

Interaction of the Triple Thallium Halogenides of Gallium, Indium and Ytterbium.

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We investigated phase equilibrium of the TlGaS_2 - TlInSe_2 and TlGaS_2 - TlYbS_2 systems. The results of physical and chemical analysis of the system TlGaS_2 - TlInSe_2 showed that this system is a eutectic type quasi-binary with wide regions of solubility. On the basis of TlGaS_2 and TlInSe_2 solid solutions are formed which reach 45 mol %. The eutectic is melted at 976 K and corresponds to the composition of $(\text{TlGaS}_2)_{0.50}(\text{TlInSe}_2)_{0.50}$. The alloys of the system TlGaS_2 - TlYbS_2 , which contain up to 50 mol % of TlYbS_2 , annealed at 950 K for 570 hours, while alloys with the concentration of TlYbS_2 50-100 mol % - at 1080 K for 640 hours. According to the results of differential-thermal analysis in the system TlGaS_2 - TlYbS_2 with the relationship of components 1:1 the compound of $\text{Tl}_2\text{GaYbS}_4$ is formed with congruent melting at a temperature of 1380 K. The region of homogeneity for this compound is absent. On the basis of TlGaS_2 , solid solutions up to 8 mol % of TlYbS_2 are formed at room temperature. A non-variant eutectic point relates to the composition of $(\text{TlGaS}_2)_{0.84}(\text{TlYbS}_2)_{0.16}$ and a temperature of 1085 K. The study of the optical absorption edge of single crystals of solid solutions $\text{Tl}(\text{GaS}_2)_{1-x}(\text{InSe}_2)_x$, where $x=0-1$, showed that the structure of the edge of solid solutions was identical to the structure of the absorption edge of TlGaS_2 , formed with a direct exciton. The temperature dependences of the position of the exciton peak in the range of temperatures of 77-180 K indicate an increase in the width of the forbidden gap of all investigated compositions with the temperature. The absorption edge of $\text{TlGa}_{1-x}\text{Yb}_x\text{S}_2$ single crystals was also investigated. In $\text{TlGa}_{0.995}\text{Yb}_{0.005}\text{S}_2$ the temperature shear coefficient of the exciton peak in the range of temperatures 77-200 K was $DE_{\text{ex}}/DT=1.5\cdot 10^{-4}\text{eV/K}$, i.e., has positive sign, as for the TlGaS_2 . A partial substitution Ga-Yb leads to the small shift of absorption edge into the long-wave region.