NREL Highlights SCIENCE

Scientists Identify New Quaternary Materials for Solar Cell Absorbers

Research provides insight for exploring use of Earth-abundant quaternary semiconductors for large-scale solar cell applications.

For large-scale solar electricity generation, it is critical to find new material that is Earth abundant and easily manufactured. Previous experimental studies suggest that Cu_2ZnSnS_4 could be a strong candidate absorber materials for large-scale thin-film solar cells due to its optimal bandgap, high adsorption coefficient, and ease of synthesis. However, due to the complicated nature of the quaternary compound, it is unclear whether other quaternary compounds have physical properties suitable for solar cell application.

Researchers at the National Renewable Energy Laboratory (NREL), Fudan University, and University College London have performed systematic searches of quaternary semiconductors using a sequential cation mutation method in which the material properties of the quaternary compounds can be derived and understood through the evolution from the binary, to ternary, and to quaternary compounds.

The searches revealed that in addition to Cu_2ZnSnS_4, $Cu_2ZnGeSe_4$ and $Cu_2ZnSnSe_4$ are also suitable quaternary materials for solar cell absorbers. Through the extensive study of defect and alloy properties of these materials, the researchers propose that to maximize solar cell performance, growth of Cu_2ZnSnS_4 under Cu-poor/Zn-rich conditions will be optimal and the formation of $Cu_2ZnSn(S,Se)_4$ alloy will be beneficial in improving solar cell performance.

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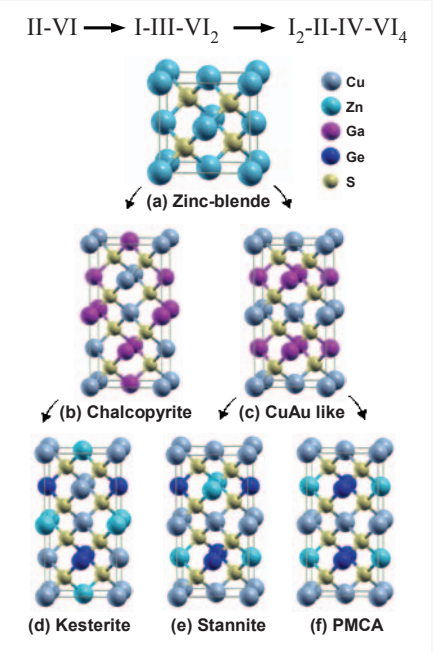

*Evolution of crystal structures of **zincblende** derived binary, ternary, and quaternary compounds.*

Key Research Results

Achievement

Research reveals that in addition to Cu_2ZnSnS_4, $Cu_2ZnGeSe_4$ and $Cu_2ZnSnSe_4$ are also suitable quaternary materials for solar cell absorbers.

Key Result

Researchers propose that to maximize solar cell performance, growth of Cu_2ZnSnS_4 under Cu-poor/Zn-rich conditions will be optimal and the formation of $Cu_2ZnSn(S,Se)_4$ alloy will be beneficial in improving solar cell performance.

Potential Impact

This research provides insight for exploring use of Earth-abundant quaternary semiconductors for large-scale solar cell applications.

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