UNIVERSITY of HOUSTON
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Enhancing Thermoelectric Performance in Single-Crystal-Like Semiconducting Films by Tuning the Carrier Scattering Mechanism

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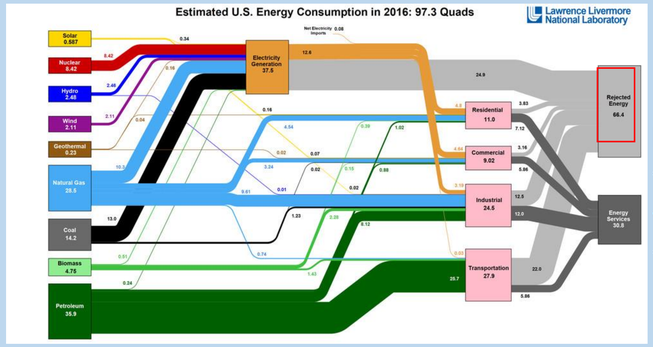
Motivation

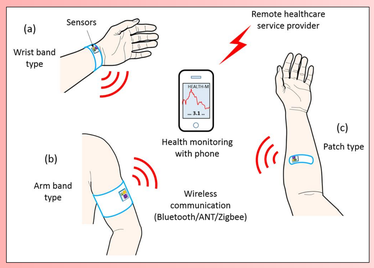


Rejected Heat Energy from Industry → 3 year worth of energy for Texas !

WASTE ENERGY HARVESTING

High Temp. Heat Recovery

Low Temp. Heat Recovery



Theory

- Physicist "Thomas Johann Seebeck" (1821)
- Thermoelectric effect is direct conversion of temperature differences to electric voltage and vice versa.
- Thermoelectric device efficiency (figure of merit)

$$zT = \frac{\sigma S^2 T}{k}$$

σ- Electrical Conductivity, S – Seebeck Coefficient and *k* – *lattice thermal conductivity*

Literature Review

- Thermoelectric devices are solid-state energy conversion (reliable)
- Low energy conversion efficiency 🤔

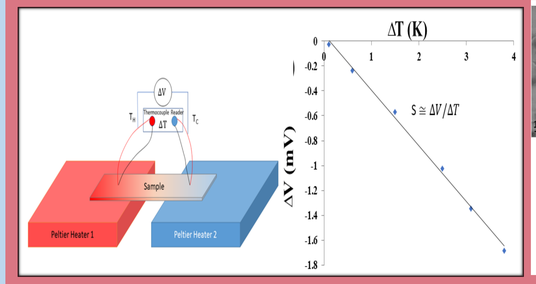
Two main approaches to enhance the thermoelectric (TE) efficiency

1. Phonon Engineering
2. Electronic-structure Engineering (**Power Factor - σS^2**)

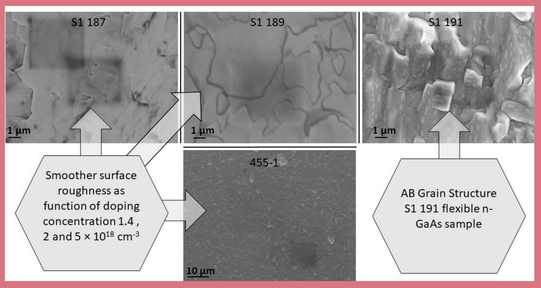
Majority of work → Reducing lattice thermal conductivity *(k)*

We present the PF enhancement in **state-of-the-art flexible single crystal like GaAs thin films.**

Experiment



Setup for measuring Seebeck coefficient of various GaAs thin film flexible samples

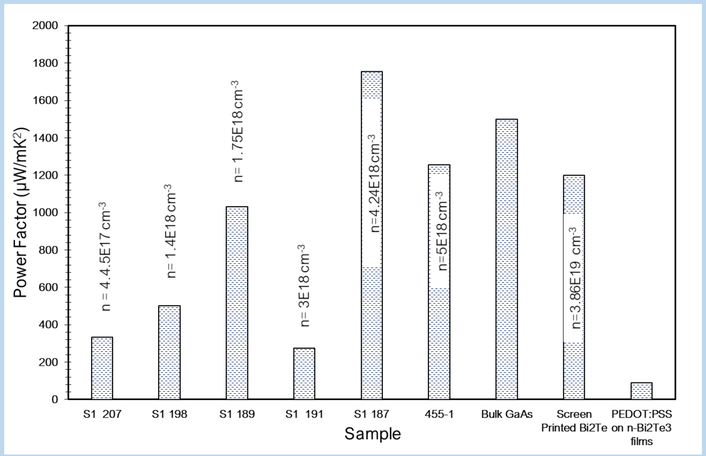


Scanning Electron Microscopy images of different GaAs thin Samples.

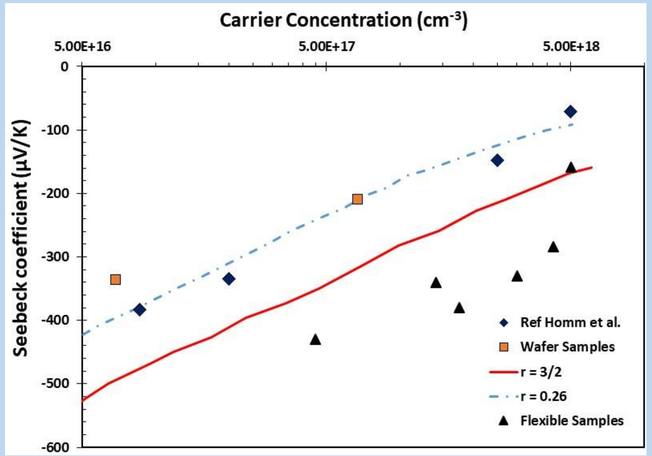
Conclusion

- We shows enhanced Power factor for low cost GaAs flexible thin films beating power factors for state of the art screen printed BiTe TE.
- Further research is on going to explain the carrier mobility paradoxically increase as a function of carrier concentration.

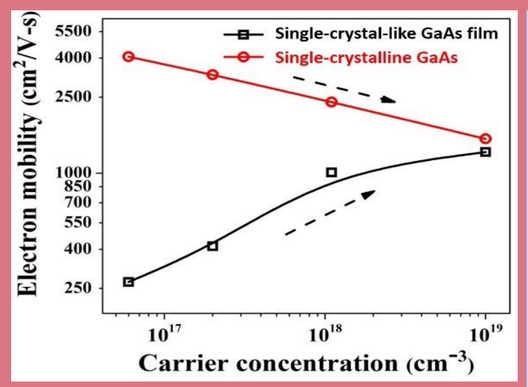
Results



Power factor



Pisarenko Plot showing the Seebeck Coefficient vs. carrier concentration



Electron mobility vs. carrier concentration for single-crystal-like flexible GaAs film in comparison to single crystal GaAs

Reference

https://energy.gov/articles/could-teg-improve-your-cars-efficiency