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Semiconductor Doping

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Doping of Semiconductors

- Semiconductors are not intrinsically conductive
- To make them conductive, replace silicon atoms in the lattice with dopant atoms that have valence bands with fewer or more e^- 's than the 4 of Si
- If more e^- 's, then the dopant is a donor: P, As
 - The extra e^- is effectively released from the bonded atoms to join a cloud of free e^- 's, free to move like e^- 's in a metal

Extra free e^-

Si : Si : Si : P Si : P : Si :
Si : Si : Si : Dope Si : Si : Si :

- The larger the # of donor atoms, the larger the # of free e^- 's \rightarrow the higher the conductivity

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Doping of Semiconductors (cont.)

- Conductivity Equation:

$$\sigma = q\mu_n n + q\mu_p p$$

Labels for the equation: σ is conductivity; q is charge magnitude on an electron; μ_n is electron mobility; n is electron density; μ_p is hole mobility; p is hole density.
- If fewer e^- 's, then the dopant is an acceptor: B

Si : Si : Si : B Si : B : Si :
Si : Si : Si : Dope Si : Si : Si :
hole

 - Lack of an e^- = hole = h^+
 - When e^- 's move into h^+ 's, the h^+ 's effectively move in the opposite direction \rightarrow a h^+ is a mobile (+) charge carrier

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