

FUNDAMENTALS OF NANOELECTRONICS

Basic Concepts

1. The New Perspective

Energy Band Model

3. What and Where

is the Voltage?

4. Heat & Electricity:

Second Law & Information

2.1. Introduction

2.2. $E(p)$ or $E(k)$ relation

2.3. Counting States

2.4. Density of states

2.5. Number of modes

2.6. Electron density (n)

2.7. Conductivity vs n

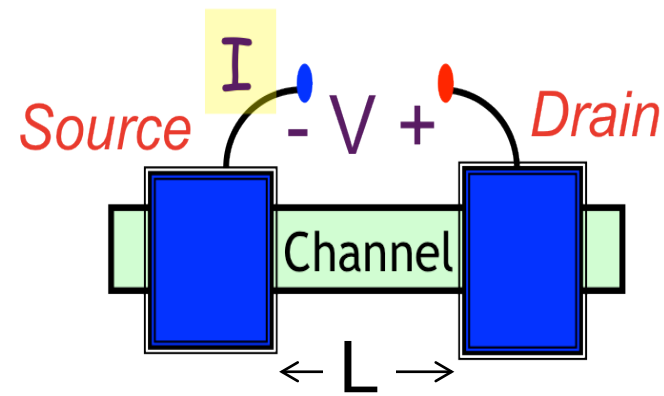
2.8. Quantum Capacitance

2.9. The Nanotransistor

2.10. Summing up ..



2.7a Conductivity versus n



New perspective

$$\sigma = \frac{G_B}{A} \lambda$$

$$\sigma = q^2 \frac{n}{m} \tau$$

Red arrows indicate the correspondence between λ in the first equation and τ in the second, and between G_B/A and $q^2 n/m$.

Drude formula

$$M = \left(\frac{p}{h} \right)^{d-1} \{1 \quad 2W \quad \pi A\}$$

$$\frac{G_B}{A} = \frac{q^2}{h} \left(\frac{p}{h} \right)^{d-1} \{1 \quad 2 \quad \pi\}$$

A red arrow points from the $2W$ term in the equation above to the 2 term in this equation.

$$n = \left(\frac{p}{h} \right)^d \left\{ 2 \quad \pi \quad \frac{4\pi}{3} \right\}$$

A red arrow points from the 2 term in the curly braces to the 2 term in the equation above.

$$N(p) = \left(\frac{p}{h} \right)^d \left\{ 2L \quad \pi WL \quad \frac{4\pi}{3} AL \right\}$$

2.7b Conductivity versus n

New perspective

$$\sigma = \frac{G_B}{A} \lambda$$

$$\sigma = q^2 \frac{n}{m} \tau$$

Drude formula

$$\frac{G_B}{A} = \frac{q^2}{h} \left(\frac{p}{h} \right)^{d-1} \left\{ 1 \quad 2 \quad \pi \right\}$$

$$\frac{q^2 n}{m} = \frac{q^2}{m} \left(\frac{p}{h} \right)^d \left\{ 2 \quad \pi \quad \frac{4\pi}{3} \right\}$$

$$\frac{G_B / A}{q^2 n / m} = \frac{m}{p} \left\{ \frac{1}{2} \quad \frac{2}{\pi} \quad \frac{3}{4} \right\}$$

$$\frac{\lambda}{\tau} = \frac{v \tau}{\tau} \left\{ 2 \quad \frac{\pi}{2} \quad \frac{4}{3} \right\}$$

$$\frac{1}{m} = \frac{dv}{dp} \quad \text{X}$$

$$\bullet \quad \frac{1}{m} = \frac{v}{p}$$

2.7c Conductivity versus n

$$I/A = q n v, \quad \frac{dp}{dt} + \frac{p}{\tau} = qF$$

$\swarrow$ $v = \frac{p}{m}$ $\downarrow$ $p = qF\tau$

New perspective

$$\sigma = \frac{G_B}{A} \lambda$$

$\swarrow$ $\swarrow$
 $\sigma = q^2 \frac{n}{m} \tau$

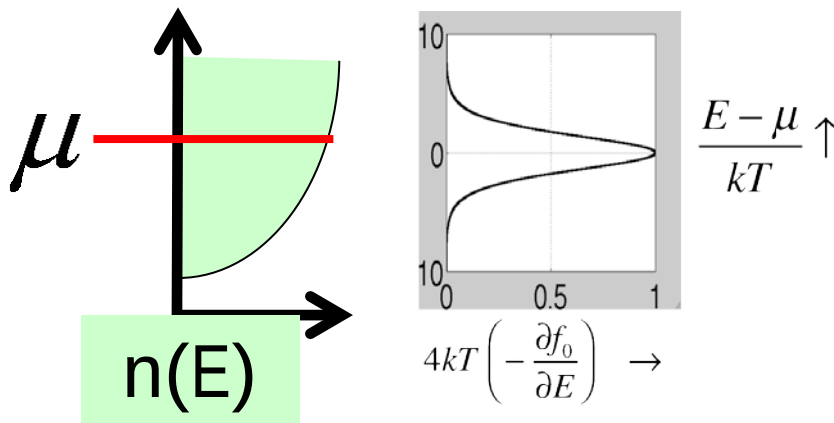
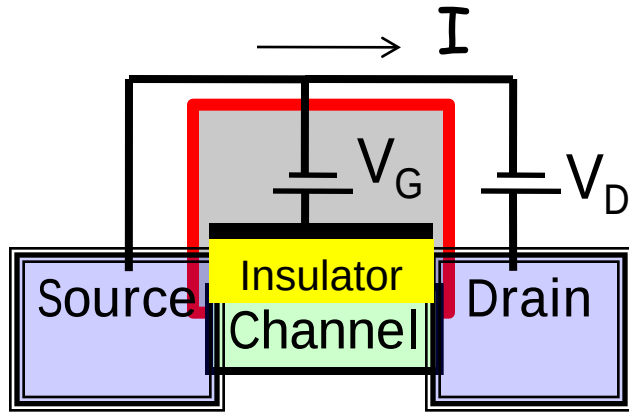
Drude formula

$$\frac{G_B \lambda / A}{q^2 n \tau / m} = \frac{m v}{p} \rightarrow 1$$

$$\frac{G_B / A}{q^2 n / m} = \frac{m}{p} \left\{ \frac{1}{2} \quad \frac{2}{\pi} \quad \frac{3}{4} \right\}$$

$$\frac{\lambda}{\tau} = \frac{v \tau}{\tau} \left\{ 2 \quad \frac{\pi}{2} \quad \frac{4}{3} \right\}$$

Coming up next ..



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