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Photoluminescence and Cathodoluminescence of Layered $ZnIn_2S_4$ and $Zn_2In_2S_5$ Compounds Thermally Processed in Sulfur Vapor and Vacuum

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Abstract

The phenomena of nonradiative recombination have been investigated for various semiconductors of the family of $Zn_xIn_2S_{3+x}$ (x = 1, 2, 3) compounds that exhibit photoluminescence in a wide energy range. These properties are promising for a vast range of applications in various branches of engineering. The luminescent properties of the layered compounds were investigated under the action of accelerated electrons – cathodoluminescence - and X-ray radiation. The experimental results of investigations conducted on the luminescent properties of layered compounds $ZnIn_2S_4$ (three-packet polytype III), $Zn_2In_2S_6$ (III), and $Zn_3In_2S_6$ (I) are presented. Processing of layered compounds of the $Zn_xIn_2S_{3+x}$ (x = 1, 2, 3) family in sulfur vapor leads to the displacement of the photoluminescence emission maximum to the low energy region, and the thermal processing in vacuum shifts it towards the high energy range. The obtained results show that it is possible to change the limits of the spectral range of light radiation from 1.36 to 2.71 eV. The calculation of the excitation rate on the material's surface and in its volume (Rs and Rv) under the action of accelerated electrons and X-ray radiation, a high level of excitation energies and excitation current allow one to specify the structure and nature of the energy levels in the forbidden energy band. The basic bands in the luminescent emission spectrum of zinc and indium bisulfides $Zn_xIn_2S_{3+x}$ (x = 1, 2, 3): a red band with the maximum at 1.79 eV, an orange band with the maximum of 2.08 eV, and a yellow-green band with a maximum at 2.34 eV were identified.

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Keywords: layered compounds, photoluminescence, cathodoluminescence, bisulfides, accelerated electrons, X-ray radiation, nonradiation recombination

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