgSe for various values of $\Delta$ and $\lambda$: 2', $\Delta = 2000$, $\lambda = -80$; 3', $\Delta = 2000$, $\lambda = -120$; 2'', 3'', $\Delta = 3000$, $\lambda = -80$.

studies by the Faraday method with specimens 1×1×8 mm in magnetic fields of 0.5-8 kOe. To determine the Fe concentration in the HgSe the isotopic solution method was used with reference specimens. The Fe distribution coefficient in the HgSe was estimated from the measured concentration in each plate, for the given crystal growth conditions (Fig. 1).

Figure 2 shows temperature dependences of Hall mobility for both "pure" and doped mercury selenide specimens. As is evident from the figure, for all specimens the temperature behavior of mobility is identical, with the Hall coefficient being temperature independent in the range 80-400 K, and its value identical for specimens with differing Fe concentration. Low temperature annealing (~200°C) in selenium vapors for two weeks did not change charge carrier concentration.

Figure 3 shows temperature dependences of magnetic susceptibility of HgSe with various concentrations of the impurity Fe. It follows from the figure that with growth in Fe concentration in HgSe specimen paramagnetism increases. In the interval 80-400 K specimen 2 is diamagnetic ($\chi < 0$), although in absolute value its magnetic susceptibility is less than $\chi$ of the undoped specimen. At temperatures below 110 K specimen 3 transforms to a paramagnetic state, while specimen 4 was paramagnetic over the entire temperature interval.

Temperature dependences of magnetic susceptibility of Fe ions

$$\chi_{Fe}^{-1} = \chi_{HgSe<Fe>^{-1} - \chi_{<Fe>}}$$