Thermoelectric Characterization of Silicon

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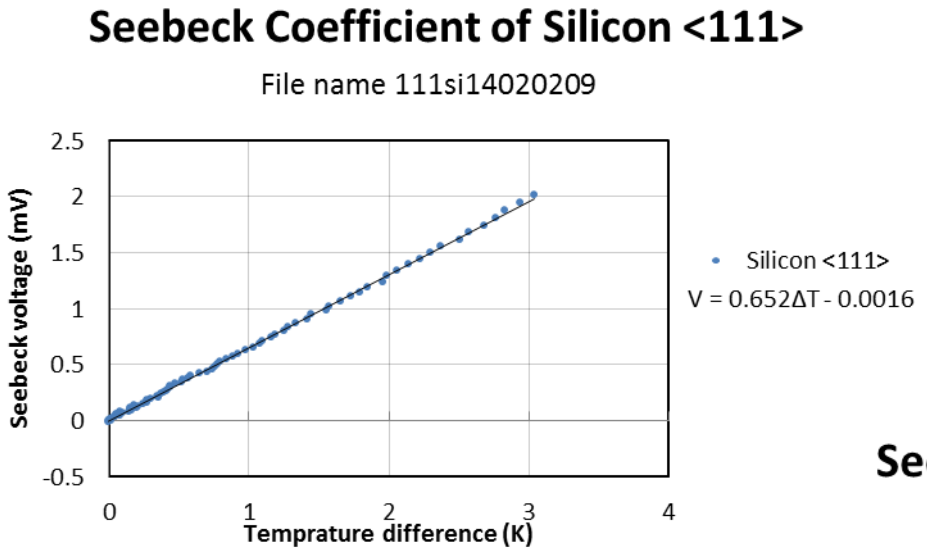
The Samples

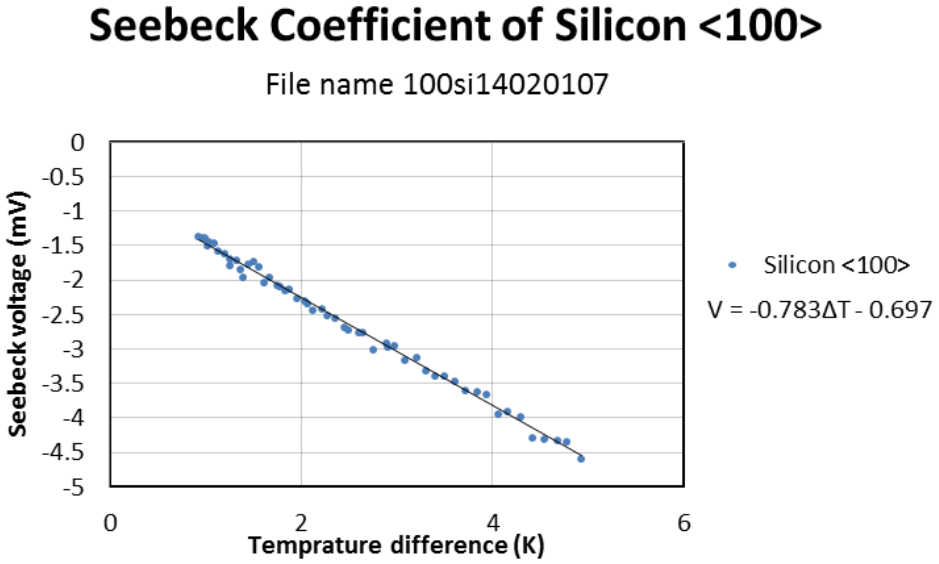
- The first sample was doped to be p type grown in the <111> configuration
- This sample was 650 µm thick
- Resistivity was marked as $0.008\Omega cm<\rho<0.02\Omega cm$

- The second sample was doped to be n type grown in the <100> configuration
- This sample was 620 µm thick
- Resistivity was marked as $0.01\Omega cm<\rho<0.025\Omega cm$

Experimental Seebeck Data



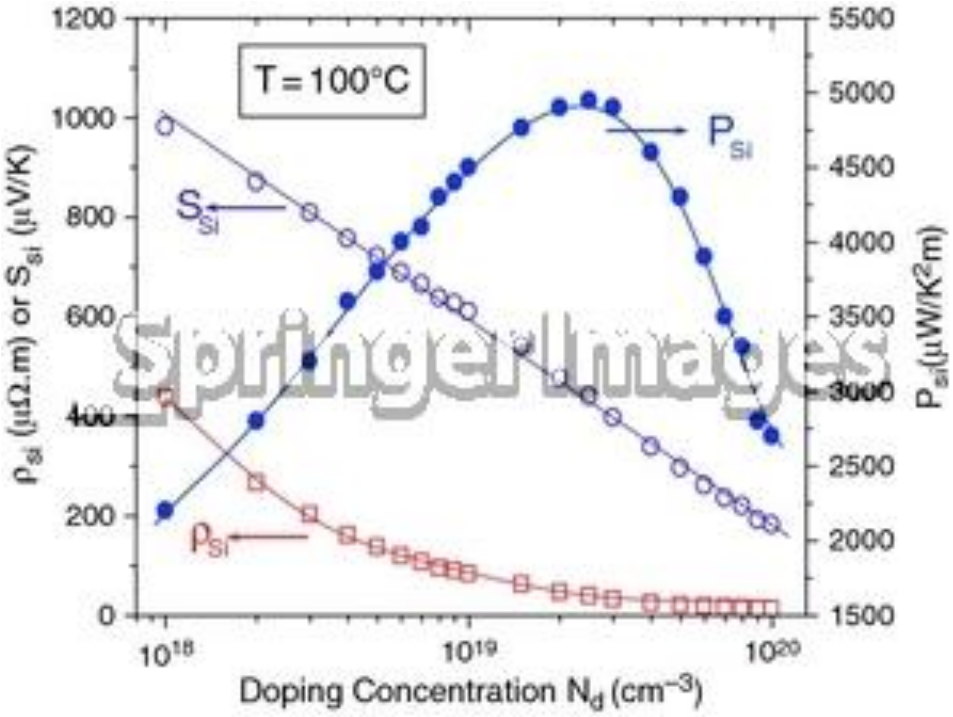
- 111 Silicon
  - p-type
  - 652 µV K^{-1}



- 100 Silicon
  - n-type
  - -783 µV K^{-1}

Seebeck Coefficient

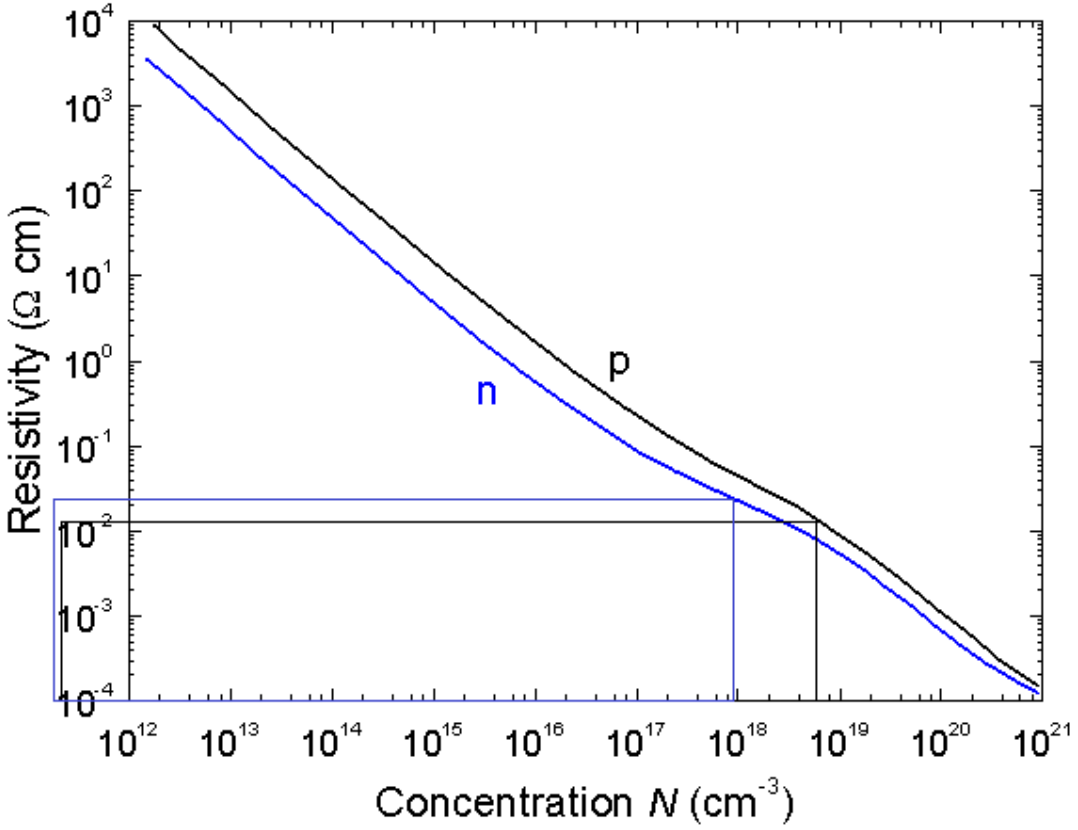
- p type S=650μV/K
- n type S=-800μV/K



- http://www.springerimages.com/Images/RSS/1-10.1007_978-1-4419-0040-1_12-23

Resistivity and Carrier Concentration

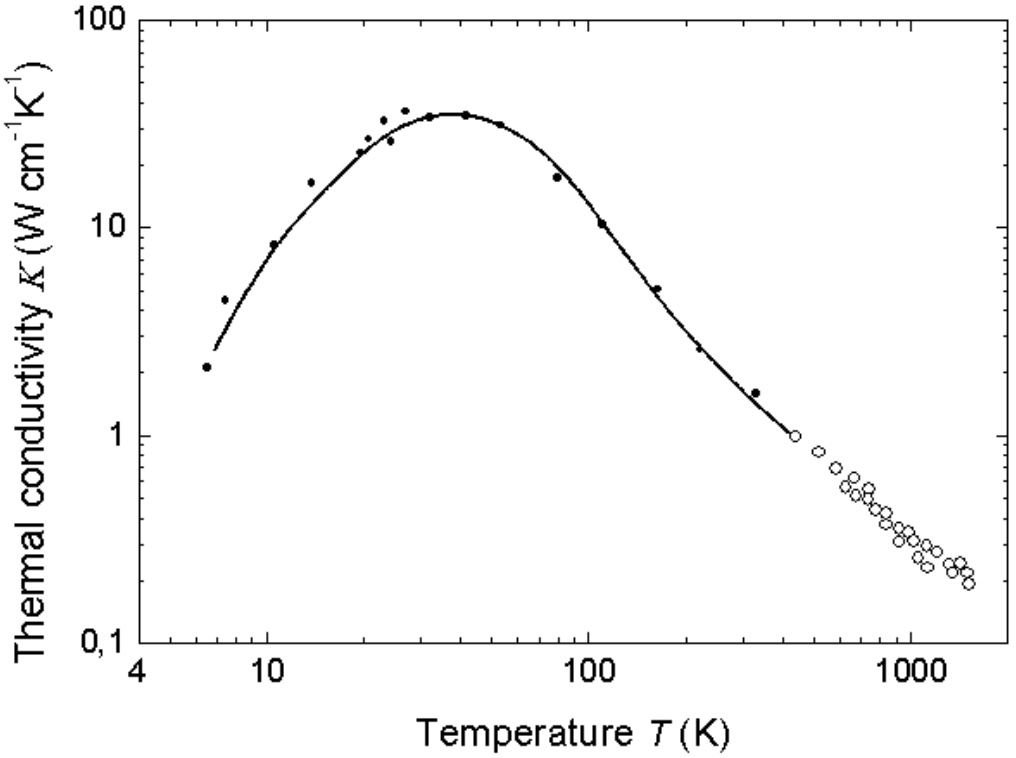
- Contacts were made by pressing on indium on the corners
- The p type silicon has ρ=0.014 Ωcm and p=6.25*10^18 cm^-3
- The n type silicon has ρ=0.021 Ωcm and n=9.5*10^17 cm^-3



- http://www.ioffe.rssi.ru/SVA/NSM/Semicond/Si/Figs/135.gif

Thermal Conductivity

The thermal conductivity of Silicon at temperatures greater than 100K is nearly independent of the dopant level. The thermal conductivity is 148 W/mK



http://www.ioffe.rssi.ru/SVA/NSM/Semicond/Si/Figs/151.gif

Thermal Conductivity at 20K

- The thermal conductivity varies only slightly as a function of carrier concentration even at low temperatures

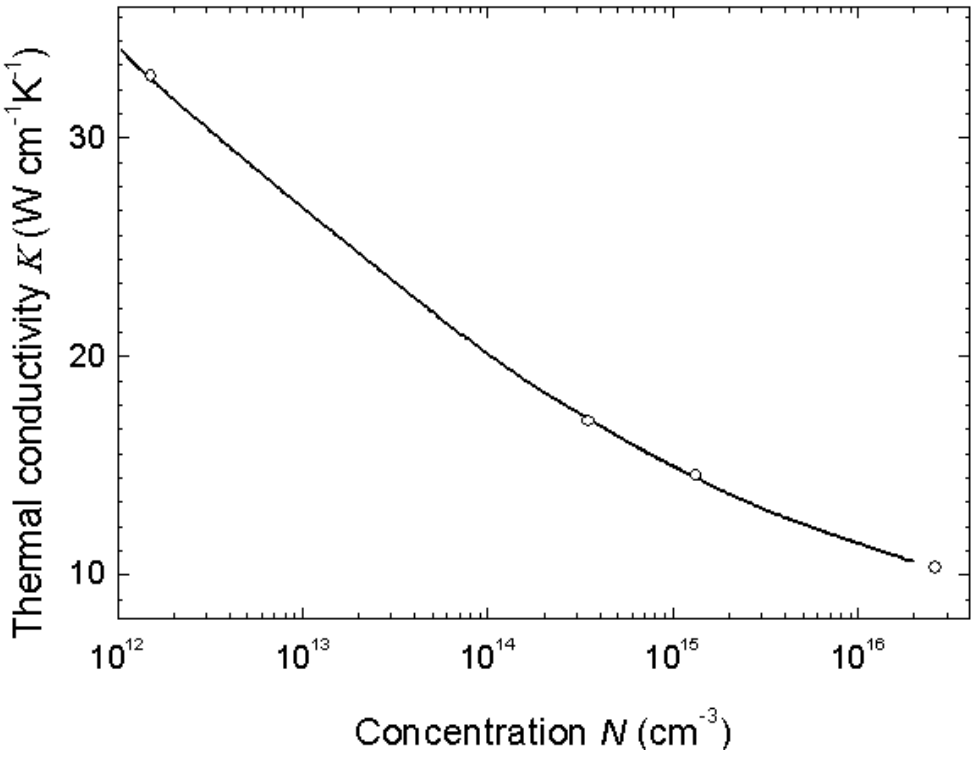


Figure of merit

$$ZT = \frac{S^2 \sigma T}{\kappa} = \frac{S^2 T}{\kappa \rho}$$

p type

- S=650μV/K
- ρ=0.014 Ωcm
- κ=148 W/mK
- T = 300K
- ZT = 0.006

n type

- S=-800μV/K
- ρ=0.021 Ωcm
- κ=148 W/mK
- T = 300K
- ZT = 0.006