Stabilized Copper Selenide Thermoelectric Materials and Methods of Fabrication

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OVERVIEW

Enhanced stability and thermoelectric properties of new copper selenide (Cu2Se) material

- A material that shows chemical and structural stability, scalable to large production formats
- An option for the p-type component of thermoelectric generators (TEGs)

BACKGROUND

Thermoelectric generators (TEGs) are devices that directly convert heat to electricity and have been useful for generating power from waste heat and in remote or otherwise inhospitable environments. They offer the promise of widespread power generation from waste heat sources in a variety of industries, such as the manufacturing of steel. The widespread deployment of TEGs has been hampered because the most effective thermoelectric materials contain lead, which can present health hazards. Many of the candidate materials to replace current lead-containing TEG devices suffer from intrinsic chemical instability at elevated temperatures. This list includes copper selenide (Cu2Se), a compound with a high figure of merit (ZT) value indicating excellent performance in TEGs, though it lacks chemical stability. As such, new approaches are needed to improve the effectiveness of thermoelectric generators.

INNOVATION

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Category

Materials
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Researchers have developed a p-type thermoelectric material composed of earth-abundant metals that has excellent figures of merit over a range of operating temperatures from 25-575 degrees Celsius. This material demonstrates chemical and structural stability, addressing the largest areas of concern for competing thermoelectric materials generated from earth-abundant metals. The characteristics of the material result from nanometer-scale inclusions within the bulk material that are generated during the manufacturing process by the addition of a metal that has poor solubility within the bulk material. Manufacturing involves a two-step process that is scalable to large production formats. The available technology is therefore an excellent material for the p-type component of a TEG. Development of a complementary n-type material that is also lead-free will enable a fully lead-free, stable, and high performing TEG device. Such a device would be essential for the expanded use of TEGs in industries ranging from consumer electronics and medical devices to the automotive and large-scale power production industries.