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Urbach's tail in the absorption spectra of $CuIn_5Se_8$ and $CuGa_3Se_5$ single crystals

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Abstract

Optical absorption spectra of $CuIn_5Se_8$ and $CuGa_3Se_5$ single crystals grown by chemical vapour transport were investigated in the range of 10–300 K. The logarithmic variation of the absorption coefficient with photon energy observed in both compounds just below the fundamental absorption edge shows a linear dependence at different temperatures in agreement with Urbach's rule. The Urbach energy as well as the energy associated with the electron/exciton–phonon interaction related to Urbach's tail are estimated. The latter is found to be around 52 (41) meV for $CuIn_5Se_8$ ($CuGa_3Se_5$). It is lower than that 58 (60) meV earlier reported for these compounds and confirms higher structural quality of samples studied. It is shown that the temperature of the Urbach energy can be modeled in $CuIn_5Se_8$ ($CuGa_3Se_5$) as an Einstein oscillator with the Einstein temperature equal to 222 (266) K. It is found that in the material studied structural disorder is dominant at 300 K. It may be caused by some compositional deviation from stoichiometry. The latter was observed in the studied samples by using the EDAX method.