# AD2

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## Contents

# ABSTRACT

# 1 Introduction

# 2 Results

## 2.1 Chap 1

$$\sigma = \frac{ne^2\tau}{m^*} \tag{1}$$

At it is a monovalent metal and the FCC-Unit cell contains 4 atoms the concentration of the conduction electrons $N$ can be calculated as:

$$N = \frac{4}{a^3} =$$

So for the collision time $\tau$ follows:

$$\tau = \frac{\sigma \cdot m^* \cdot a^3}{4e^2}$$

For a thin metal wire with a length of $10\,cm$, a square cross section with a side of $0.1\,mm$ and a potential difference along the wire of $0.2\,V$

The electric field $E$ in the wire can be calculated as:

$$E = \frac{U}{L} = 2\frac{V}{m}$$

And for the drift velocitiy follows:

$$v_D = -\frac{e\tau}{m^*} \cdot E$$

#### Fermi

$$f(E) = \frac{1}{e^{(E-E_F)/kT} + 1} \tag{2}$$

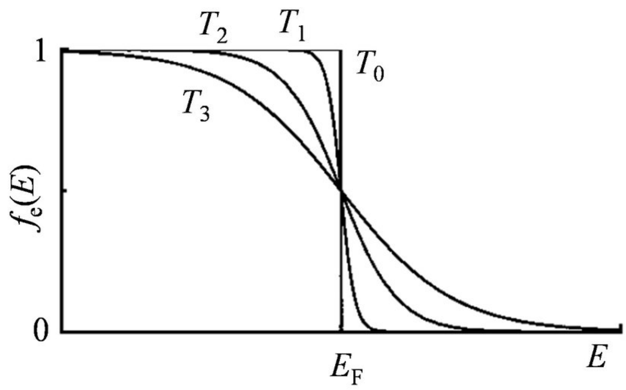


Figure 1: Fermi-Dirac distribution function at different temperatures: T3> T2>T1 (and T0 = 0 K). At the absolute zero temperature (T0), the probability of an electron to have an energy below the Fermi energy EF is equal to 1, while the probability to have higher energy is zero.

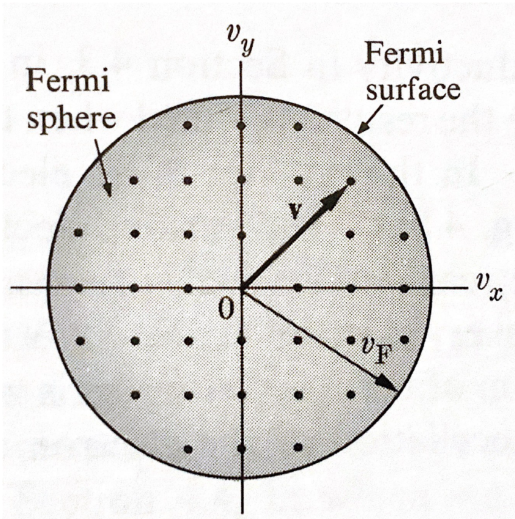


Figure 2: The Fermi surface and the Fermi sphere [1, asdfadf]

### Cyclotron

$$-e(\vec{v} \times \vec{B}) = m\frac{d\vec{v}}{dt} \tag{3}$$

### Plasma Frequency

$$w_P = \frac{Ne^2}{\epsilon_L m^*} \tag{4}$$

## 2.2 Chap 2

## 2.3 Chap 3

### Question 1

The carrier distribution function in CB für an intrinsic semiconductor is given as the product:

$$g_e(E)f(E)$$

with

$$g_e(E) = \frac{1}{2\pi^2}\left(\frac{2m_e^*}{\hbar}\right)^{\frac{3}{2}}(E-E_C)^{\frac{1}{2}}$$

$$f(E) = \frac{1}{e^{(E-E_F)/k_BT}+1} \approx e^{-\frac{E-E_F}{k_BT}}$$

So for the maximum

$$\frac{d}{dE}\left(\frac{1}{2\pi^2}\left(\frac{2m_e^*}{\hbar}\right)^{\frac{3}{2}}(E-E_C)^{\frac{1}{2}}e^{-\frac{E-E_F}{k_BT}}\right) = 0$$

By dividing through the constant factors:

$$\frac{d}{dE}\left((E-E_C)^{\frac{1}{2}}e^{-\frac{E}{k_BT}}\right) = 0$$

$$\frac{1}{2}(E-E_C)^{-\frac{1}{2}}e^{-\frac{E}{k_BT}} + \frac{-1}{k_BT}(E-E_C)^{\frac{1}{2}}e^{-\frac{E}{k_BT}} = 0$$

And finaly

$$E = E_C + \frac{k_BT}{2}$$

### Question 2

$$N_c = 2\left(\frac{m_e^*k_BT}{2\pi\hbar^2}\right)^{\frac{3}{2}}$$

$$N_c = 2.415\cdot 10^{24}\frac{1}{m^3}$$

$$N_v = 2\left(\frac{m_h^*k_BT}{2\pi\hbar^2}\right)^{\frac{3}{2}}$$

$$N_v = 1.796 \cdot 10^{25} \frac{1}{m^3}$$

$$n_i = p_i = 2 \left( \frac{k_B T}{2\pi\hbar^2} \right)^{\frac{3}{2}} (m_e^* m_h^*)^{\frac{3}{4}} e^{-\frac{E_g}{2k_B T}}$$

$$n_i = p_i = 0.959 \cdot 10^3 \frac{1}{m^3}$$

$$E_{Fi} = \frac{E_g}{2} + \frac{3}{4} k_B T \ln \left( \frac{m_h^*}{m_e^*} \right)$$

$$E_{Fi} = 1.326 eV$$

# 3 Conclusion

# References

[1] M.A. Omar, *Elementary Solid State Physics: Principles and Applications*, Addison-Wesley, London, 1993.

[2] Charles Kittel, *Introduction to Solid State Physics*, 7th ed., Wiley, 1996

[3] METAL OXIDE PHOTOCATALYTIC NANOSTRUCTURES FABRICATED BY DYNAMIC SHADOWING GROWTH - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Fermi-Dirac-distribution-function-at-different-temperatures-T3-T2T1-and-T0-0-K-At_fig2_280311898 [ accessed 16 Jun, 2020 ]

# List of Tables

# List of Figures