

2.4.4 Summary to: Conductors - Special Applications

Thermionic emission provides electron beams.

The electron beam current (density) is given by the *Richardson equation*:

$A_{\text{theo}} = 120 \text{ A} \cdot \text{cm}^{-2} \cdot \text{K}^{-2}$ for free electron gas model
 $A_{\text{exp}} \approx (20 - 160) \text{ A} \cdot \text{cm}^{-2} \cdot \text{K}^{-2}$

E_A = work function $\approx (2 - >6) \text{ eV}$

Materials of choice: **W**, **LaB₆** single crystal

High field effects (tunneling, barrier lowering) allow large currents at low T from small (nm) size emitter

There are several thermoelectric effects for metal junctions; always encountered in non-equilibrium.

Seebeck effect:

Thermovoltage develops if a metal A-metal B junction is at a temperature different from the "rest", i.e. if there is a temperature gradient

Peltier effect:

Electrical current I through a metal - metal (or metal - semiconductor) junction induces a temperature gradient $\propto I$, i.e. one of the junction may "cool down".

$$j = A \cdot T^2 \cdot \exp - \frac{E_A}{kT}$$

Needs **UHV**!

Essential for measuring (high) temperatures with a "thermoelement"
Future use for efficient conversion of heat to electricity ???

Used for electrical cooling of (relatively small) devices. Only big effect if electrical heating ($\propto I^2$) is small.

Questionnaire

All Multiple Choice questions to 2.4