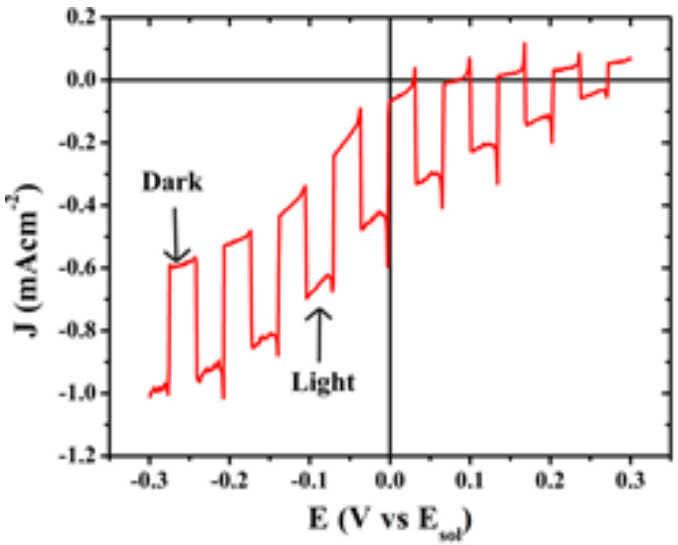
Earth-Abundant Cu-based Chalcogenide Materials as Photovoltaic Absorbers

Scientific Achievement

Photovoltaic (PV) conversion is demonstrated for the first time in Cu_3PSe_4, a member of the Cu_3MCh_4 (Ch = S,Se; M = P, As, Sb) materials family, identified using the inverse design method as absorber candidates that have stronger solar absorption than $CuInSe_2$.

Significance and Impact

The Cu_3MCh_4 materials family provides a unique opportunity for addressing needs in single- and multijunction cells for both PV and photo-electrochemical water splitting with a single, inexpensive set of absorber materials.



Photovoltage and photocurrent generation under illumination in Cu_3PSe_4 in a photoelectrochemical cell.

Research Details

- Absorber application of Cu_3PCh_4 predicted by the Spectroscopic Limited Maximum Efficiency (SLME) computational tool (L. Yu et al., *Adv. Energy Mater*. 2013 **3** *43*).
- $Cu_3PS_{4-x}Se_x$ ($0 \leq x \leq 4$) exhibits tunable bandgaps in the $1.4 \leq E_G \leq 2.4$ eV range.
- Photoelectrodes fabricated from Cu_3PSe_4 exhibit *p*-type photoresponse and an open-circuit voltage of 0.12 V and short-circuit current density of 0.25 mA/cm^2.
- Favorable hole carrier transport properties with hole mobility of 10 cm^2/Vs, comparable to CIGS.

V. Itthibenchapong, R.S. Kokenyesi, A.J. Ritenour, L.N. Zakharov, S.W. Boettcher, J.F. Wager, and D.A. Keszler, *J. Materials Chemistry C* **1** 657 (2013). DOI: 10.1039/C2TC00106C