FERMI-DIRAC STATISTICS

TOPICS COVERED:

- Fermi Energy and Fermi Level

The Fermi-Dirac distribution function is given as:

$$f_{FD}(E_i) = \frac{n_i}{g_i} = \frac{1}{e^{\alpha+\beta E_i}+1} = \frac{1}{e^{\alpha+\frac{E_i}{kT}}+1}$$

where, $\beta = 1/\mathrm{kT}$ and $\alpha = -\mu/\mathrm{kT}$

μ is the chemical potential, defined as the energy required to add an extra electron to the system. The chemical potential μ depends on temperature T and is equal to the Fermi energy (E_F) at T = 0 K

Therefore we can write:

$$f_{FD}(E_i) = \frac{n_i}{g_i} = \frac{1}{e^{\alpha+\beta E_i}+1} = \frac{1}{e^{\frac{E_i}{kT}-\frac{E_F}{kT}}+1} = \frac{1}{e^{(Ei-EF)/kT}+1}$$

This gives the probability of occupation of a given energy level E_i

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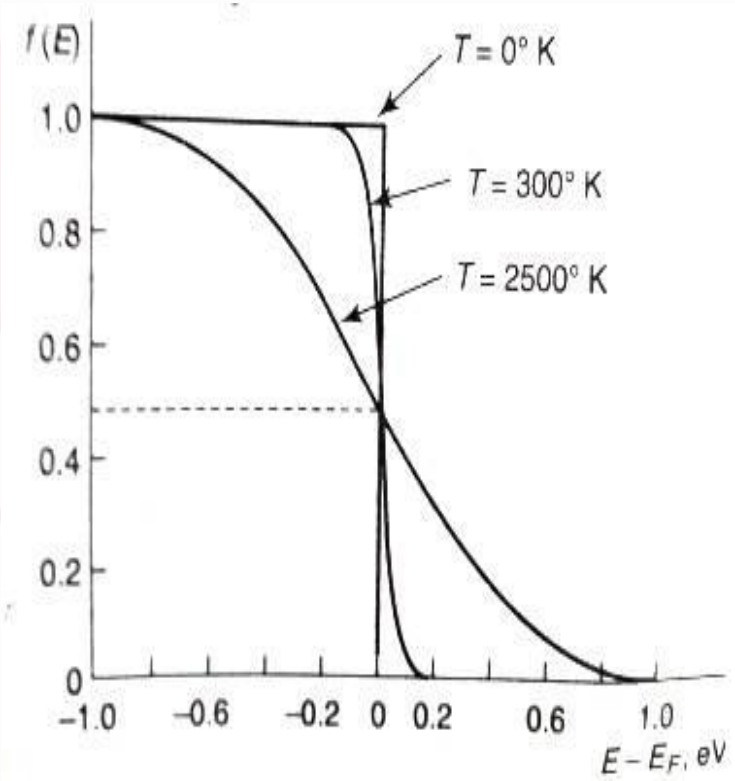
At T=0k:

$$f_{FD}(E_i) = \frac{1}{e^{(Ei-EF)/0}+1} = \frac{1}{e^{\infty}+1} = \frac{1}{\infty} = 0 \quad for\ Ei > EF$$

$$f_{FD}(E_i) = \frac{1}{e^{(Ei-EF)/0}+1} = \frac{1}{e^{-\infty}+1} = \frac{1}{0+1} = 1 \quad for\ Ei > EF$$

This is shown by the solid line in the figure. Thus at absolute zero all energy levels with $0 < E_i < E_F$ are completely filled and all energy levels with $E_i > E_F$ are empty



At any other temperature, T>0k:

$$f_{FD}(E_i) = \frac{1}{2} \quad \text{for } E_i = EF$$

DEFINITION OF FERMI ENERGY

Fermi energy is often defined as the highest occupied energy level of a material at absolute zero temperature. In other words, all electrons in a body occupy energy states at or below that body's Fermi energy at 0K.

OR

The **Fermi level** is defined as the energy level where the probability of an electron being present is 50% at temperatures T> 0K.

REFERENCES

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