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# Review on earth-abundant and environmentally benign Cu-Sn-X(X=S, Se) nanoparticles by chemical synthesis for sustainable solar energy conversion

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## Graphical abstract

### Abstract

This article provides a status review on the chemical synthesis, structural transformation, morphological engineering, and band gap energy tuning of Cu-Sn-S(Se) nanoparticles (NPs). As the fabrication of Cu-Sn-S(Se) NPs based solar cells technology faces several problems, the photovoltaic behavior of Cu-Sn-S(Se) NPs is examined using photocurrent response. Further, the influence of nanoparticle ink properties on the deposition of NPs based absorber layer was discussed in detail. The challenges and prospects of the nanoparticle based Cu-Sn-S(Se) NPs solar cells are discussed. In addition, other photovoltaic applications such as photocatalytic, hydrogen production, and dye-degradation of Cu-Sn-S(Se) NPs have been also outlined.

### Abbreviations

Ab	ambient or atmosphere
<sup>t</sup> Bu <sub>2</sub> Se <sub>2</sub>	di-tert-butyl diselenide
CR	conventional heating under refluxing conditions
DDA	dodecylamine

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