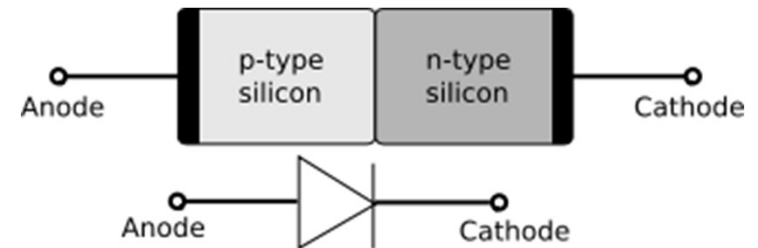


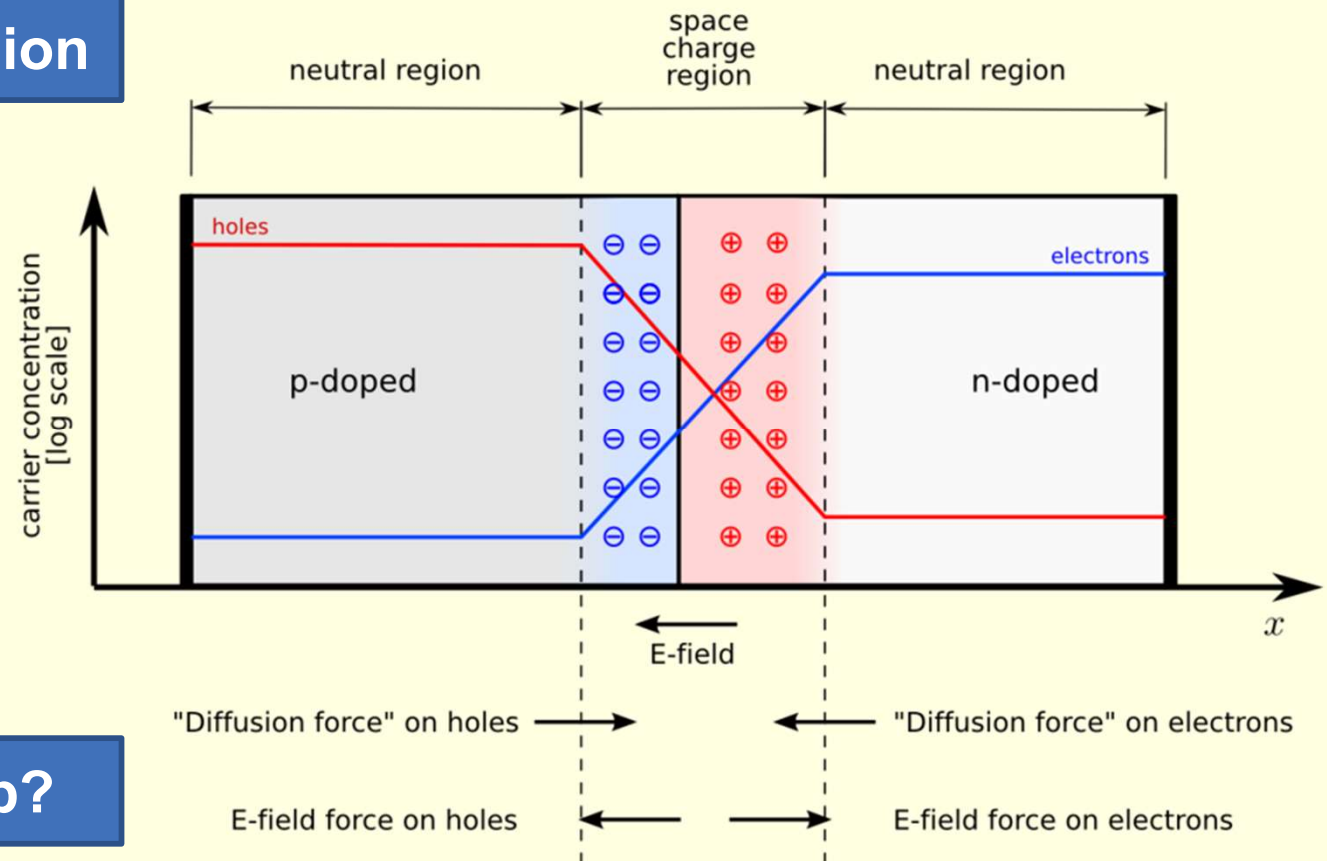
# Idealized p-n junction diode



**Ideal approximation:  
1-D, abrupt**

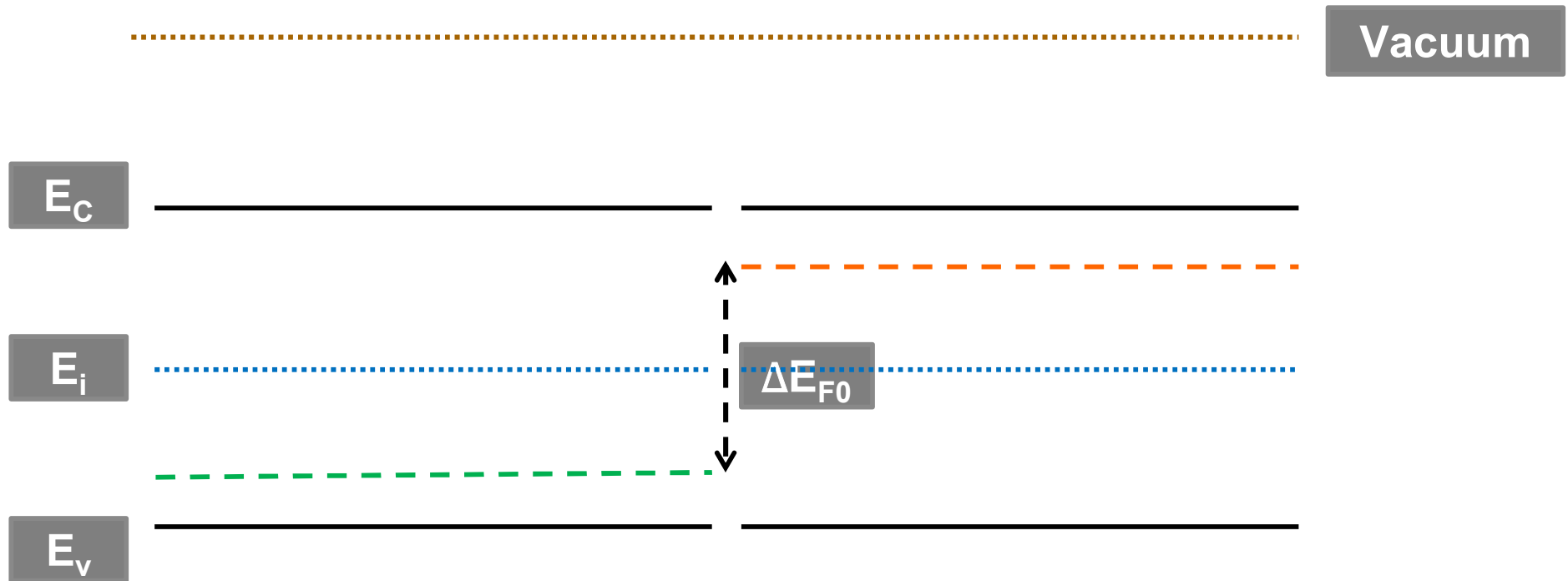


**Inhomogeneity → diffusion**



**Why/where does it stop?**

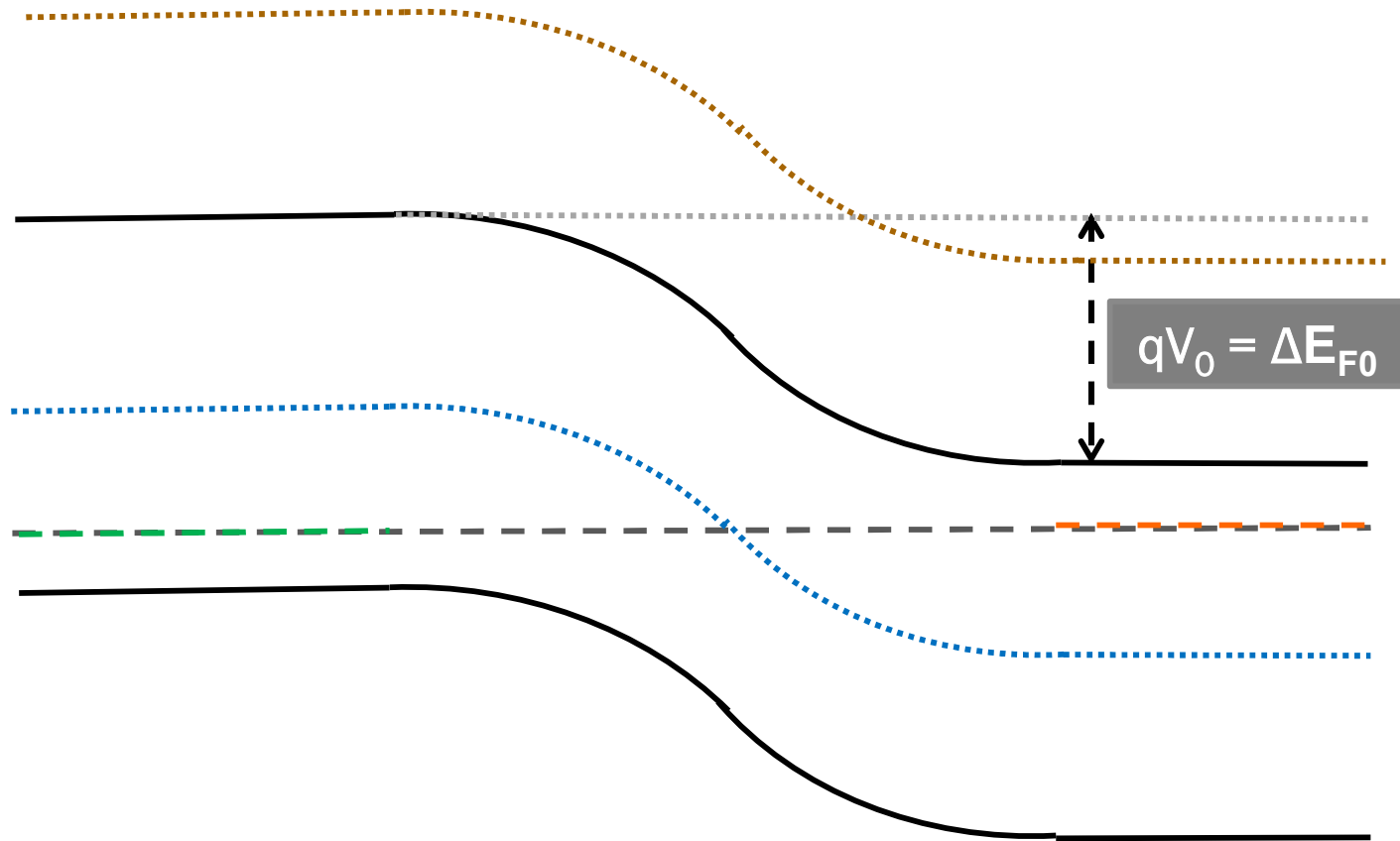
# Equilibrium barrier height...



$$E_{Fp} = E_i - \ln\left(\frac{p_{p0}}{n_i}\right) = E_i - \frac{k_B T}{q} \ln\left(\frac{N_A}{n_i}\right) \quad E_{Fn} = E_i + \ln\left(\frac{n_{n0}}{n_i}\right) = E_i + \frac{k_B T}{q} \ln\left(\frac{N_D}{n_i}\right)$$

$$\Delta E_{F0} = E_{Fn} - E_{Fp} = \frac{k_B T}{q} \ln\left(\frac{N_D}{n_i}\right) + \frac{k_B T}{q} \ln\left(\frac{N_A}{n_i}\right)$$

## ...from band diagram



$$V_0 = \frac{k_B T}{q} \ln \left( \frac{N_D}{n_i} \right) + \frac{k_B T}{q} \ln \left( \frac{N_A}{n_i} \right)$$

**Contact potential /  
built-in voltage**

$$V_0 = \frac{k_B T}{q} \ln \left( \frac{N_A N_D}{n_i^2} \right)$$

**Hetero-junction?**

# Equilibrium with potentials/band-bending

## Equilibrium, homogeneous

$$n_0 = n_i \exp\left(\frac{E_F - E_{i0}}{k_B T}\right) \qquad p_0 = n_i \exp\left(\frac{E_{i0} - E_F}{k_B T}\right)$$

## Equilibrium, inhomogeneous

$$n = n_i \exp\left(\frac{E_F - E_{i0} + eV}{k_B T}\right) = n_0 \exp\left(\frac{+eV}{k_B T}\right) \qquad E_i = E_{i0} - eV$$

$$p = n_i \exp\left(\frac{E_{i0} - E_F - eV}{k_B T}\right) = p_0 \exp\left(\frac{-eV}{k_B T}\right)$$

Drift = Diffusion?

Contact potential?

# Finis

## Artwork Sources:

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