

Structural and Semiconducting Properties
of the System $\text{Ga}_2\text{Se}_3\text{-In}_2\text{Se}_3$

B.Čelustka, S.Popović and M.Kranjčec
Institute "Ruđer Bošković", Zagreb

The structural parameters of the solid solutions in the system $\text{Ga}_2\text{Se}_3\text{-In}_2\text{Se}_3$ were not investigated previously in great details. Semiconducting properties were not studied at all and no information was published in literature.

The compounds Ga_2Se_3 and In_2Se_3 were prepared independently by direct synthesis of extremely pure elements. Their solid solutions were prepared in evacuated and sealed quartz tubes melting the appropriate molar weights of the components at temperature of 1070°C . The whole region of the system was covered by 26 different concentrations for measurements of electrical and optical properties, out of which 16 samples were also investigated by X-ray diffraction.

In the whole range of concentrations in the system $\text{Ga}_2\text{Se}_3\text{-In}_2\text{Se}_3$ there exist four different regions, i.g. four distinct phases have been established stable at room temperature. Within 100% and approx. 75% (molar) of Ga_2Se_3 the existing phase is of zinc blende type as pure Ga_2Se_3 itself. Similarity with pure Ga_2Se_3 manifests also in electrical properties, the phase shows intrinsic conductivity with the energy gap of 2 eV. From approx. 88% to 55% of Ga_2Se_3 exists a hexagonal phase designated as δ_2 . Electrical conductivity of this phase is extrinsic and caused by defects in the crystal lattice. The phase, designated as δ_1 and which is stable from 55% up to 0,5% of Ga_2Se_3 , is also hexagonal. This is a transparent, red phase, for which spectral photoconductivity, optical extinction and sharpness of the X-ray diffraction lines show their maximum values at concentration of 40% Ga_2Se_3 . From 2% to zero percent of Ga_2Se_3 δ_1 phase transforms into room temperature α rhombo-

hedral phase of In_2Se_3 . In this region electrical conductivity increase for twelve orders of magnitude.

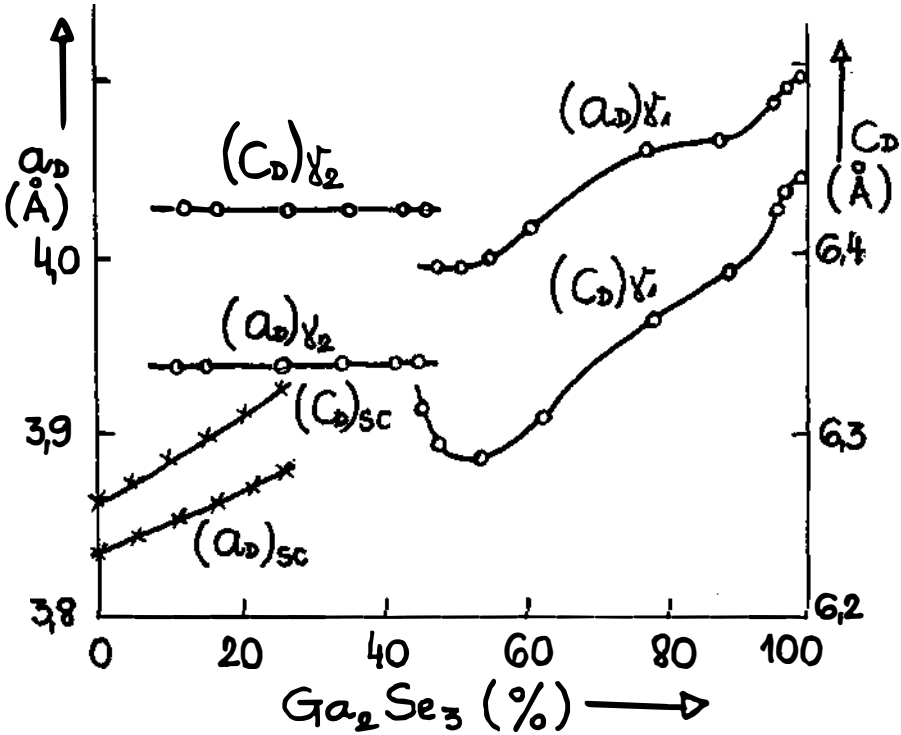


Figure 1

Figure 1 shows "deduced" parameters of the crystal unit cell (which correspond to one half of the phase diagonal and two thirds of body diagonal of the unit cell of the zinc blende phase) as a function of concentration of Ga_2Se_3 in the system.

Figure 2 shows dependence of electrical conductivity of particular phases in the system also as a function of concentration of Ga_2Se_3 .

As the γ_1 phase in the system was in the center of

of our interest, the DTA analysis was performed on samples obtained from the ingot of 25% of Ga_2Se_3 . The DTA analysis performed from room temperature gave only one signal at $(820 \pm 5)^\circ\text{C}$ corresponding to the melting point of the system. It indicates that γ_1 phase has no phase transformation above room temperature.

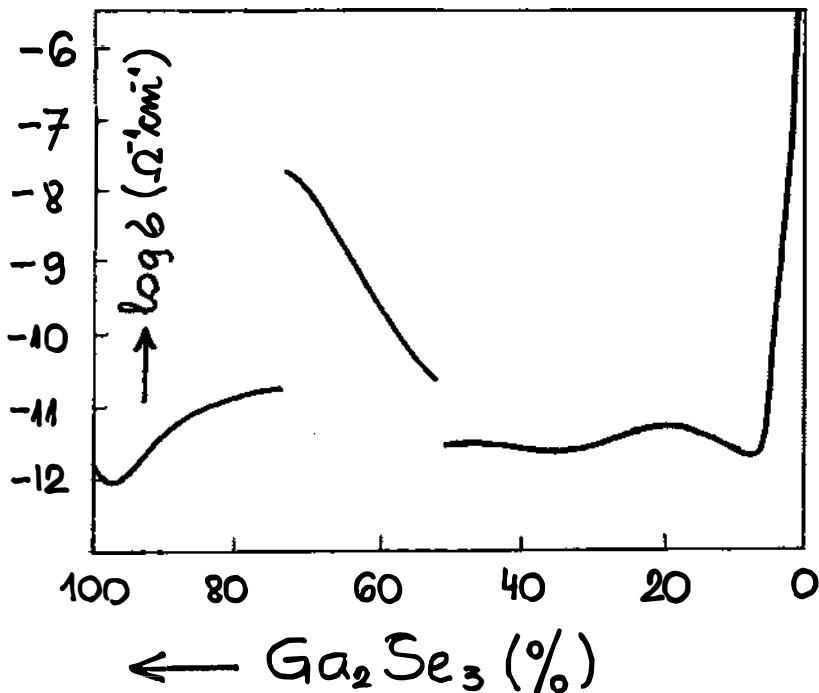


Figure 2

Bibliography:

1. A.A.Vaipolin and V.S.Grigoryeva, *Issledovania po poluprovodnikam*, Gosudarstvenoe izdatelstvo Kartja Moldovenjaske, Kishinev, 1964, p.77 .