Fundamentals of Nanoelectronics

ECE495 - Session 30, Nov 9, 2009

Transmission Coefficient

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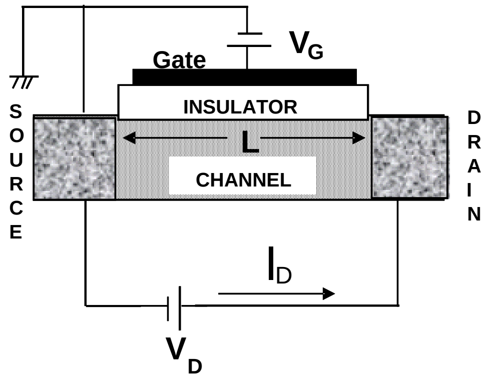
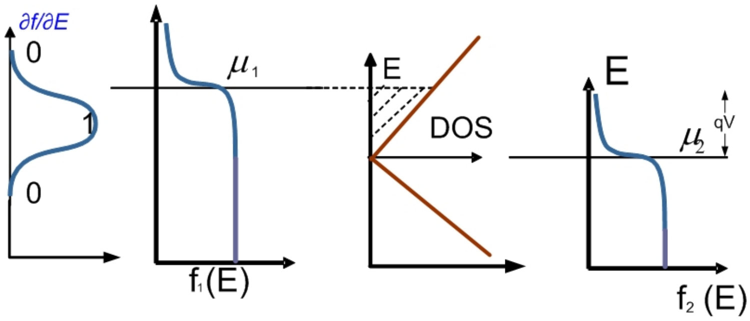
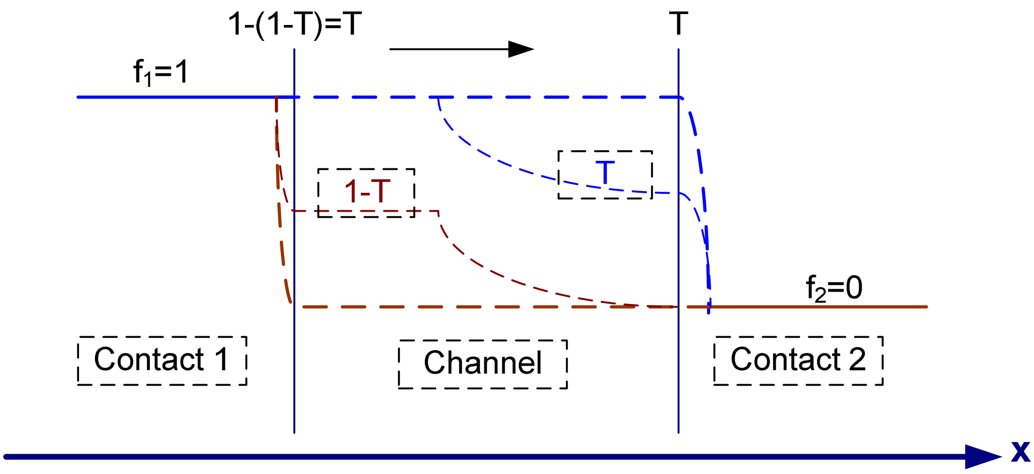
Review

$$I = \frac{q}{h}\int \underbrace{dE}_{qV}\, M(E)(\underbrace{f^{+}}_{f_1(E)} - \underbrace{f^{-}}_{f_2(E)})$$



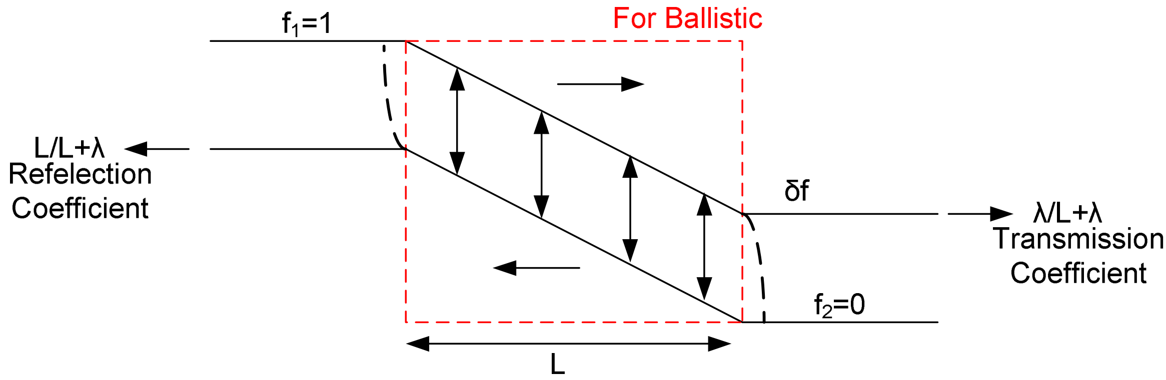


Transmission Coefficient



T, the differences are the same in both contacts and over the channel. This is because of steady state.

The second lane (f_2) is not effective on current when T is 1.



$\frac{\Delta x}{\lambda}$ shows probability of number of scattering.

$\Delta f^+ = -f^+ \frac{\Delta x}{\lambda} + f^- \frac{\Delta x}{\lambda} \Rightarrow \frac{\partial f^+}{\partial x} = -\frac{f^+ - f^-}{\lambda}$ $\quad (I)$ and we can say $\frac{\partial f^-}{\partial x} = -\frac{f^+ - f^-}{\lambda}$

As it is clear $\frac{\partial}{\partial x}(f^+ - f^-) = 0$ (the distance between f^+ and f^- is fixed along x) then

$f^+ - f^- = \delta f \quad (II)$

From (I) and (II) $-\frac{1-\delta f}{L} = -\frac{\delta f}{\lambda} \Rightarrow \lambda - \lambda\delta f = L\delta f \Rightarrow \delta f = \frac{\lambda}{L+\lambda}$

For ballistic regime (L<<λ): $\delta f \cong \frac{\lambda}{\lambda} = 1$

$$I = \frac{q}{h}\int dE M(E) \underbrace{(f^+ - f^-)}_{\frac{\lambda}{L+\lambda}(f_1 - f_2)}$$

$$I = \frac{q}{h}\int dE \frac{M\lambda}{L} \underbrace{(f_1 - f_2)}_{-\frac{\partial f}{\partial E}qV}$$ For long devices

$G = \frac{\sigma A}{L}$ and $G = \frac{M\lambda}{L} \Rightarrow \sigma = M\frac{\lambda}{A}$ M is from Quantum Mechanic