ENGR 145 Fall 2023
Homework Set #8
Due Tuesday, Nov. 14

CR Questions and Problems:

12.2 An aluminum wire 10 m long must experience a voltage drop of less than 1.0 V when a current of 5 A passes through it. Using the data in Table 12.1, compute the minimum diameter of the wire.

12.8 In terms of electron energy band structure, discuss reasons for the difference in electrical conductivity among metals, semiconductors, and insulators.

12.19 For intrinsic semiconductors, the intrinsic carrier concentration n_i depends on temperature as follows:

$$n_i \propto \exp\left(-\frac{E_g}{2kT}\right) \qquad (12.35a)$$

or, taking natural logarithms,

$$\ln n_i \propto -\frac{E_g}{2kT} \qquad (12.35b)$$

Thus, a plot of $\ln n_i$ versus $1/T$ $(\mathrm{K})^{-1}$ should be linear and yield a slope of $-E_g/2k$. Using this information and the data presented in Figure 12.16, determine the band gap energies for silicon and germanium and compare these values with those given in Table 12.3.

12.26 (a) In your own words, explain how donor impurities in semiconductors give rise to free electrons in numbers in excess of those generated by valence band–conduction band excitations.

(b) Also, explain how acceptor impurities give rise to holes in numbers in excess of those generated by valence band–conduction band excitations.

Table 12.3
Band Gap Energies, Electron and Hole Mobilities, and Intrinsic Electrical Conductivities at Room Temperature for Semiconducting Materials

Material	*Band Gap (eV)*	*Electron Mobility* $(m^2/V \cdot s)$	*Hole Mobility* $(m^2/V \cdot s)$	*Electrical Conductivity (Intrinsic)* $(\Omega \cdot m)^{-1}$
		Elemental		
Ge	0.67	0.39	0.19	2.2
Si	1.11	0.145	0.050	3.4×10^{-4}
		III–V Compounds		
AlP	2.42	0.006	0.045	—
AlSb	1.58	0.02	0.042	—
GaAs	1.42	0.80	0.04	3×10^{-7}
GaP	2.26	0.011	0.0075	—
InP	1.35	0.460	0.015	2.5×10^{-6}
InSb	0.17	8.00	0.125	2×10^{4}
		II–VI Compounds		
CdS	2.40	0.040	0.005	—
CdTe	1.56	0.105	0.010	—
ZnS	3.66	0.060	—	—
ZnTe	2.40	0.053	0.010	—

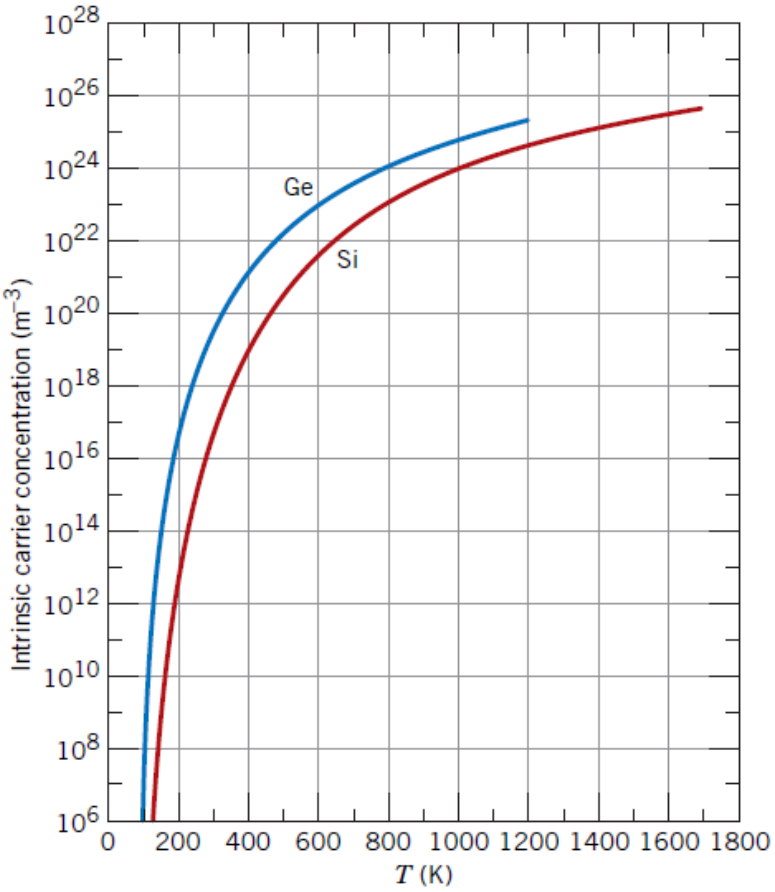

Figure 12.16 Intrinsic carrier concentration (logarithmic scale) as a function of temperature for germanium and silicon.