Earth-Abundant Cu-based Chalcogenide Materials as Photovoltaic Absorbers

Scientific Achievement
Photovoltaic (PV) conversion is demonstrated for the first time in Cu$_3$PSe$_4$, a member of the Cu$_3$MCh$_4$ (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$_3$MCh$_4$ 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.

Research Details
- Cu$_3$PS$_{4-x}$Se$_x$ (0 ≤ x ≤ 4) exhibits tunable bandgaps in the 1.4 ≤ E$_G$ ≤ 2.4 eV range.
- Photoelectrodes fabricated from Cu$_3$PSe$_4$ 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.