Silicon for thermoelectrics?

Recently improved figure of merit for silicon nanowires:

\[ ZT = \frac{S^2 \sigma T}{k} \approx 0.6 \]

+ Si inexpensive and abundant
+ immense technological background already at hand
+ porous Si is nanostructured but macroscopic
+ large scale fabrication possible

Porous silicon fabrication

1. Electrochemical etching from Si wafers [1]
2. Liquid-phase doping (Boron or Phosphor)
3. Surface passivation (RTA)

Thermal properties of porous Si[2]

- \( \kappa \) vs. temperature - measurement with 3\( \omega \) method
- \( \kappa \) vs. structure size - comparison with Si nanowires
- thermal conductivity modeling: \( \kappa = \frac{1}{3} cv_{eff} \)
- higher thermal conductivity than wires

Electrical properties of porous Si

- structure size 44 nm
- successful doping
- tunable electrical properties
- ZT superior to bulk Si
- decreased electron mobility
- smaller structure size necessary

Summary

- successful fabrication of 100 \( \mu \)m porous Si films
- decrease in thermal conductivity and electrical conductivity => only moderate ZT enhancement
- ZT superior to bulk, more optimization required

References

[2] de Boor et al., submitted
[3] Li et al., APL, 2003, 83, 2934