2.1.4 Summary to: Conductors - Definitions and General Properties

What counts are the *specific* quantities:

- Conductivity σ (or the specific resistivity **ρ = 1/** σ.
- current density ***j***.
- (Electrical) field strength · ***E***.

$$\sigma = |q| \cdot n \cdot \mu$$

$$j = \sigma \cdot E$$

σ (of conductors / metals) obeys (more or less) several rules; all understandable by looking at ***n*** and particularly ***μ***.

- Matthiesen rule:
  Reason: Scattering of electrons at defects (including phonons) decreases ***μ***.

$$\rho = \rho_{Lattice}(T) + \rho_{defect}(N)$$

- "ρ(***T***) rule":
  about **0,04 %** increase in resistivity per **K**
  Reason: Scattering of electrons at phonons decreases ***μ***.

$$\Delta\rho = \alpha_\rho \cdot \rho \cdot \Delta T \approx \frac{0{,}4\%}{^oC}$$

- Nordheim's rule:
  Reason: Scattering of electrons at **B** atoms decreases ***μ***.

$$\rho \approx \rho_A + const. \cdot [B]$$

Major consequence: You can't beat the conductivity of pure **Ag** by "tricks" like alloying or by using other materials
(Not considering superconductors).

Non-metallic conductors are *extremely* important.

- Transparent conductors (TCO's)
  ("ITO", typically oxides).

No flat panels displays = no notebooks etc. without ITO!

- Ionic conductors (liquid and solid).

Batteries, fuel cells, sensors, ...

- Conductors for high temperature applications; corrosive environments, ..
  (Graphite, Silicides, Nitrides, ...).

Example: $MoSi_2$ for heating elements in corrosive environments (dishwasher!).

- Organic conductors (and semiconductors).

The future High-Tech key materials?

Numbers to know (order of magnitude accuracy sufficient)

ρ(decent metals) about 2 μΩcm.
ρ(technical semiconductors) around 1 Ωcm.
ρ(insulators) > 1 GΩcm.

Questionaire

All Multiple Choice questions to 2.1