Combining an Earth-abundant chalcopyrite with a silicon layer could significantly boost conversion efficiency above that of single-junction silicon solar cells.

A current technological challenge in photovoltaics (PV) is to implement a lattice-matched, optically efficient material to be used in conjunction with silicon for tandem PV cells.

III-V materials currently hold the world-record conversion efficiencies for both single- and multijunction cells. Researchers at the National Renewable Energy Laboratory (NREL), collaborating with the Colorado School of Mines, are investigating materials that have similar properties to the III-V materials, but that are also lattice-matched to silicon. The II-IV-V$_2$ chalcopyrites are a promising class of materials that could satisfy both of these criteria.

NREL researchers have synthesized bulk single-crystalline ZnSiP$_2$, and characterized the material by structural and optical techniques. ZnSiP$_2$ is a member of the II-IV-V$_2$ class of materials and is known to have a bandgap of ~2 eV and a lattice mismatch with silicon of 0.5%. In addition, its elements are Earth abundant.

NREL has grown single crystals of ZnSiP$_2$ by a flux growth technique that results in thin platelets that are up to 1 mm thick, 4 mm wide, and 10 mm long. Structure and phase purity have been confirmed by X-ray diffraction. Initial optical measurements show strong luminescence and confirm an ~2-eV bandgap. The research has shown that there is no sub-bandgap absorption that would be detrimental to the silicon cell performance, and that ZnSiP$_2$ forms an epitaxial interface with Si.

This material, in conjunction with silicon PV, could find an application as a monolithic tandem layer, as well as a passivated contact or surface-passivation layer.

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