Lecture 11

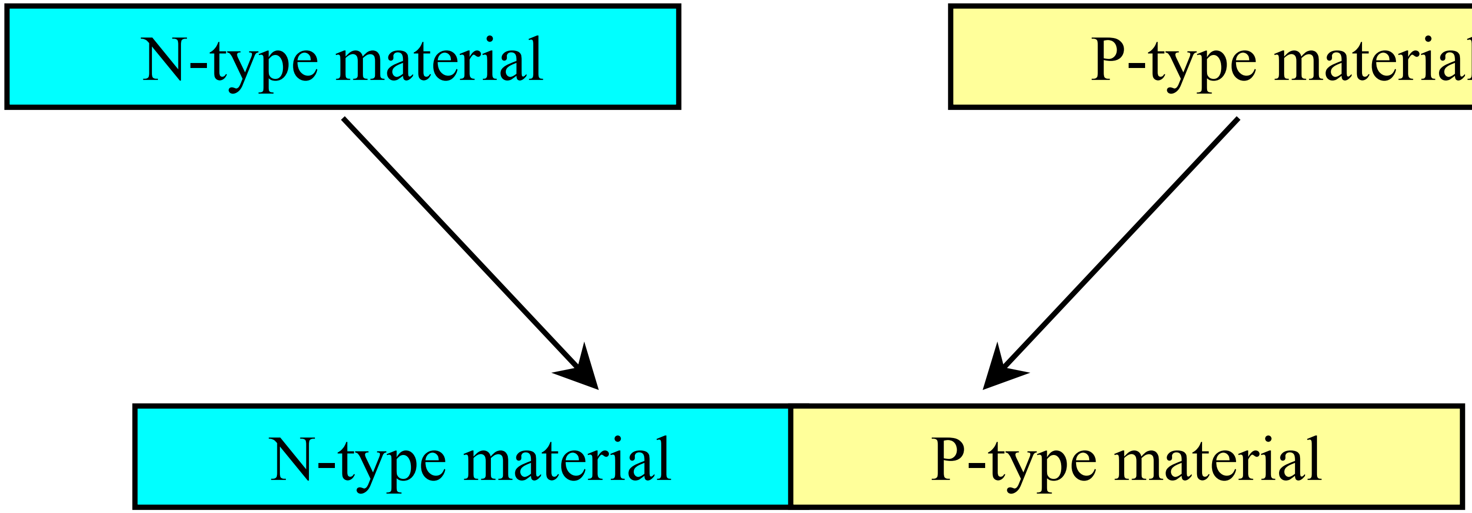
P-N Junction Diodes: Part 1

How do they work? (postponing the math)

Reading:

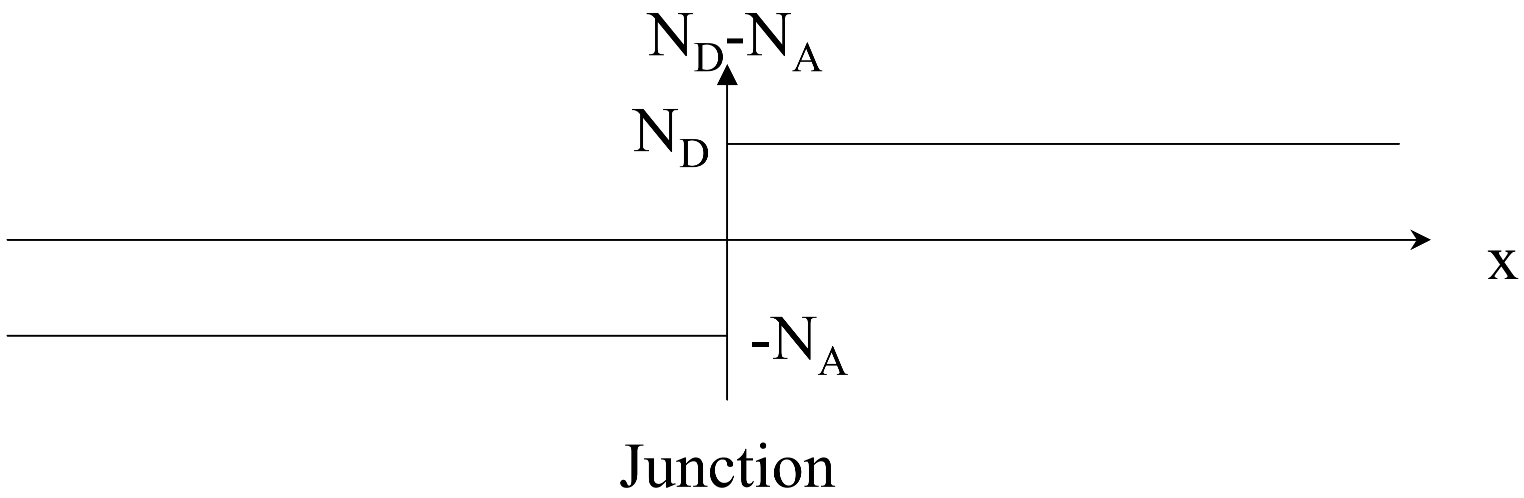
Pierret 5.2

Our First Device: p-n Junction Diode



A p-n junction diode is made by forming a p-type region of material directly next to a n-type region.

Our First Device: p-n Junction Diode



In regions far away from the "junction" the band diagram looks like:

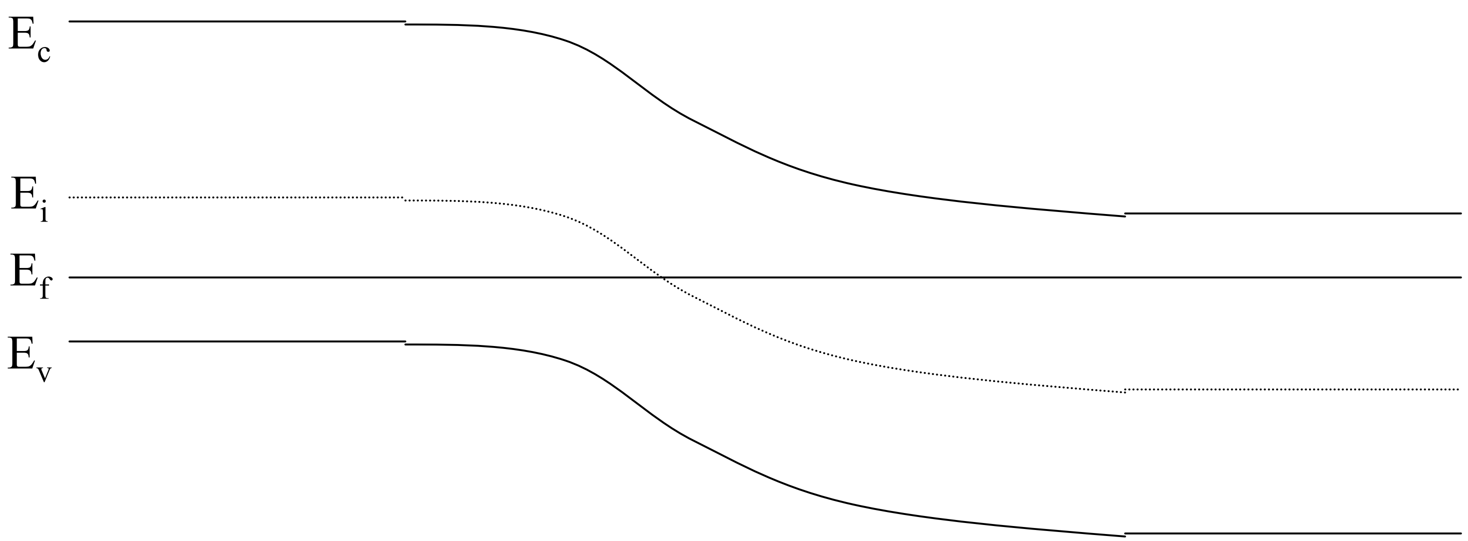
Our First Device: p-n Junction Diode

But when the device has no external applied forces, no current can flow. Thus, the fermi-level must be flat!

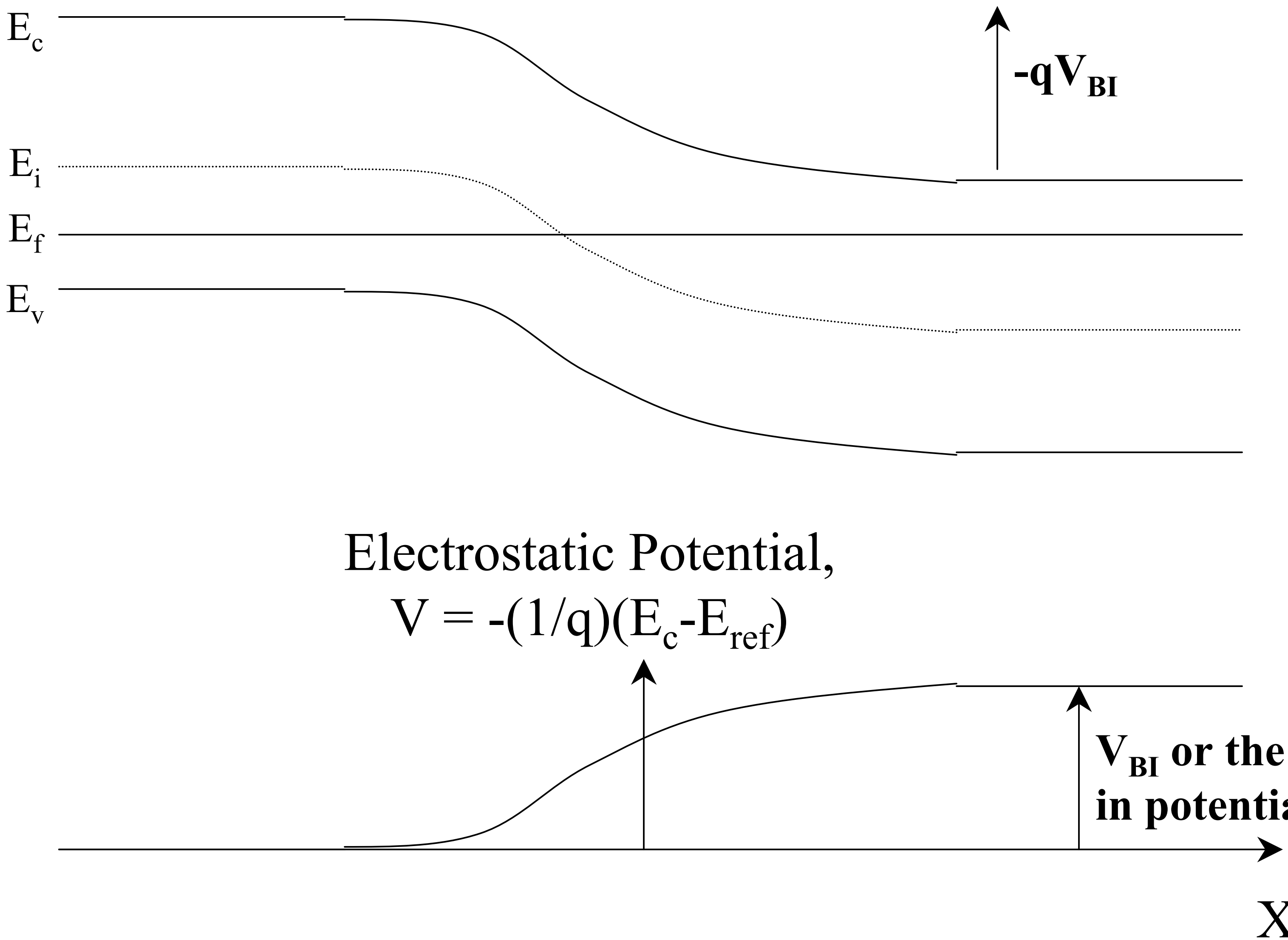
We can then fill in the junction region of the band diagram as:

or…

Our First Device: p-n Junction Diode

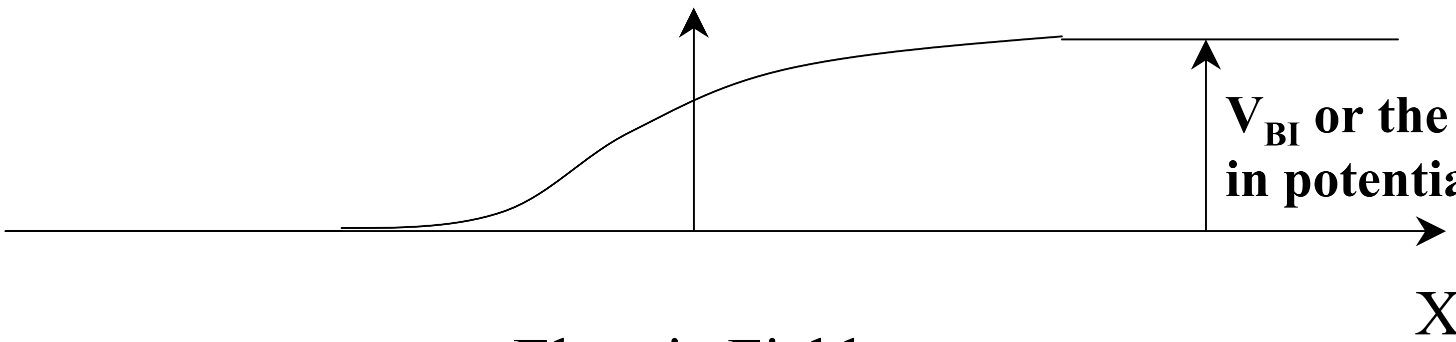


Our First Device: p-n Junction Diode



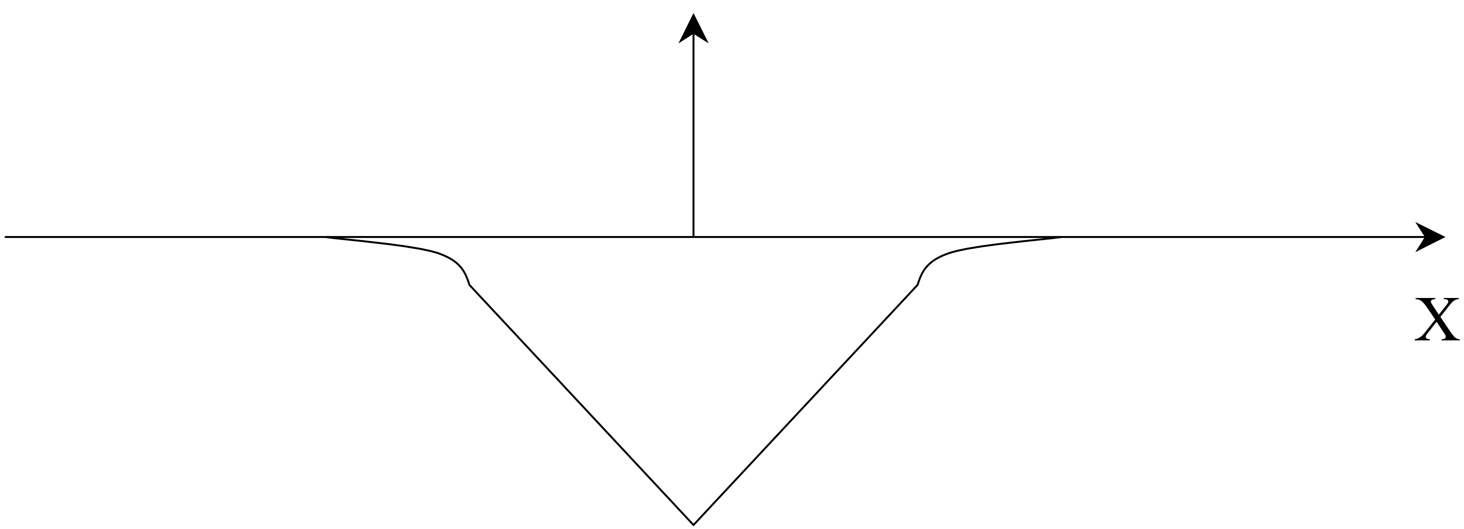
Our First Device: p-n Junction Diode

Electrostatic Potential,
$V=-(1/q)(E_c-E_{ref})$



Electric Field

$\mathit{E}=-dV/dx$



Our First Device: p-n Junction Diode

Poisson's Equation:

Electric Field **Charge Density (NOT resistivity)**

$$\nabla \bullet E = \frac{\rho}{K_s \varepsilon_o} \quad or\ in\ 1D,\ \frac{dE}{dx} = \frac{\rho}{K_s \varepsilon_o}$$

Permittivity of free space

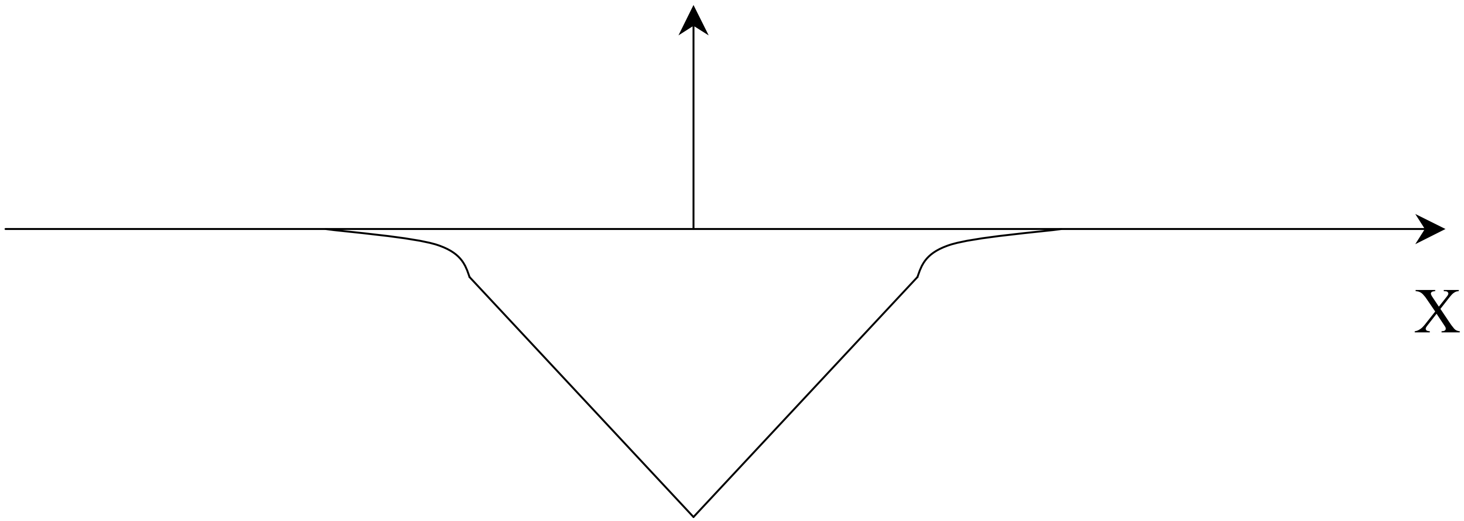
Relative Permittivity of Semiconductor

(previously referred to as ε_R)

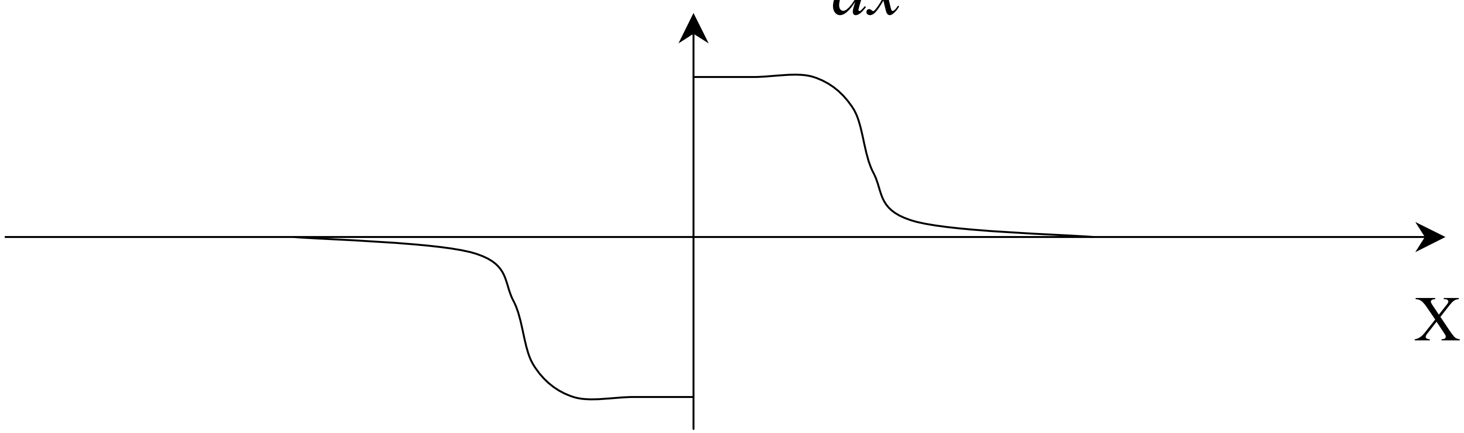
$$\rho = q(\, p - n + N_D - N_A \,)$$

Our First Device: p-n Junction Diode

Electric Field, E=-dV/dx



$$\rho = K_s \varepsilon_o \frac{dE}{dx}$$



Our First Device: p-n Junction Diode