**Multiwavelength excitation Raman scattering of Cu2ZnSn1-xGex(S,Se)4 solid solution in single crystals for band gap engineering and earth abundant photovoltaic application**

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**Abstract.** Raman spectroscopy was used to evaluate the zone-center optical phonons of Cu2ZnSn1-xGex(S,Se)4 single crystals, leading to a complete characterization of their vibrational properties. High quality of thesamples grown by chemical vapour transport was approved by analysis of X-ray dispersion and diffraction spectra. The analysis has been performed by using Raman scattering excited with different wavelengths, which allowed presenting the ﬁnger print spectra of the solid solutions in the resonant and non-resonant conditions. The Raman spectra show more than 30 characteristic peaks for different Cu2ZnSn1-xGexS4 and Cu2ZnSn1-xGexSe4 samples. The two mode behavior was found for most of the peaks in both solutions. However, the most intense mode exhibited one mode behavior in selenium containing compounds and two mode behavior in sulfur containing compounds. Possible reasons for this difference are discussed.

**Keywords:** Cu2ZnSn1-xGex(S,Se)4, single crystals, X-ray,raman spectroscopy, Fingerprint spectra

<http://www.sciencedirect.com/science/article/pii/S0925838816327694>