

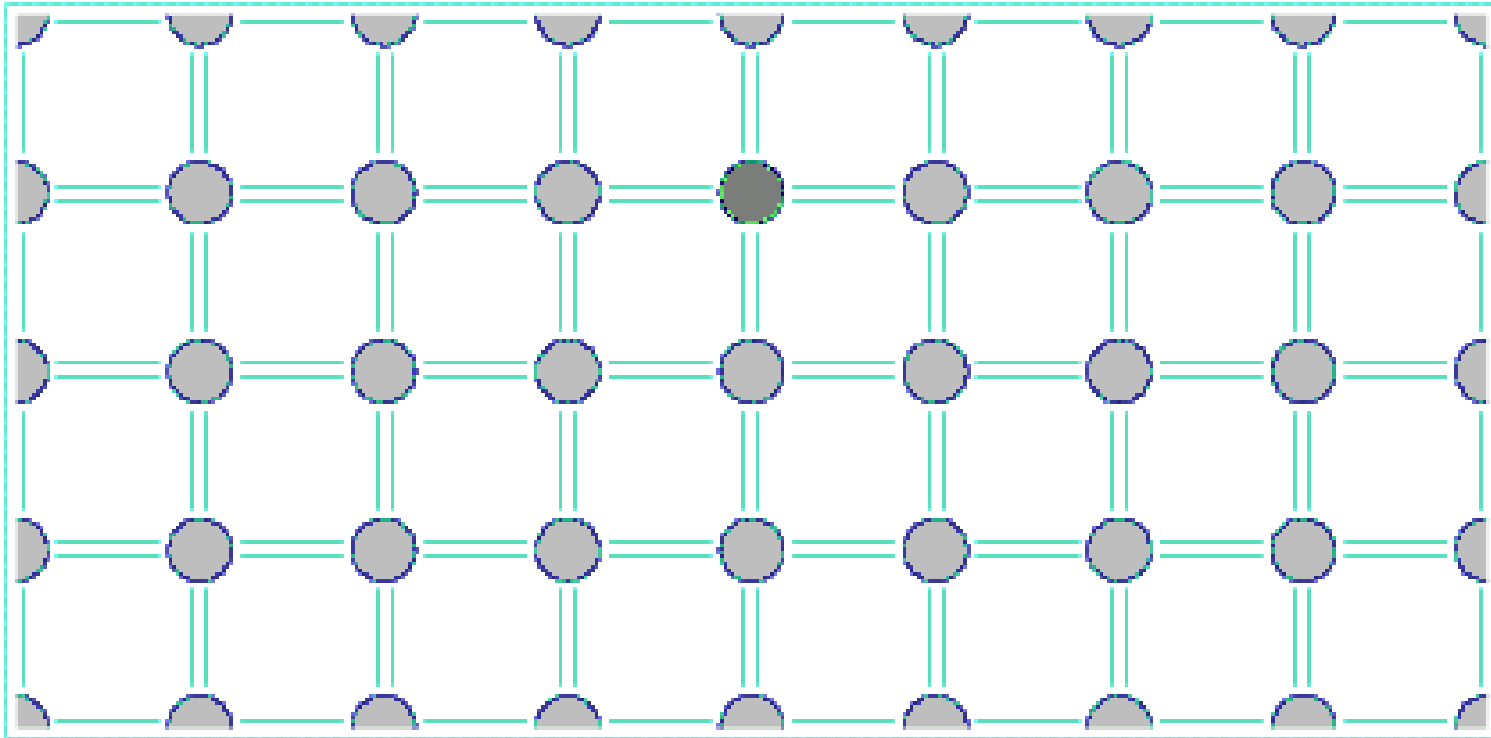
Lecture 7

- Last time:
 - Underdamped 2nd order transfer functions
- Today :
 - Bode plots for general transfer functions
 - Start: semiconductor properties of Si

Electronic Properties of Silicon

- Silicon is in Group IV
 - Electronic structure: $1s^2 2s^2 2p^6 3(sp)^4$
 - Diamond lattice, with 0.235 nm bond length
- Very poor conductor at room temperature:
why?

Bond Model for Silicon

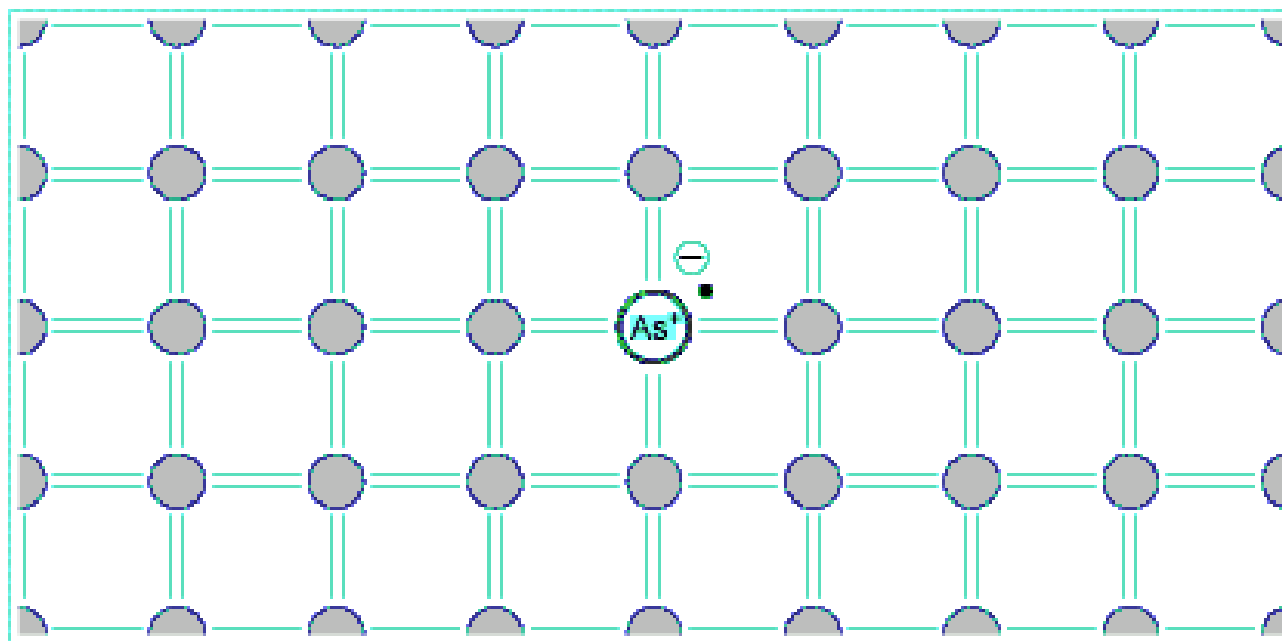


Thermal Equilibrium (Pure Si)

- Balance between generation and recombination determines $n_o = p_o$
- Strong function of temperature: $T = 300$ K

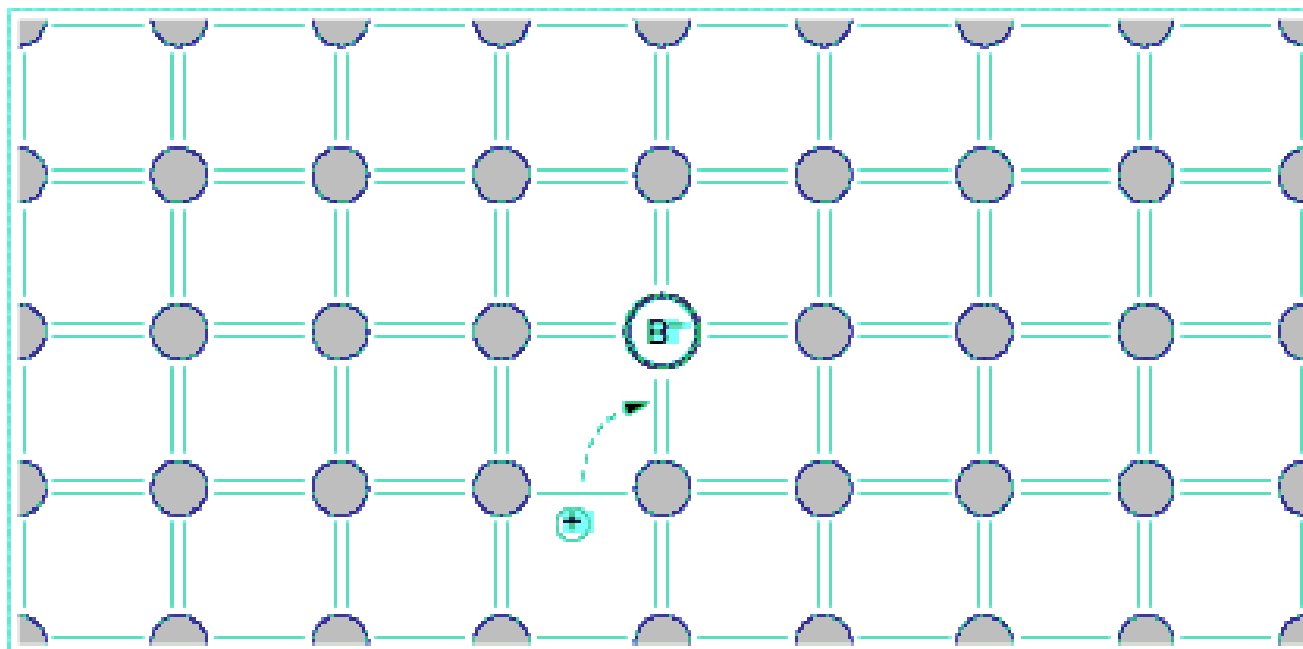
Doping with Group V Elements

- P, As: extra bonding electron ... lost to crystal at room temperature



Doping with Group III Elements

- Boron: 3 bonding electrons \rightarrow one bond is unsaturated



Mass Action Law

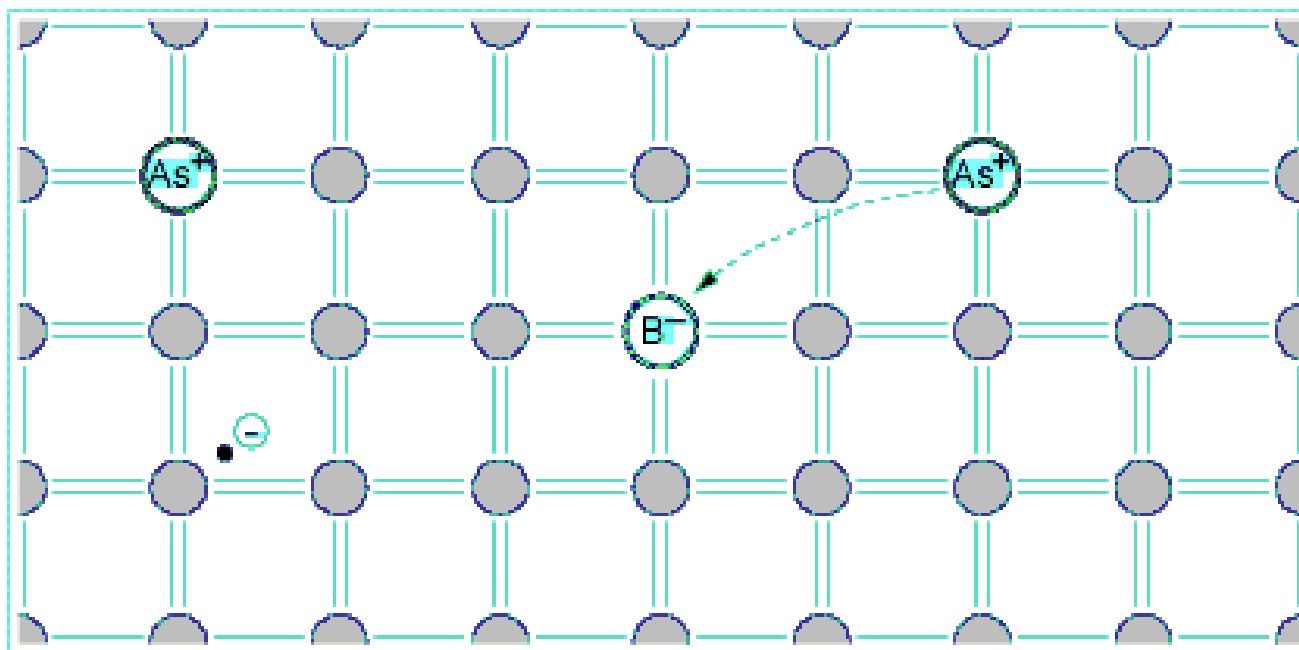
- Balance between generation and recombination:

$$p_o \cdot n_o = n_i^2$$

- N-type case:
- P-type case:

Compensation

- Dope with *both* donors and acceptors



Compensation (cont.)

- More donors than acceptors: $N_d > N_a$

$$n_o =$$

- Hole concentration:

$$p_o =$$