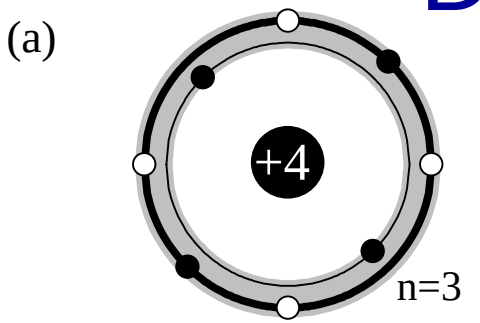
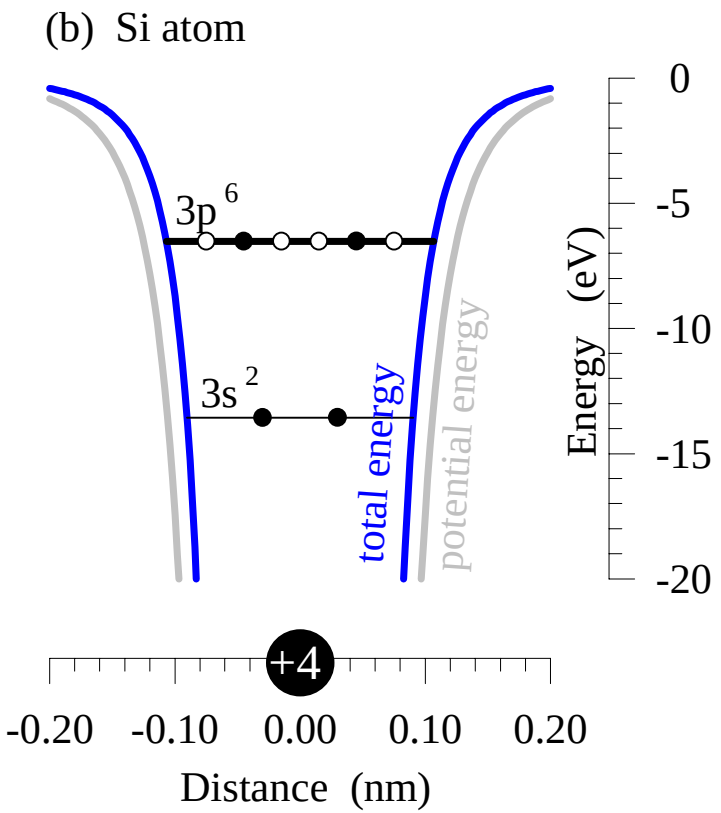
# 2. Diagrama de Bandas de Energia

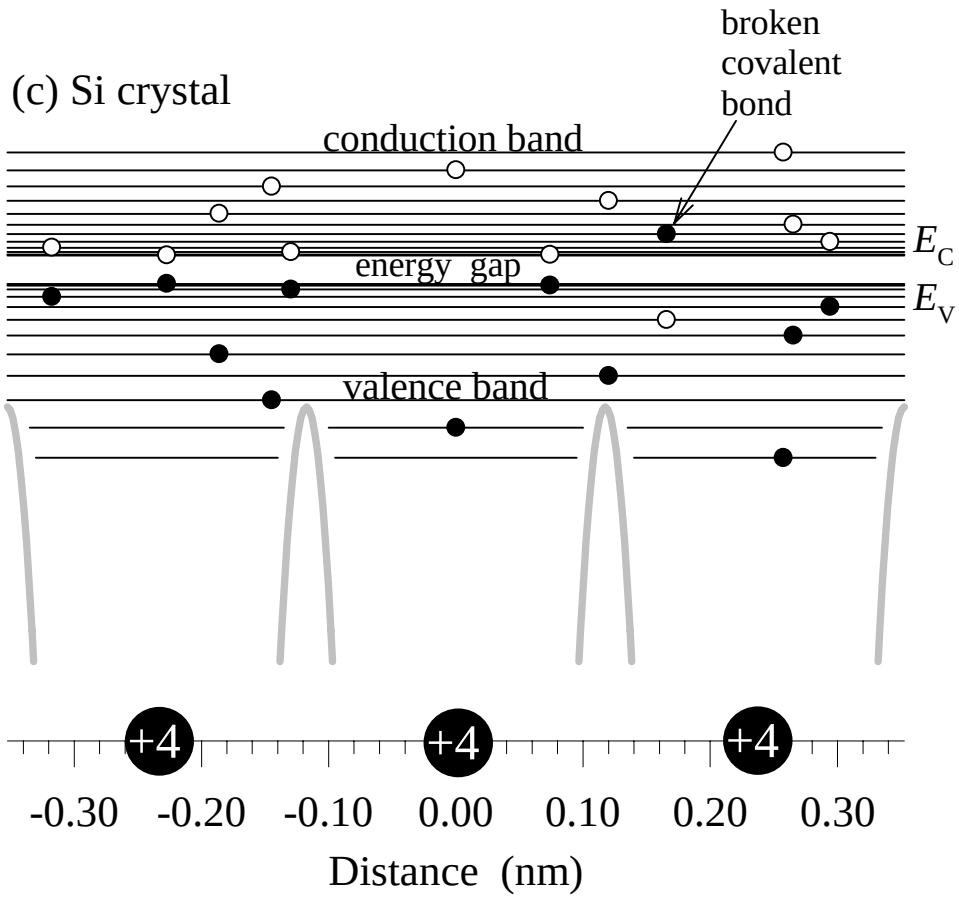
# Diagrama de bandas do Si




filled electron state

empty electron state

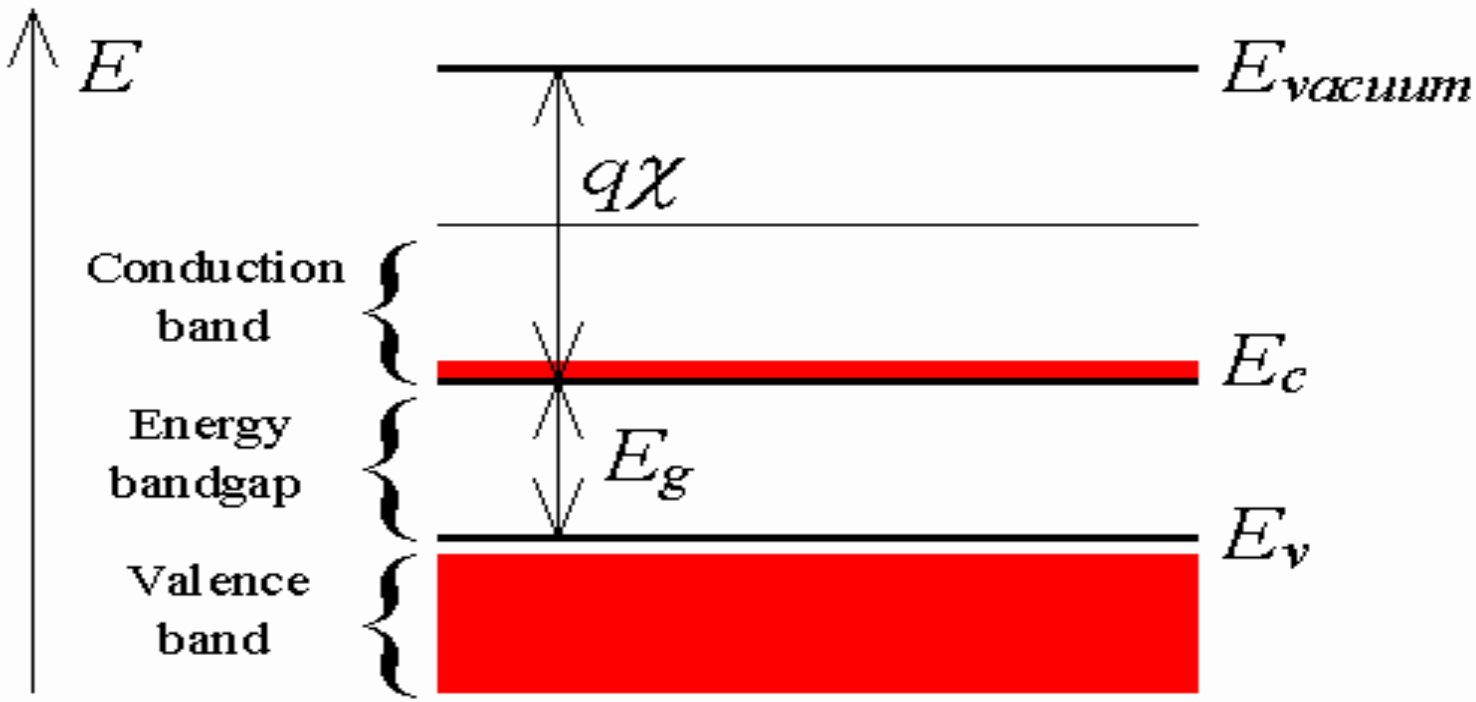


# Parâmetros do diagrama de bandas do Si

$\chi \rightarrow$ afinidade eletrônica (Si) = 4,15 V

Eg $\rightarrow$ largura da faixa proibida (Si) = 1,1 eV

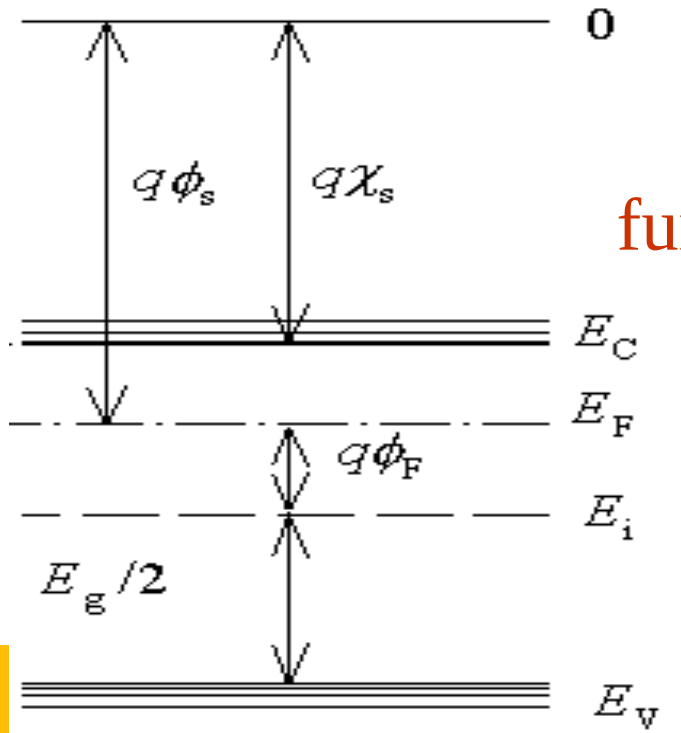


# Parâmetros do diagrama de bandas do Si, cont.

**Si (n)**

$\phi_{si} = \chi + Eg/2 + \phi_F = 4{,}7 + \phi_F$

$$\Phi_F = -\frac{kT}{q}\ln\left(\frac{N_D}{ni}\right)$$

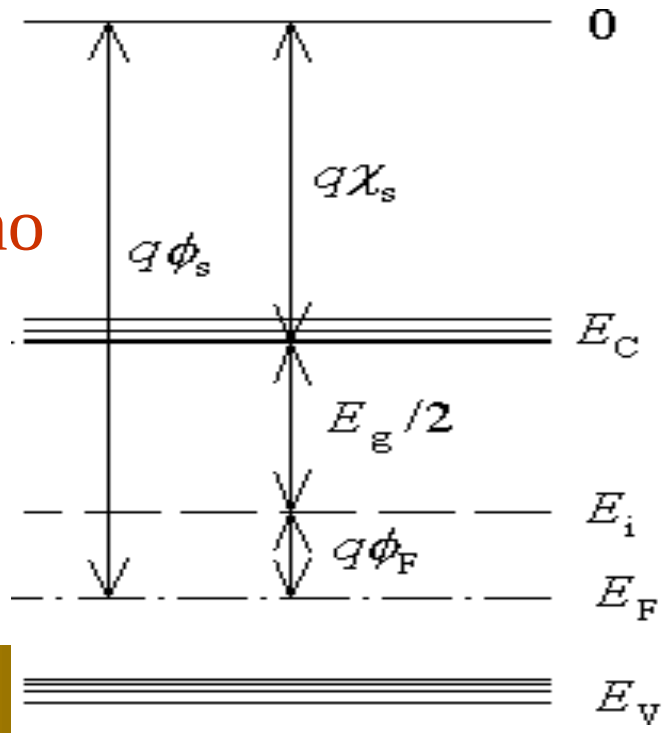



$\phi_{si}$
função trabalho

**Si (p)**

$\phi_{si} = \chi + Eg/2 + \phi_F = 4{,}7 + \phi_F$

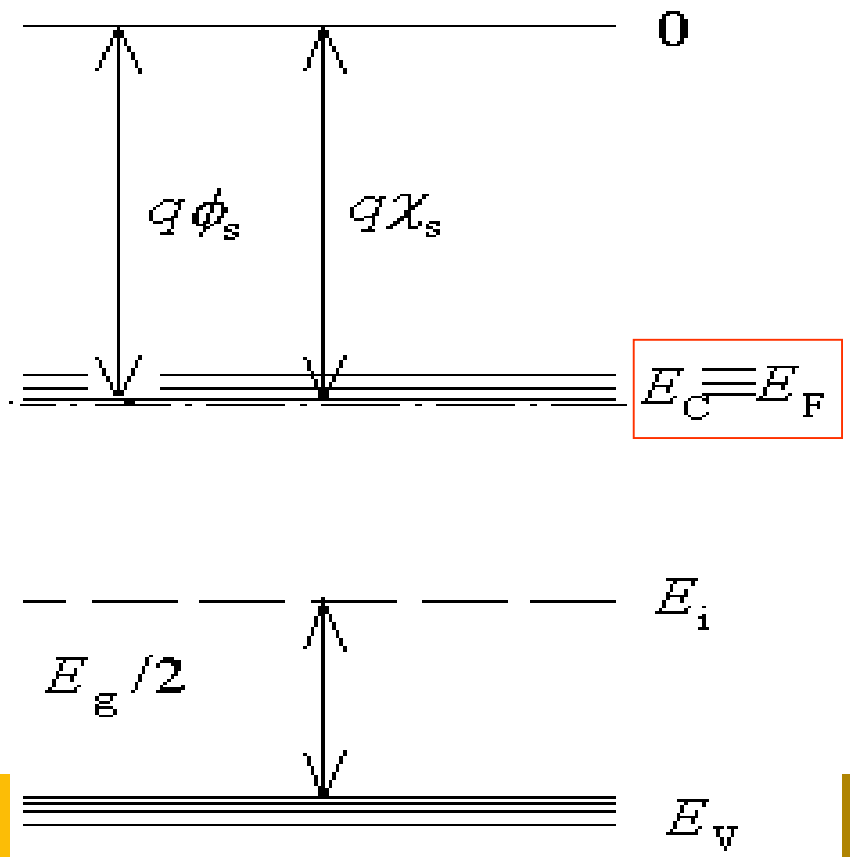
$$\Phi_F = \frac{kT}{q}\ln\left(\frac{N_A}{ni}\right)$$



# Parâmetros do diagrama de bandas do Si - poli

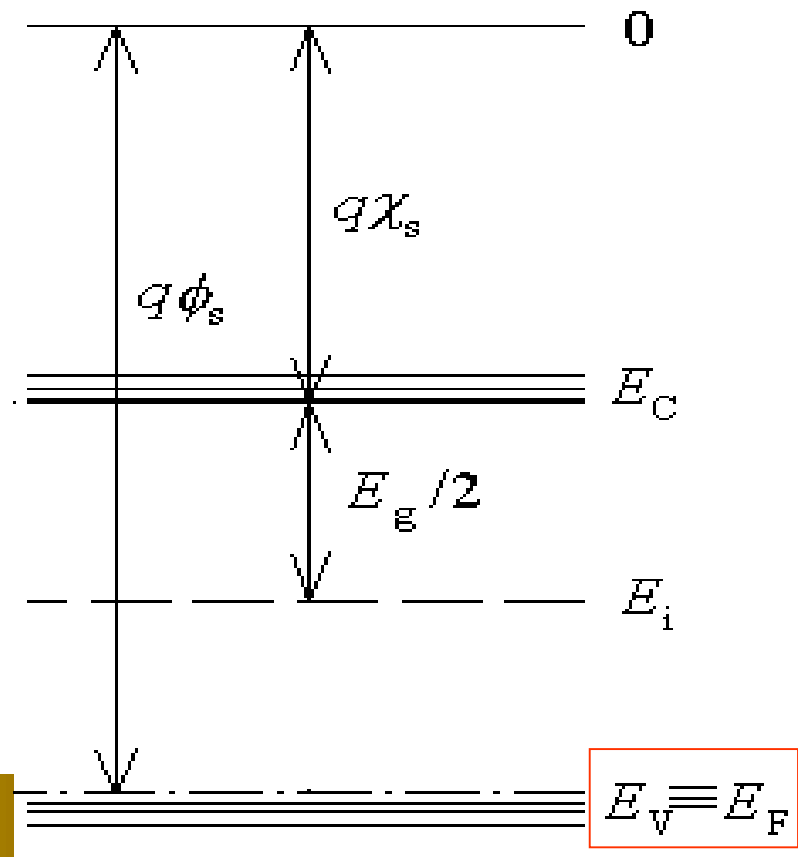
**Si poli $n^+$**

$$\phi_{si} = \chi = 4{,}15\ V$$



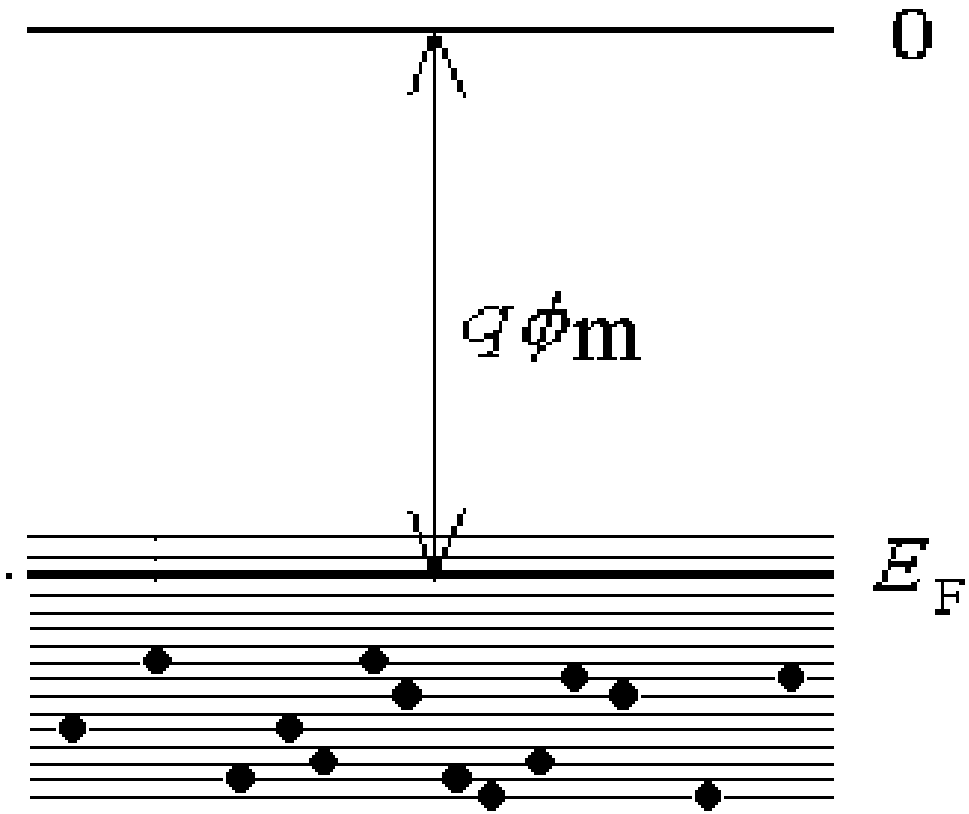

**Si poli $p^+$**

$$\phi_{si} = \chi + Eg = 5{,}25\ V$$

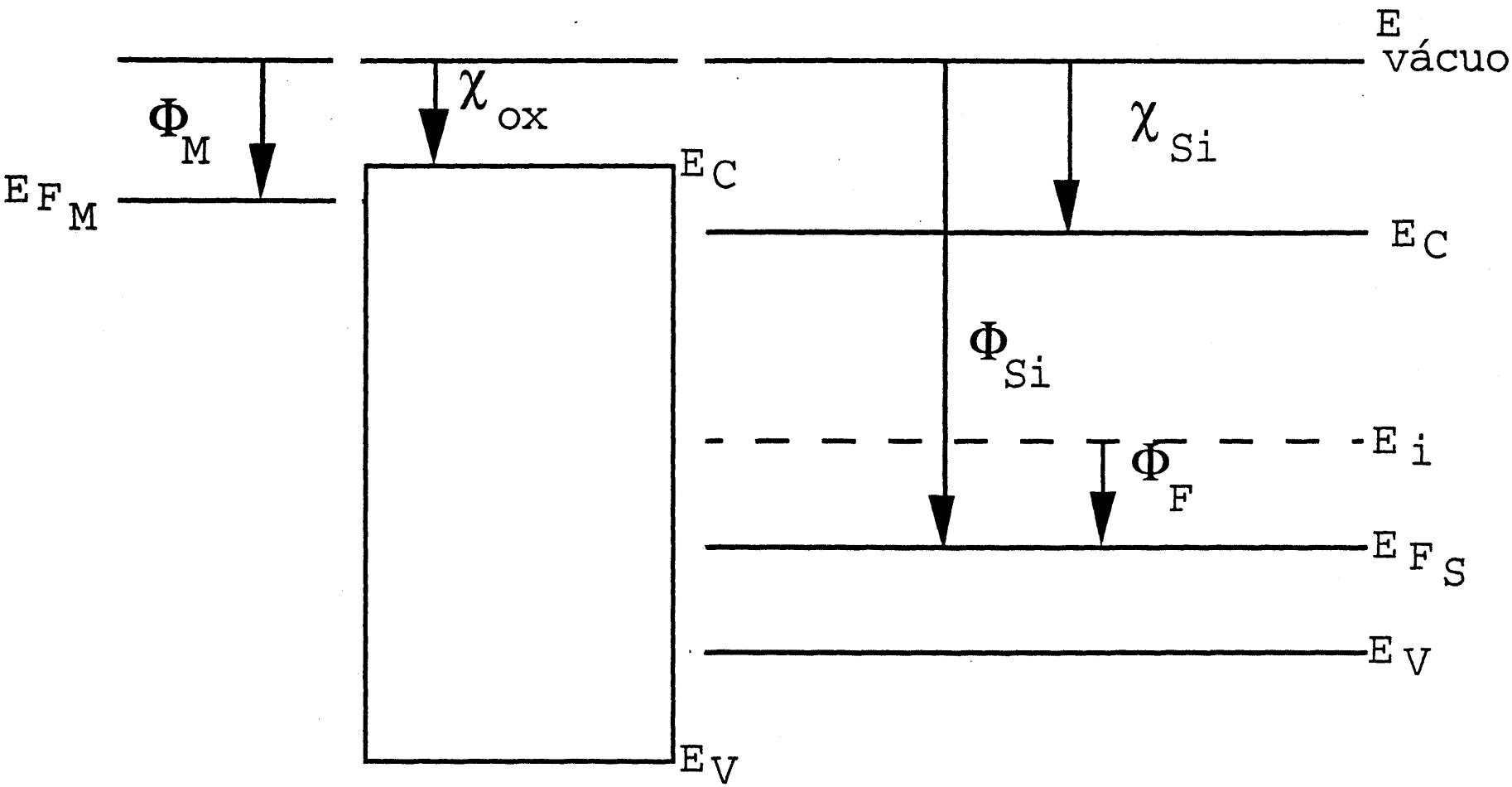


# Parâmetros do diagrama de bandas do Metal

$\phi_{Al} = 4{,}1\ V$



# Diagrama de bandas
# Metal - Óxido - Semicondutor



# Exercícios

1. Determine o valor de $\phi_{MS} = \phi_{Metal} - \phi_{Silício}$ e desenhe os diagramas de energia, para os seguintes casos:

a) M=Al ; Si = dopado com boro, 1E+15 at./cm$^3$;

$\phi_M$ =4,1 V $\phi_{Si}$ = 4,99 V ($\phi_F$ = 0,29) $\phi_{MS}$= -0,89 V

b) M=Al ; Si = dopado com fósforo, 1E+15 at./cm$^3$;

$\phi_M$ = 4,1 V $\phi_{Si}$ = 4,41 V ($\phi_F$ = -0,29) $\phi_{MS}$= -0,31 V

a) M=Si poli n$^+$ ; Si = dopado com boro, 1E+16 at./cm$^3$;

$\phi_M$ = 4,15 V $\phi_{Si}$ = 5,05 V ($\phi_F$ = 0,35) $\phi_{MS}$= -0,9 V

a) M=Si poli p$^+$ ; Si = dopado com fósforo, 1E+16 at./cm$^3$.

$\phi_M$ = 5,25 V $\phi_{Si}$ = 4,35 V ($\phi_F$ = -0,35) $\phi_{MS}$= +0,9 V

Dados: k=1,38 E-23 J/K, T=25$^O$C,

q=1.6 E-19. ni=1.45 E+10 at./cm$^3$