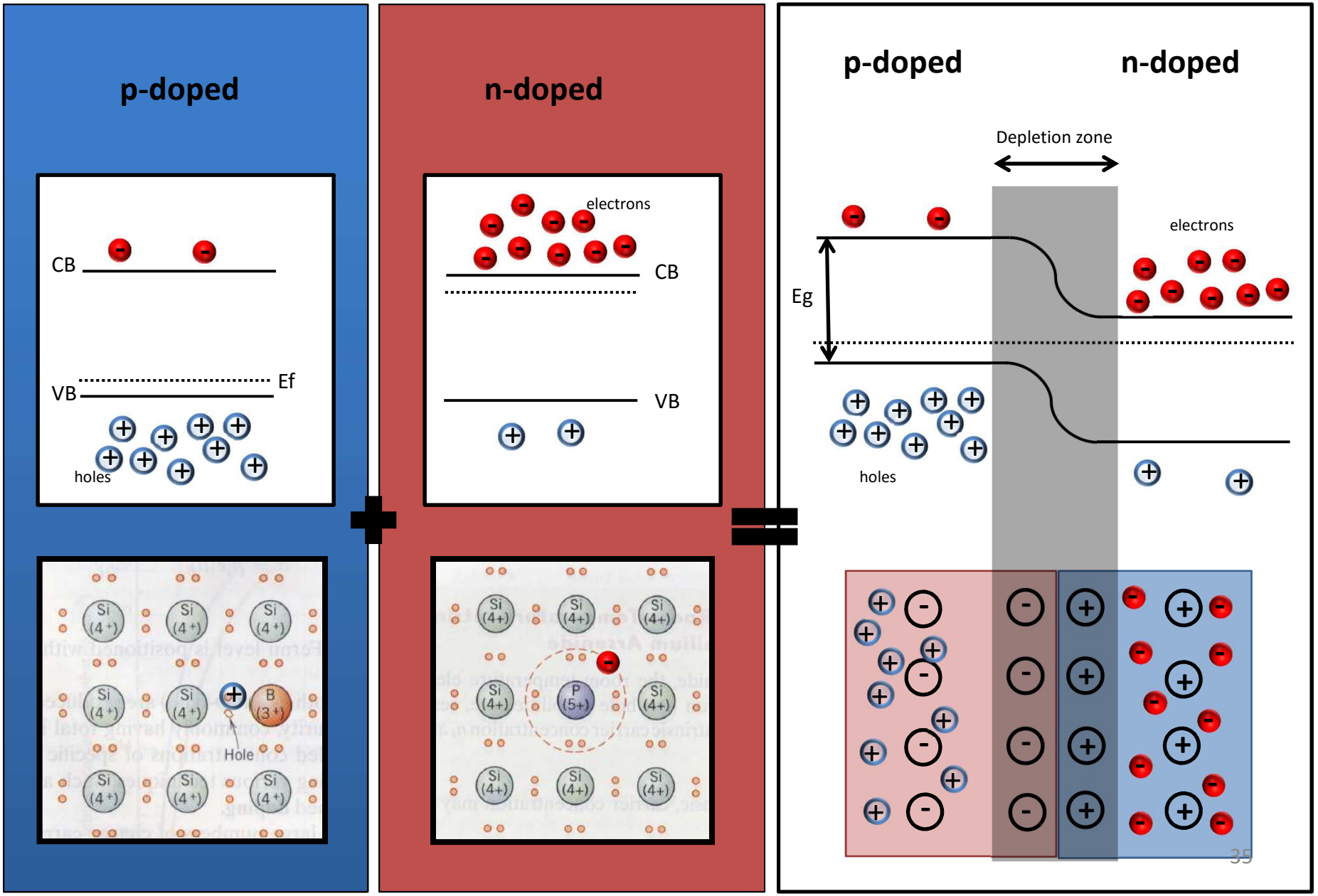
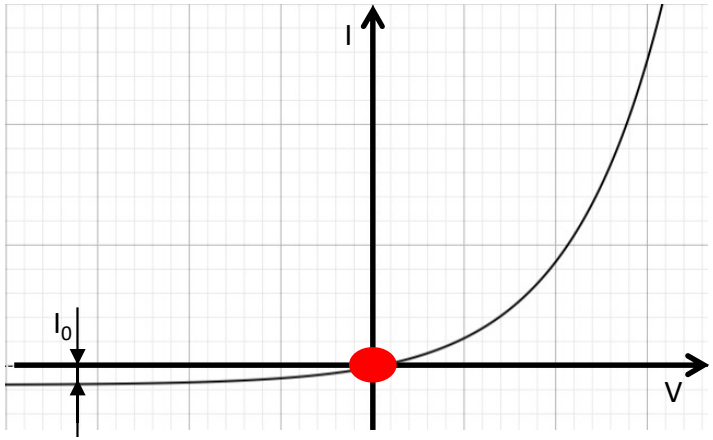
p-n junction

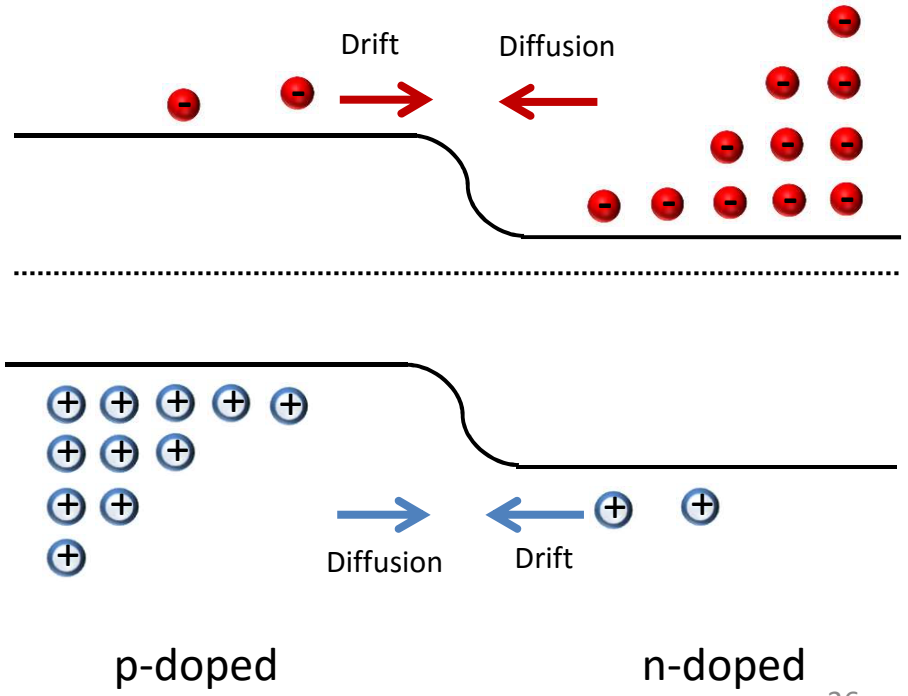

p-doped
n-doped
CB
VB
Ef
holes
electrons
Hole
Si (4+)
B (3+)
P (5+)
p-doped
n-doped
Depletion zone
Eg
electrons
holes

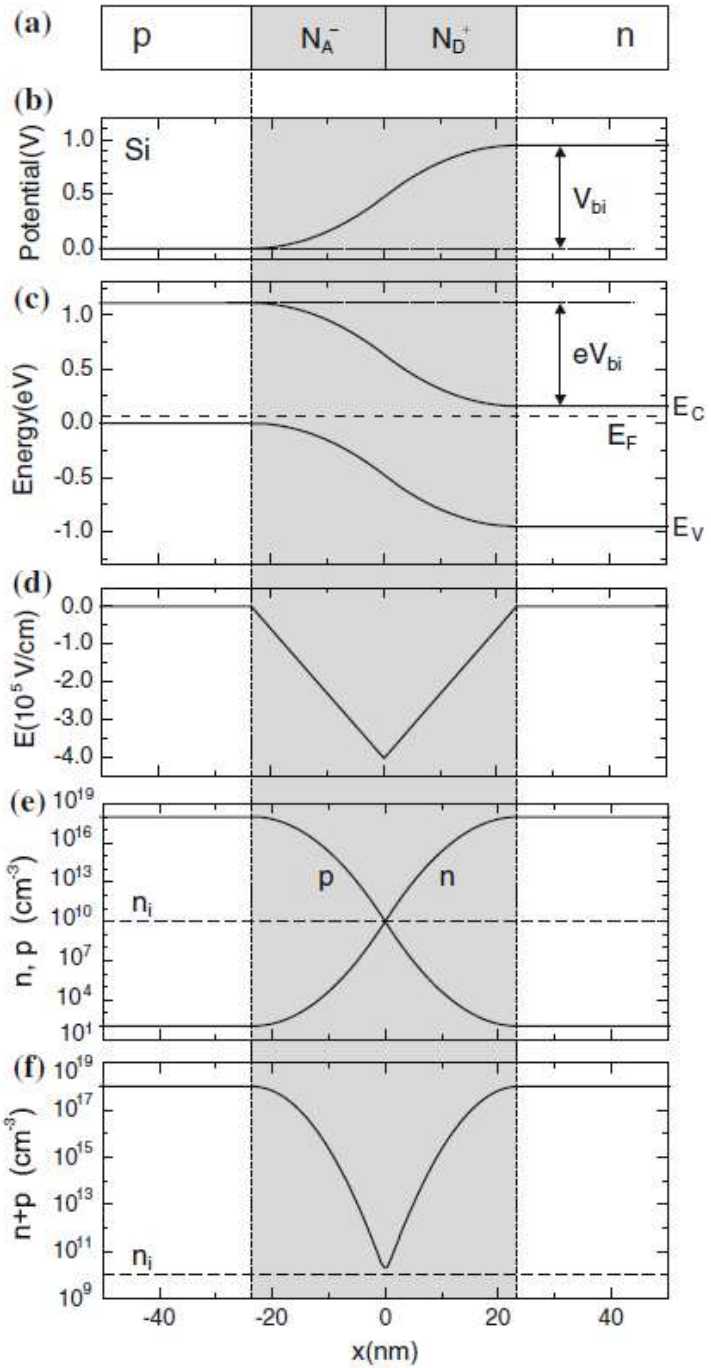
p-n junction



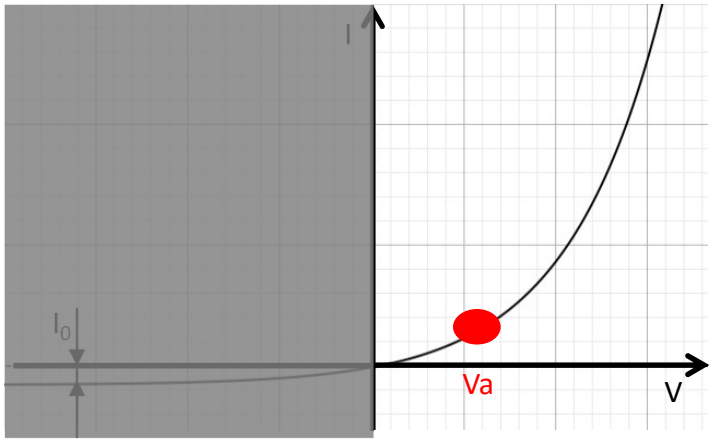
Jn drift = Jn diffusion

Jp drift = Jp diffusion



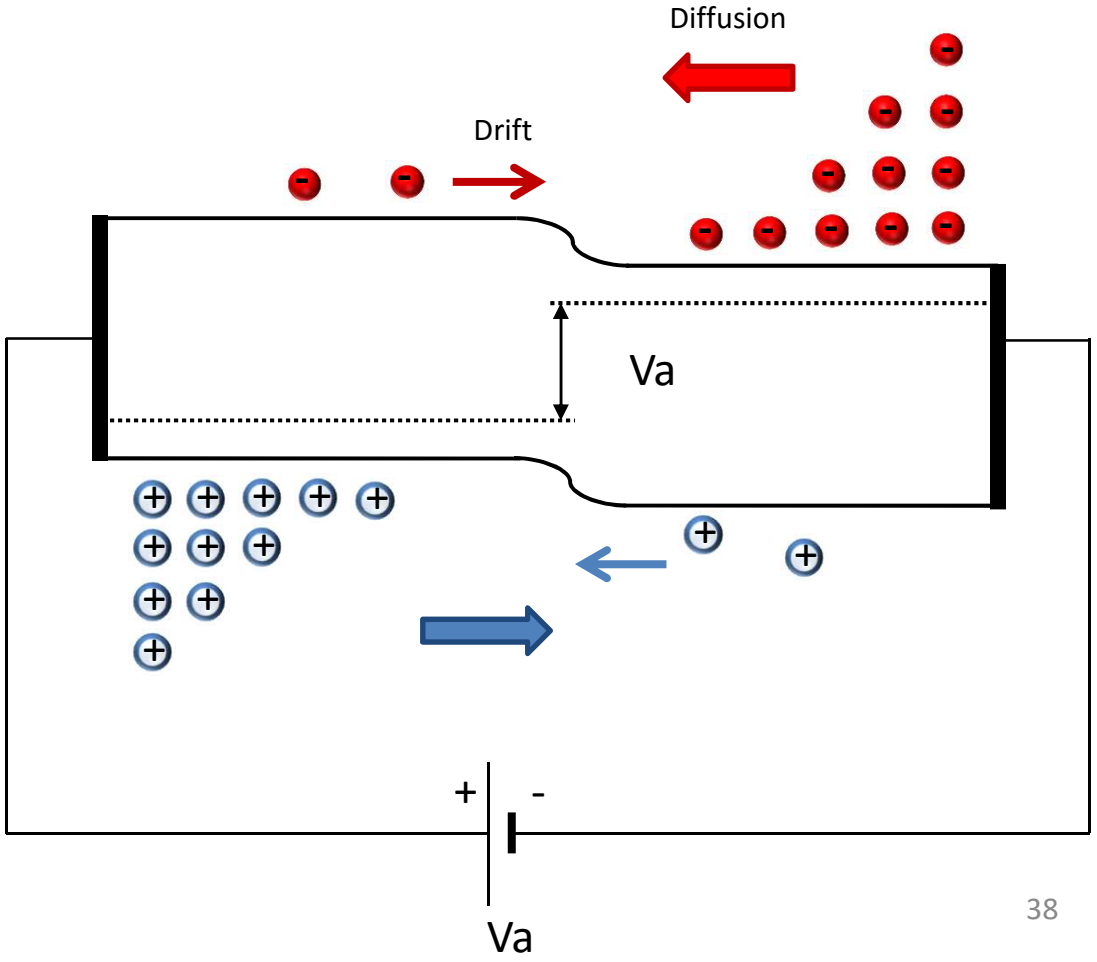

(a)
p
N_A^-
N_D^+
n
(b)
Potential(V)
1.0
0.5
0.0
Si
V_{bi}
(c)
Energy(eV)
1.0
0.5
0.0
-0.5
-1.0
eV_{bi}
E_C
E_F
E_V
(d)
$E(10^5 V/cm)$
0.0
-1.0
-2.0
-3.0
-4.0
(e)
$n, p\ (cm^{-3})$
10^{19}
10^{16}
10^{13}
10^{10}
10^{7}
10^{4}
10^{1}
p
n
n_i
(f)
$n+p\ (cm^{-3})$
10^{19}
10^{17}
10^{15}
10^{13}
10^{11}
10^{9}
n_i
-40
-20
0
20
40
x(nm)

Forward Bias

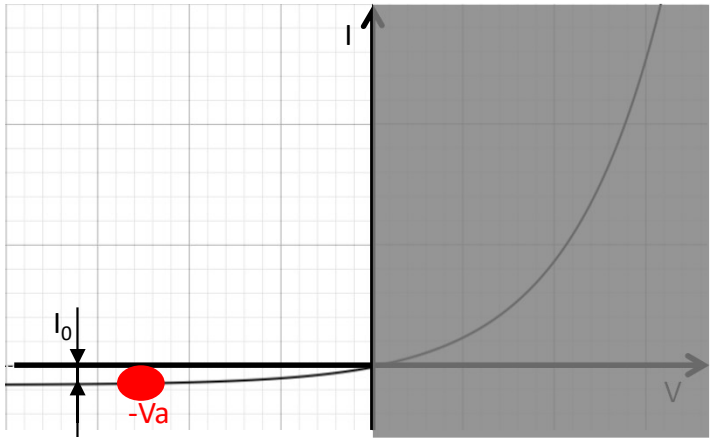


Jn drift < Jn diffusion

Jp drift < Jp diffusion

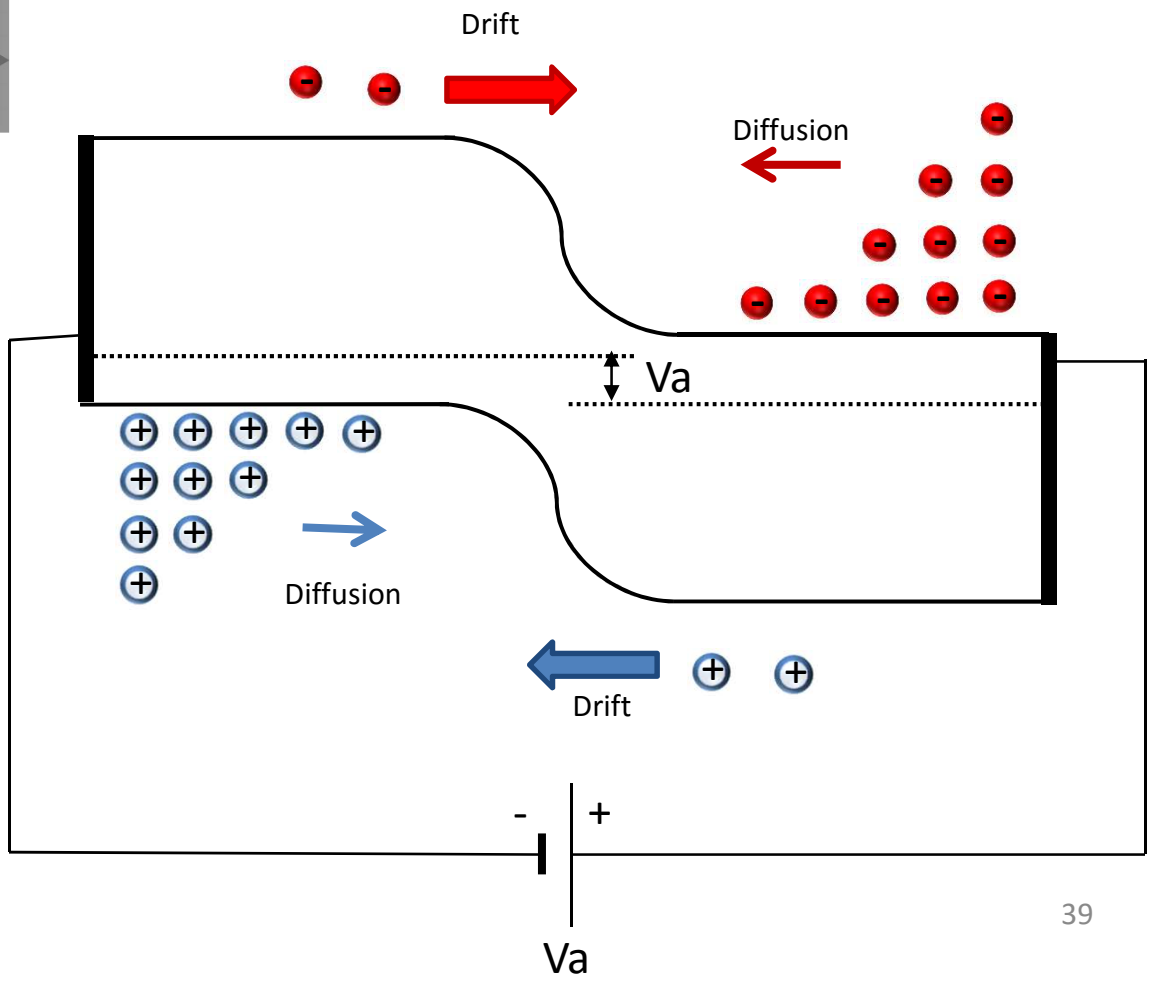


Reverse Bias

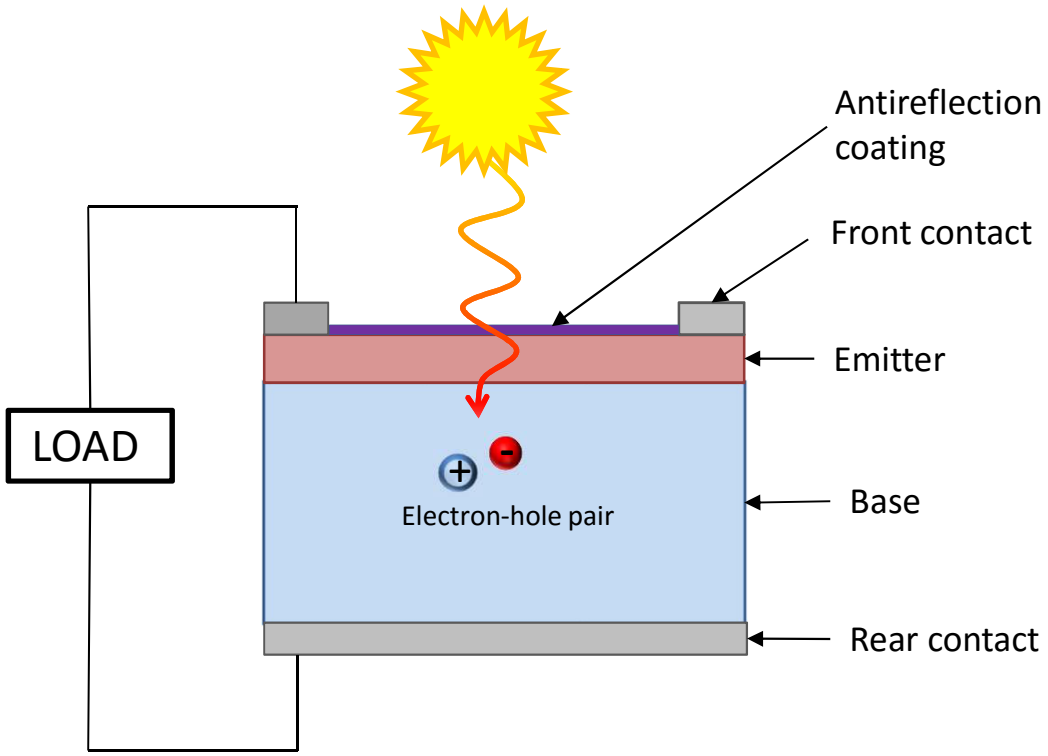


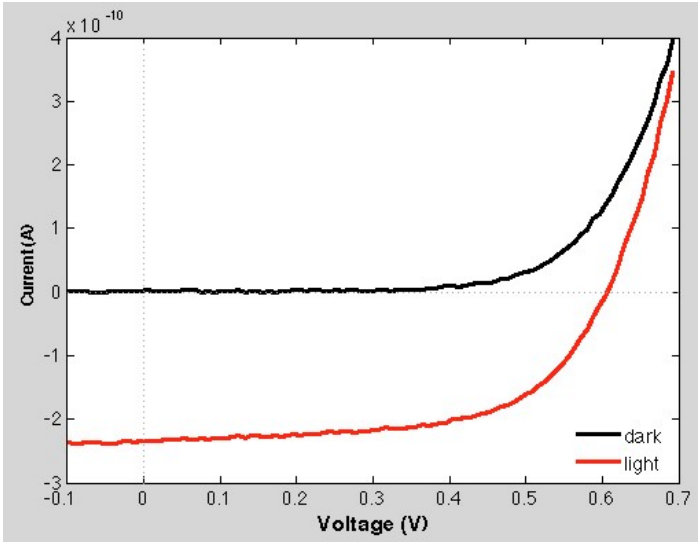
Jn drift > Jn diffusion

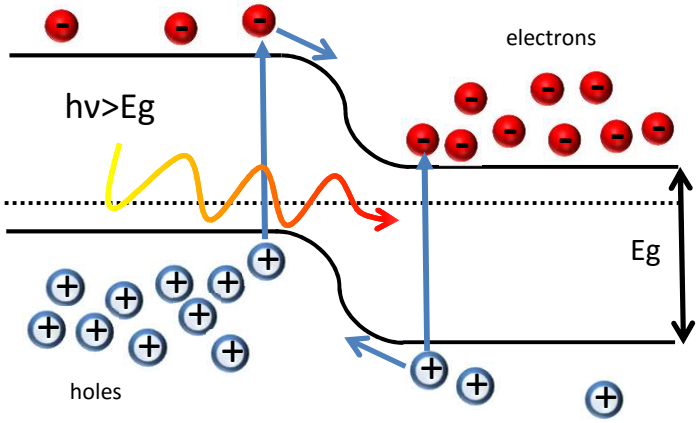
Jp drift > Jp diffusion



Solar Cell





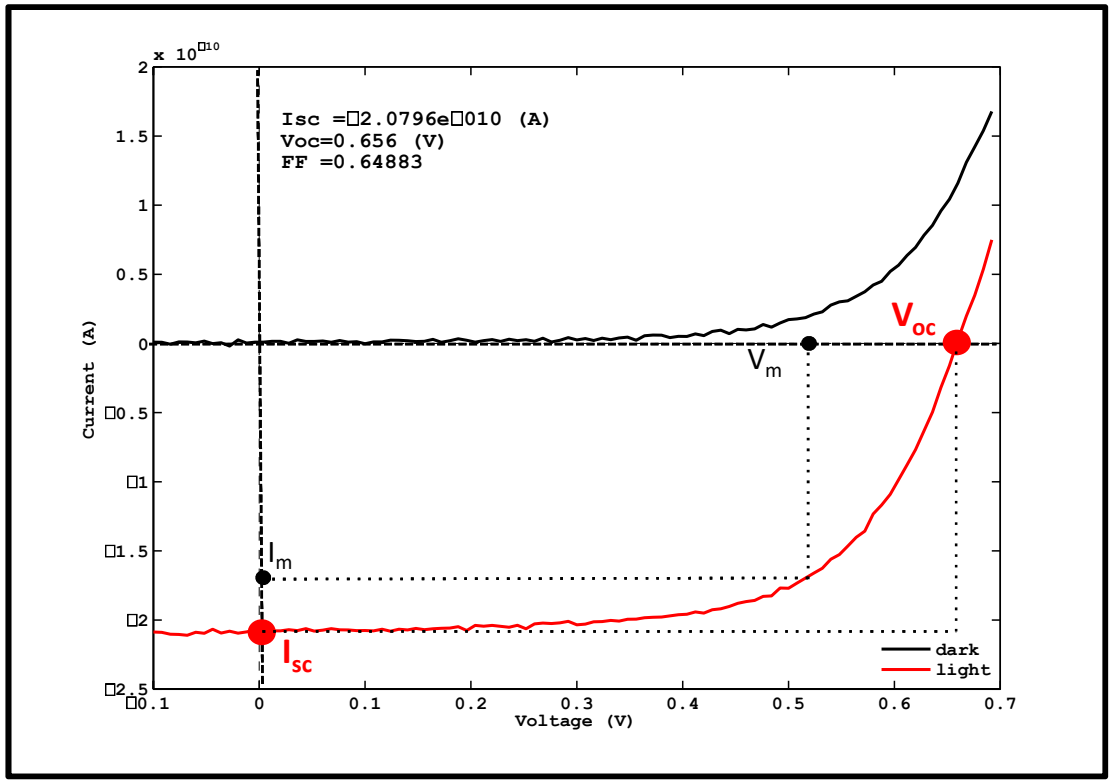


hv<Eg photons almost not absorbed (transparent)

hv=Eg photons have just enough energy to be absorbed

hv>Eg photons strongly absorbed. Spare energy evacuated through thermalization

I-V curve



$$I = I_s \left(\exp\left[\frac{e\,(V - R_s I)}{n\,kT} \right] - 1 \right) + \frac{V - R_s I}{R_p}$$

$$FF = \frac{V_{\max} \cdot I_{\max}}{V_{oc} \cdot I_{sc}}$$

$$Eff = \frac{V_{oc} \cdot I_{sc} \cdot FF}{P_{in}}$$

I_{sc} (short circuit current) : maximum amount of photogenerated carrier collected

V_{oc} (open circuit voltage) : voltage require to balance the photocurrent and the forward bias

FF (Fill Factor) : measure of how square is the curve

Eff (Efficiency) : electric power converted from the sun light

n (Ideality factor) : indicate unusual recombination mechanisms