Scilight

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Maximizing the efficiency of transverse thermoelectric generators

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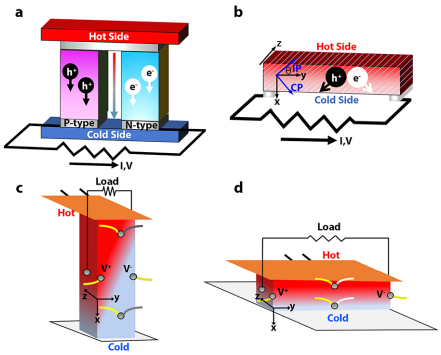
Goniopolar materials and device geometry aid in generator waste heat recovery.



Conventional thermoelectric devices are constructed from two materials arranged in a longitudinal series with one material conducting negatively charged carriers and the other conducting positively charged carriers. Because heat and current flow occur in the same direction, this geometry results in irreversible efficiency losses and thermal degradation of the hot end contacts.

Scudder et al. experimentally explored device design considerations for optimizing the performance of transverse thermoelectric generators, which have the potential to overcome the challenges presented by their traditional counterparts.

Using a single goniopolar material, an electric current can be generated perpendicular to heat flow in transverse devices, allowing the placement of electrical contacts away from hot ends.

“Transverse thermoelectrics have received very little attention experimentally because only a few goniopolar materials exist currently,” said co-author Joshua Goldberger.

One goniopolar compound, rhenium silicide (Re_4Si_7), exhibits both positive and negative carrier behavior along different directions of the crystal, making it an ideal choice for use in transverse thermoelectrics.

The researchers also found that the appearance of transverse thermal gradients in the Re_4Si_7 generator showed significant differences in performance between isothermal and adiabatic geometries. The isothermal configuration allowed for a larger transverse electric field with a minimal transverse thermal gradient and resulted in a much more efficient generator.

“Our study shows experimentally that not only can transverse thermoelectric generators be created, but they can have virtually no efficiency losses, provided the geometry of heat flow is properly account for,” said Goldberger.

Source: “Adiabatic and isothermal configurations for Re_4Si_7 transverse thermoelectric power generators,” by Michael R. Scudder, Karl G. Koster, Joseph P. Heremans, and Joshua E. Goldberger, *Applied Physics Reviews* (2022). The article can be accessed at https://doi.org/10.1063/5.0073354.