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Original Article

Enhanced photovoltaic effects of microwave-assisted polyol-synthesized $Cu_2(Pd/Zn)SnS_4$ kesterite nanoparticles

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Highlights

- â€¢The suppression of the detrimental antiâ€“site defect in the $Cu_2(Pd/Zn)SnS_4$ kesterite nanomaterial, by the replacement of Zn atoms with Pd atoms.
- â€¢Pd-induced photoluminescence redshift emission ($\lambda_{max(Emission)}$Â =Â 755Â nm) for CPTS nanomaterial.
- â€¢Electrochemical double layer capacitance (EDLC) value of 0.5Â Î¼F cmâ€“2 was obtained for CPTS nanomaterial.
- â€¢CPTS-based photovoltaic cell device gave improved open circuit voltage (900Â mV) and fillâ€“factor (83.4%) values.
- â€¢Preliminary photovoltaic efficiency of 1.01% was achieved for CPTS-based device for a superstrate device architecture.

Abstract

Kesterite materials show excellent optical and semiconductive properties for use as pâ€“type absorber layer in photovoltaic (PV) applications, but they have a high open circuit voltage deficit ($V_{oc,def}$) due to high antisite defect and secondary phase

formation, resulting in poor device performance. This work reports a PV cell composed of Cu_2PdSnS_4 (CPTS) nanoparticles as an absorber layer yielding highly improved V_{oc} of 900Â mV, which is two times that of fabricated pristine Cu_2ZnSnS_4 (CZTS) PV cell. Improved PV cell parameters such as fillâ€“factor (*FF*) of 83.4% and power conversion efficiency (*PCE*) of 1.01% were obtained for CPTS devices which are 3â€“fold that of pristine CZTS devices. Optical studies revealed enhanced redshift absorption for CPTS nanoparticles. Electrochemical studies show improved current production, high electron mobility and low charge resistance for CPTS nanoparticles. This study shows that the improved photovoltaic properties can be attributed to enhancement in the bulk properties when Zn atoms are replaced by Pd atoms in kesterite nanomaterials as absorber layer material for PV applications.

Keywords

Antisite defects; Copper palladium tin sulfide (CPTS); Kesterite; Nanomaterial and photovoltaic cell

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