Challenges of Thermoelectric Generators and Coolers

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MOTIVATION

- Performance of a Thermoelectric device is based on the Figure of Merit expressed as,

$$zT = \frac{\sigma S^2}{\kappa} T \quad (1)$$

Where **σ** is electrical conductivity, S is Seebeck coefficient, κ is thermal conductivity, and T is temperature.

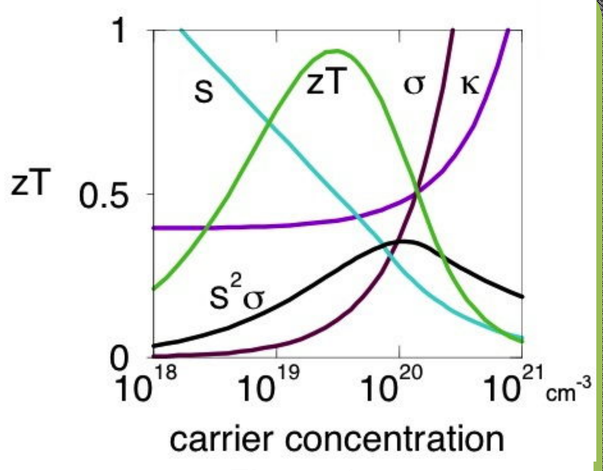

Figure 1

- Figure 1 shows the interdependence between **σ**, S, and κ, and their influence on zT. This interdependence illustrating the challenges in designing an optimal zT material.
- We demonstrate these challenges using a Silicon Germanium alloy and doped Bismuth Telluride thermoelectric materials.

CONCEPT Power Generation and Cooling

Cooling Process

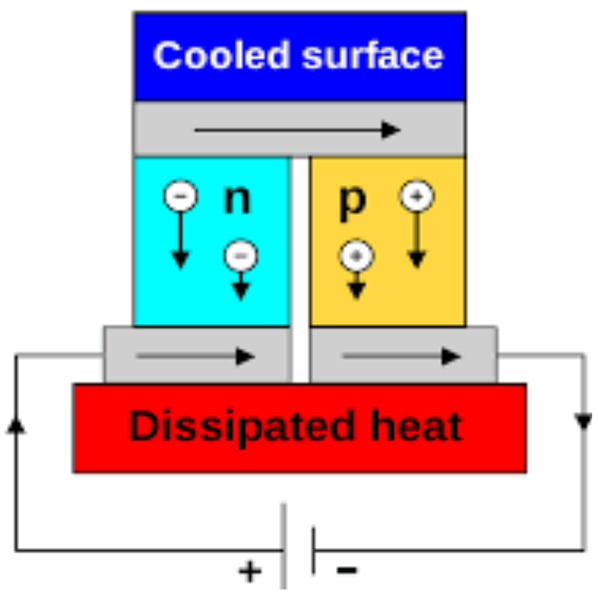

Figure 2: Schematic illustration of a thermoelectric cooling device

Power Generation

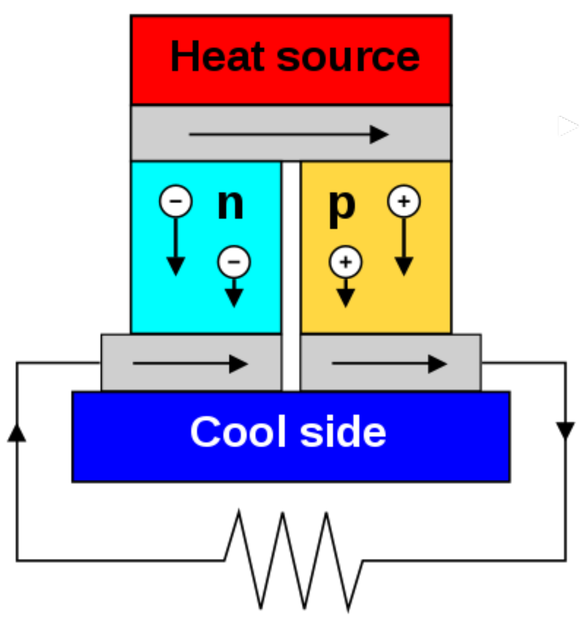

Figure 3: Schematic illustration of a thermoelectric power generation device.

RESULTS

Si-Ge Alloy

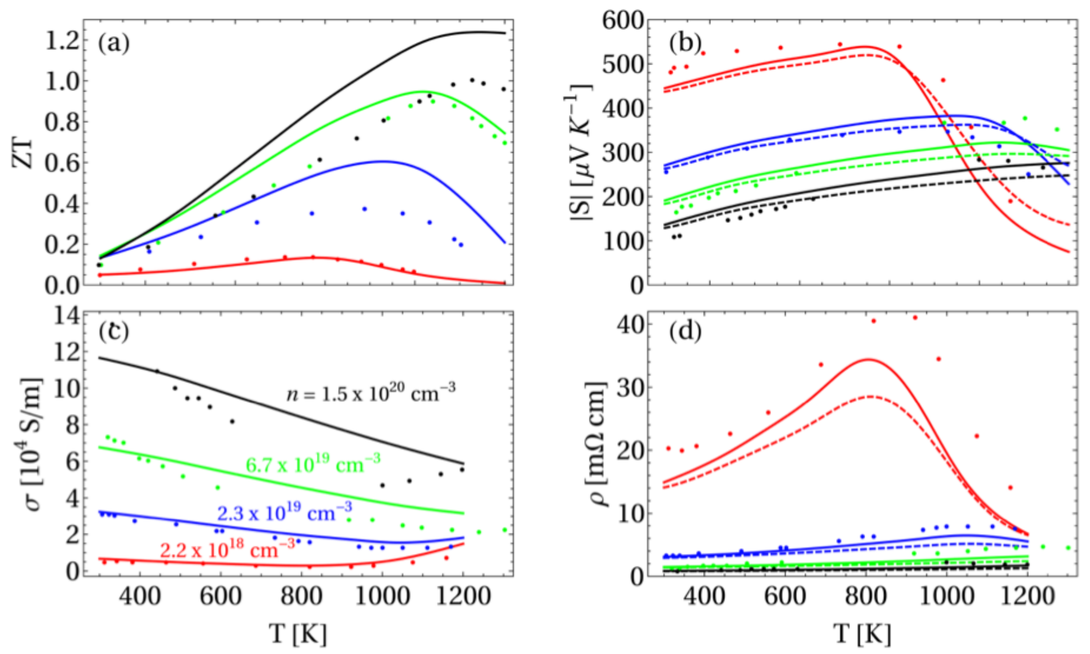

Figure 4: Thermoelectric properties of a 30% Ge alloy vs Temperature T for various doping concentrations. The graphs depict relationships between the following values and temperature; (a) Figure of Merit, (b) Seebeck coefficient S, (c) electrical conductivity σ, and (d) electrical resistivity ρ.

Doped Bi_2Te_3

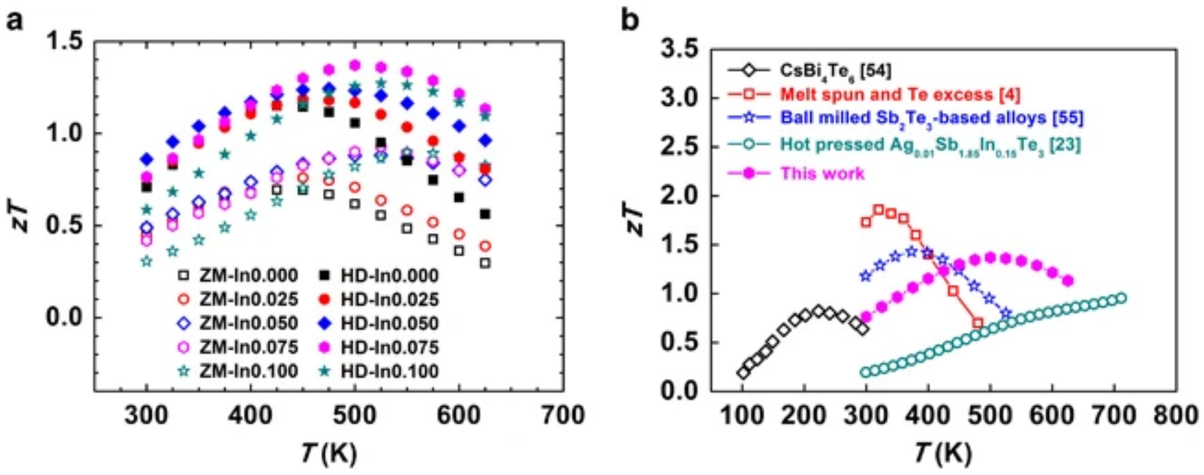

Figure 5: (a) The dependance of zT of Bismuth Telluride ($Bi_{0.3}Sb_{1.625}In_xTe_3$) on temperature at different indium doping concentrations. (b) A comparison of the zT-Temperature relation of several materials.

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CONCLUSIONS/FUTURE WORK

- The zT is influenced by doping concentration.
- The doping concentration affect the three interdependent parameters, thus the challenge in designing an optimal material.
- We intend on using the data gathered to aid the development of our product, which will utilize the Peltier effect to extract drinkable water from the atmosphere.

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