CONCENTRATION PHASE TRANSITION IN α- AND β-Ag_2Te WITH Ag EXCESS

F.F. ALIYEV
Institute of Physics of Academy of Sciences of Azerbaijan
370143, Baku, Husseyn Javid Avenue, 33

N.A. VERDIYEVA
State Oil Academy of Azerbaijan Republic
370010, Baku, Azadlig avenue, 20

It is established, that atoms of Ag in α- and β-Ag_2Te form two sublattices of Ag atoms. At the transition from first stage Ag(I) to second one Ag(II) the concentrational phase transition in α- and β-Ag_2Te takes place.

Silver telluride belongs to narrow-gap semiconductor, having high electron mobility and low lattice heat conductivity; it has structural phase transition within temperature interval 390÷450 K according the scheme:

$$\alpha_{335K} \rightarrow \alpha_{405K} \rightarrow \beta_{420K} \rightarrow \beta_{440K}$$ [1,2].

The phase transition entails a number of certain electrical and thermal peculiar properties changes. Therefore, research of electrical parameters concentration and temperature dependences is important for definition of application range in electronics.

The investigations with series of Ag_2Te samples of stochiometric composition with excess of Te (up to ~1,0 at.%) and Ag (up to 0,25 at.%) are carried out.

As well known [1], excess of Te up to 1,0 at.% does not initiate the second phase lost and leads to p-Ag_2Te formation without any changes in crystal structure. At the same time it was determined that hole concentration is proportional to the Te content. Excess of Ag in homogeneity region leads to n-Ag_2Te formation.

During researches of kinetic effects it was found out in n-Ag_2Te that excess of Ag right up to ~1,0 at.% leads to increase of electron concentration in α-Ag_2Te up to $n \approx 5{,}0 \cdot 10^{19}$ sm^{-3}, and up to $2 \cdot 10^{19}$ sm^{-3} in β-Ag_2Te. Excess of Ag up to 0,12 at.% sharply decreases n: about on two degrees in α-Ag_2Te and 1,5 in β-Ag_2Te (see the figure), in other words, there is concentration phase transition (CPT). This fact is not available in guides.

Authors supposed that silver can be an electron donor in chalcogenid of silver and give two electrons to conduction band ($Ag^{+} \rightarrow Ag^{3+} + 2e^{-}$), two electron state formed while the process is localized due to interaction with lattice or vacancies or any another defects. Our date obtained on samples with Ag content up to 0,10 at. % in α-Ag_2Te completely confirm the authors' statement [3]. The electron concentration in Ag_2Te and in homogeneity region β-Ag_2Te from excess 0,12 increases proportional to the silver content. That means that excess of Ag plays the role of one-electron donor.

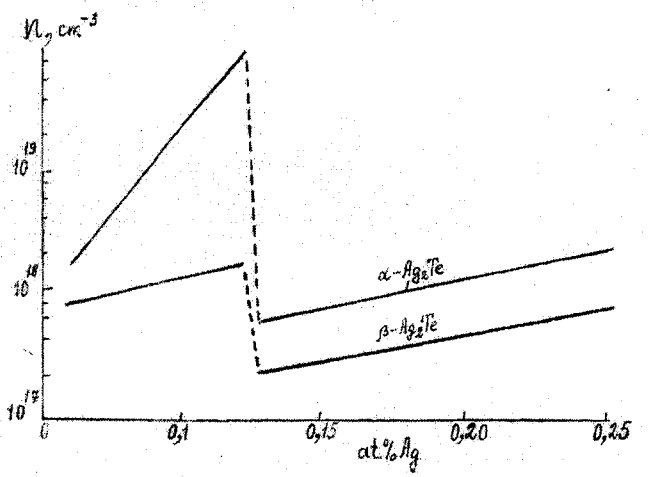

Fig. Electron concentration depending on excess of silver.

In the research [4] is noted, that there are two types of silver atoms with different structures in Ag_2Te: Ag(I) is surrounded by four atoms of Te on 2,87; 2,91; 3,04 and 2,99 Å distances; atom of Ag(II) has five nearest neighbors on 3,04; 3,01; 2,95 and 2,85 Å distances. In both cases the cell holds 4(Ag_2Te) and all atoms occupy 4 level position. According to [5], 6,5 Ag(I) is situated on 8 tetrahedral hollows and 11,5 Ag(II) - on 4 octahedral hollows in high temperature lattice of Ag_2Te, so it statistically occupies 12 positions. By the model [6], 4 Ag(I) occupy 4 from 8 tetrahedral hollows, 2 Ag(II) hold in octahedral hollows with 50 % probability, and 2 Ag(III) situated in disordered form in two positions 16(e) (XXX) at X = 2/3 and 1/3.

Thus, atoms of Ag form two sublattices of silver atoms in both phases. During transition from first position Ag(I) to the second one Ag(II), the concentration phase transition in α- and β-Ag_2Te takes place.

[1] *S.A. Aliev, F.F. Aliev, G.P. Pashaev.* Neorgan. mat., 1993, v.29, № 8, p.1073-1077.
[2] *S.A. Aliev, F.F. Aliev, Z.S. Gasanov.* FTT, 1998, v. 40, № 9, p.1693-1697.
[3] *I.A.Drabkin,B.Ya.Moyjes.* FTP,1987,v.21,9,p.1715-1718.
[4] *A.I. Fruch.* Z.Kristallogr., 1959, v.112, p. 44 - 52.
[5] *G. Llabres, P. Messien.* Bull. Soc. Roy. Sci. Liege, 1968, v.37, № 5-8, p. 329.
[6] *P. Rahles.* Zeit. Physics chem., 1936, v.31, p. 157 - 194.

F.F. Əliyev, N.Ə. Verdiyeva

Ag ARTIQLIĞI İLƏ α- VƏ β-Ag_2Te KRİSTALINDA KONSENTRASİYA FAZA KEÇİDİ

Gümüş atomları Ag_2Te kristalının α- və β-fazasında iki cür alt qəfəs əmələ gətirdiyi müəyyən olunmuşdur. Ag(I) vəziyyətindən Ag(II)-yə keçidində α- və β-Ag_2Te kristalında konsentrasiya faza keçidi baş verir.

Ф.Ф. Алиев, Н.А. Вердиева

КОНЦЕНТРАЦИОННЫЙ ФАЗОВЫЙ ПЕРЕХОД В α- И β-Ag_2Te С ИЗБЫТКОМ Ag

Установлено, что атомы Ag в α- и β-Ag_2Te образуют две подрешетки атомов серебра. При переходе из первого положения Ag(I) во второе Ag(II) происходит концентрационный фазовый переход в α- и β-Ag_2Te.

Дата поступления: 20.04.01 *Редактор: Ю.Г. Асадов*