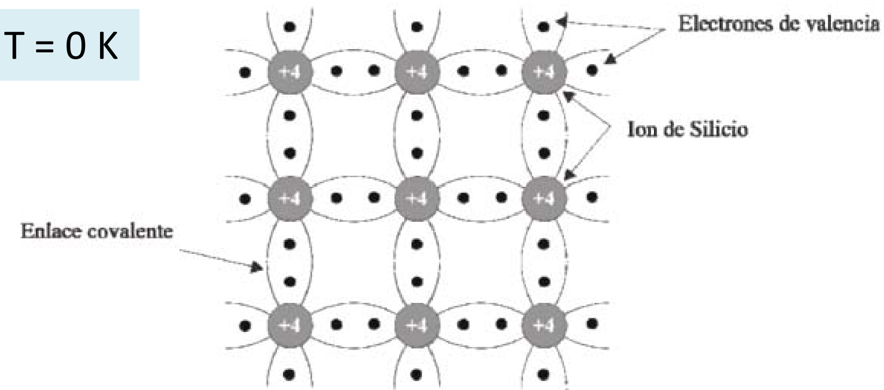
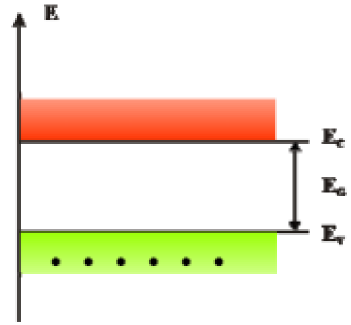
TEMA 2: **PROPIEDADES FUNDAMENTALES DE LOS SEMICONDUCTORES**

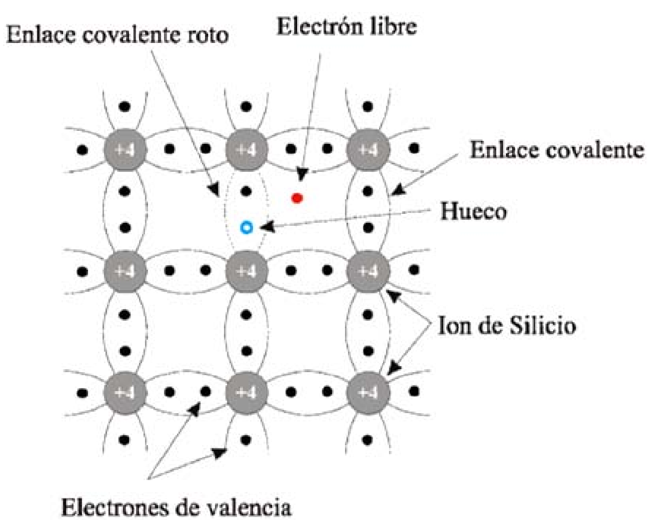
<u>Semiconductor Intrínseco</u>:

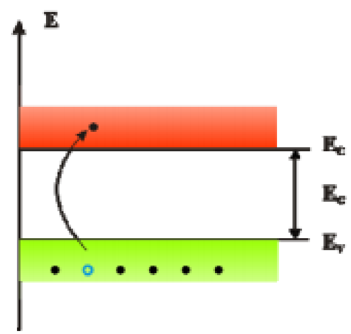
T = 0 K

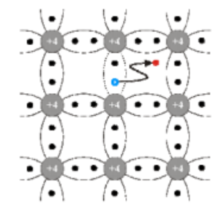


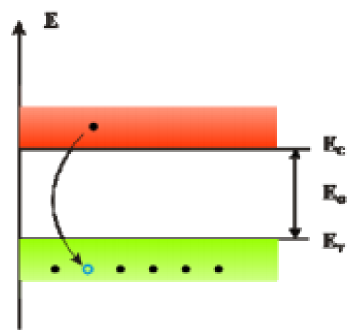


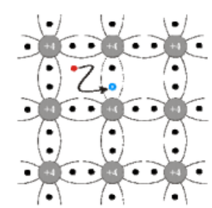
T > 0 K

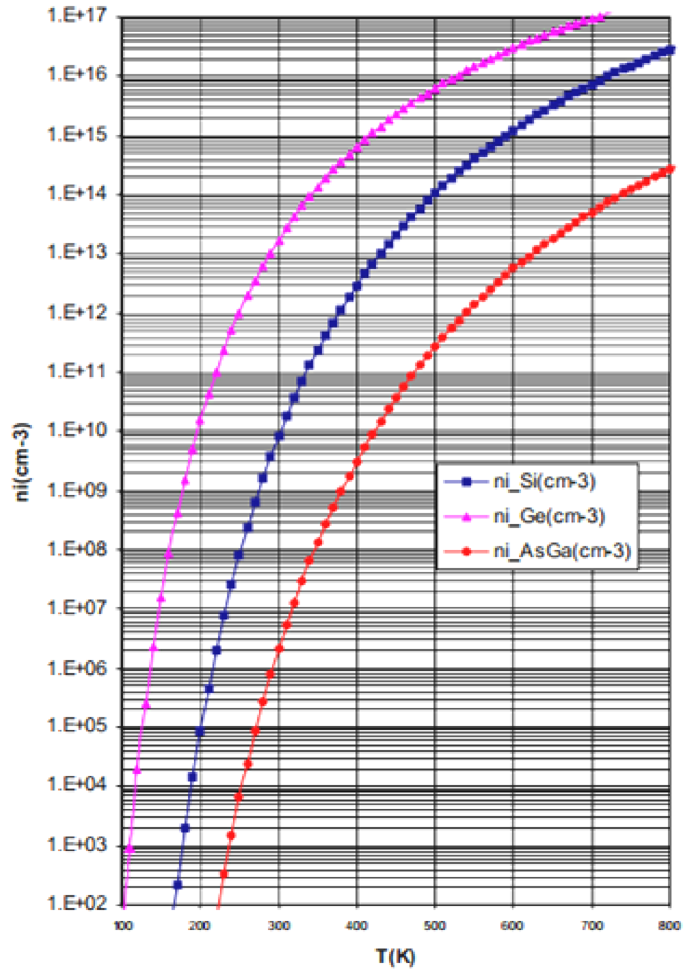










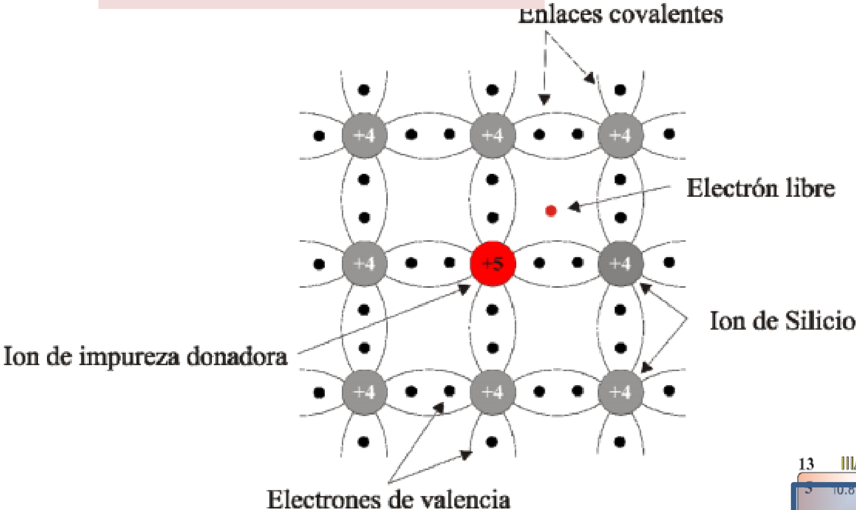


$n_i\ (Si)_{300K} = 1.45\ 10^{10}\ cm^{-3}$

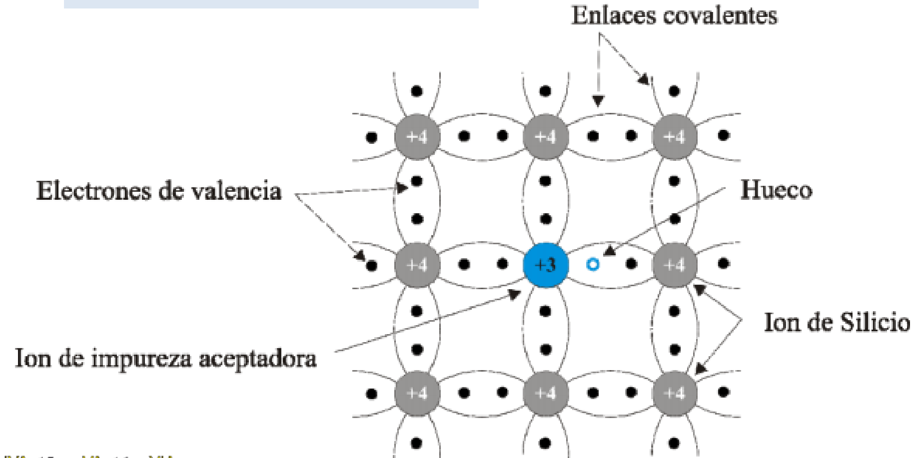
Dependencia de la concentración intrínseca (n_i) de Si, Ge, GaAs en función de la temperatura

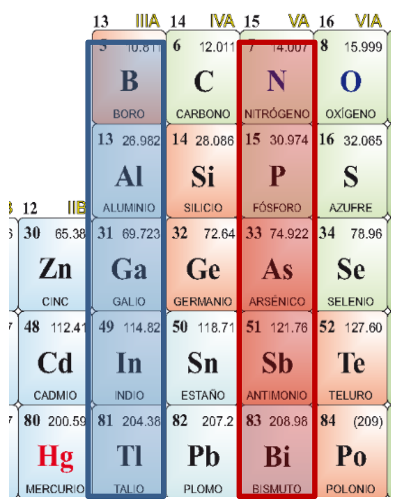
Semiconductor Extrínseco:

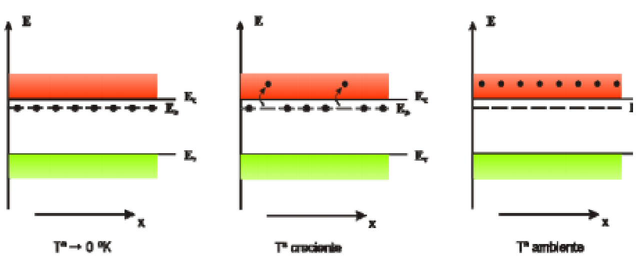
• *DONADORES* $(D \rightarrow D^{+})$

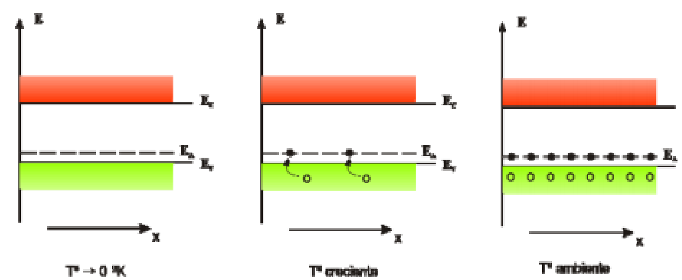


• *ACEPTORES* $(A \rightarrow A^{-})$









Energías de ionización de impurezas en Si, Ge

Impureza	Si	Ge
Fósforo	0.045	0.012
Arsénico	0.05	0.0127
Boro	0.045	0.0104
Aluminio	0.06	0.0102

$K_B T_{300K} \approx 0.0258$ eV

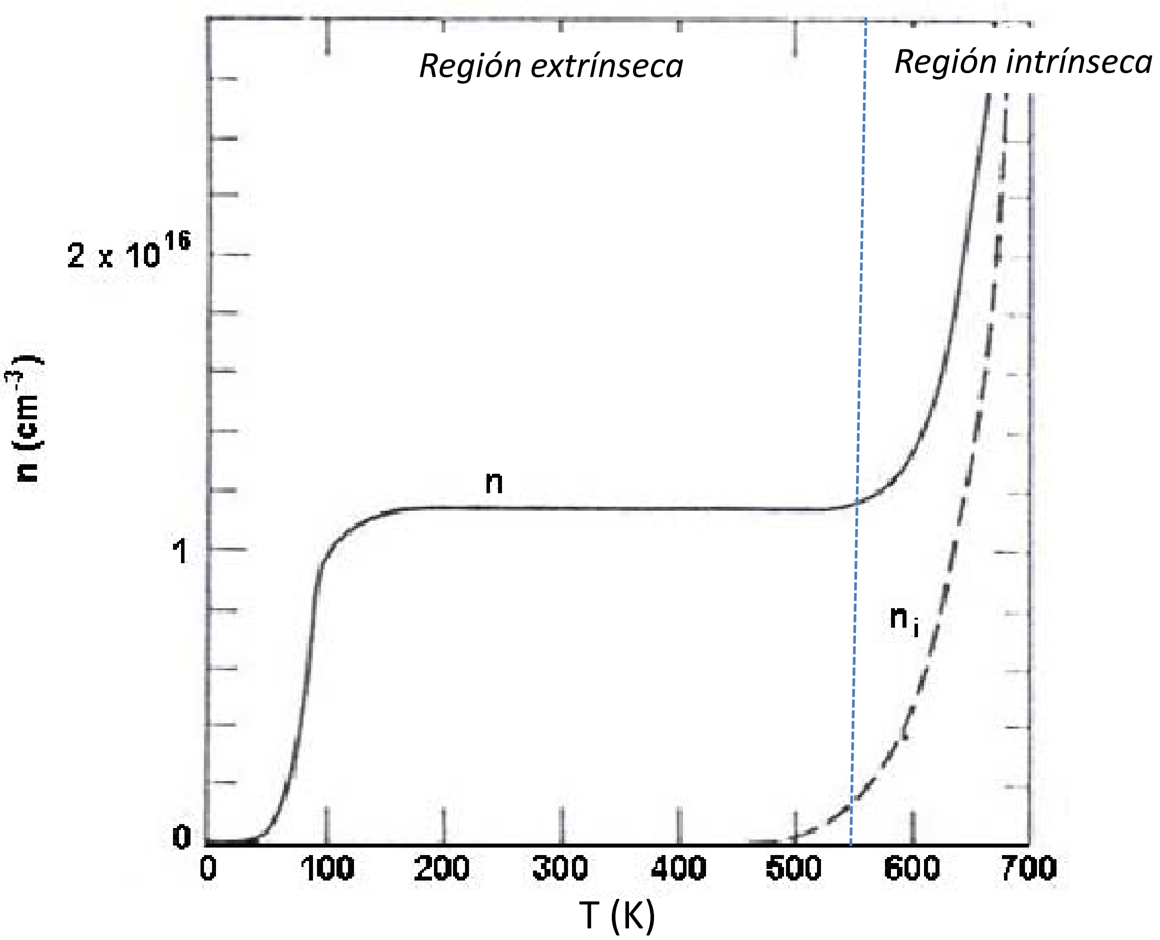
Energías de ionización de impurezas en GaAs

Impureza	Donadoras
Selenio	0.0059
Teluro	0.0058
Silicio	0.0058
Germanio	0.0061

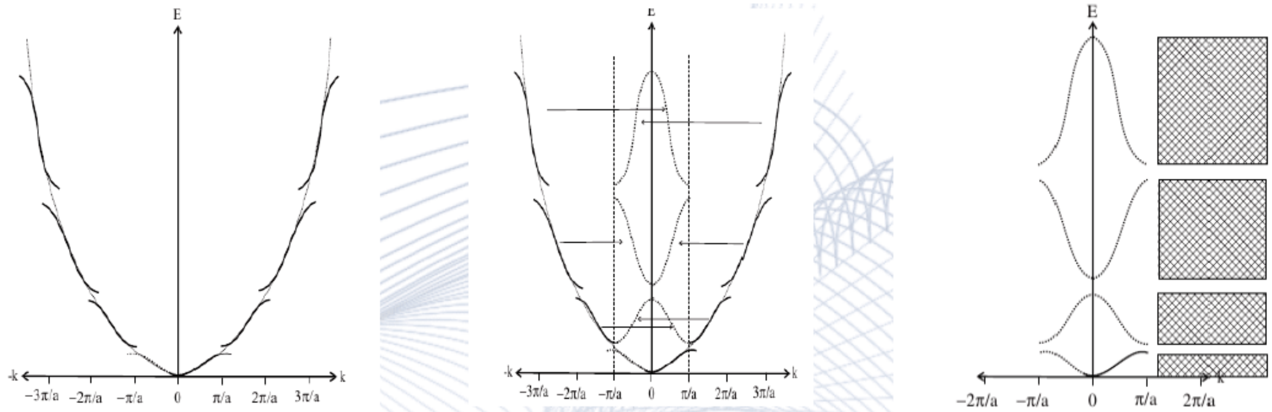
Impureza	Aceptoras
Berilio	0.028
Zinc	0.0307
Cadmio	0.0347
Silicio	0.0345
Germanio	0.0404

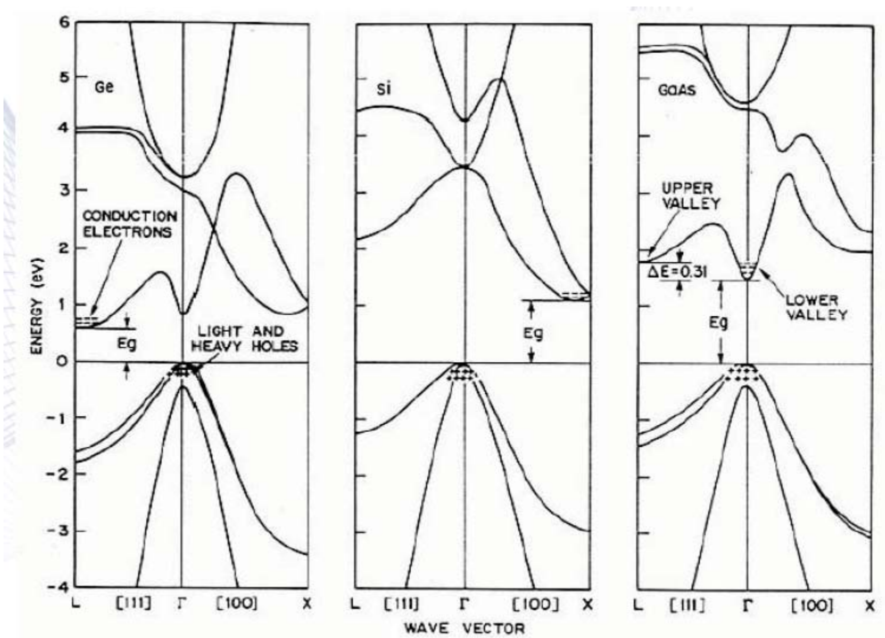
- Impurezas donadoras tipo (VI) que tienden a sustituir al As (tipo V)
- Impurezas aceptoras (tipo II) que tienden a sustituir al Ga (tipo III)
- Impurezas anfóteras (tipo IV), pueden sustituir al Ga (donadoras) o al As (aceptoras)

SEMICONDUCTORES EN EQUILIBRIO



Concentración de electrones en silicio tipo n, en función de la temperatura.

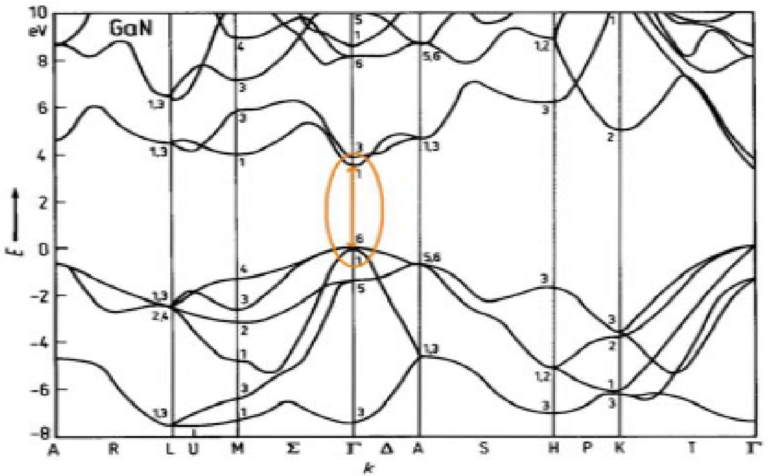


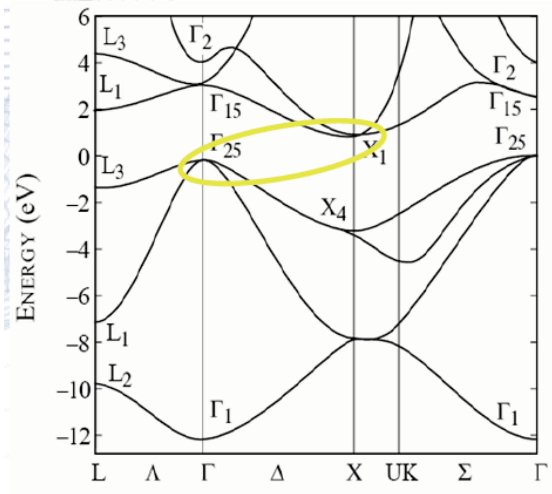


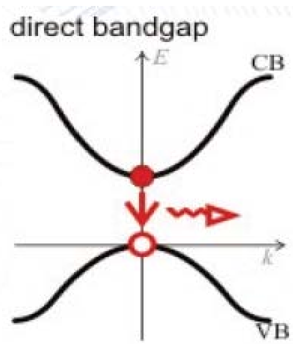
ENERGY-BAND STRUCTURES OF Ge, Si, and GaAs

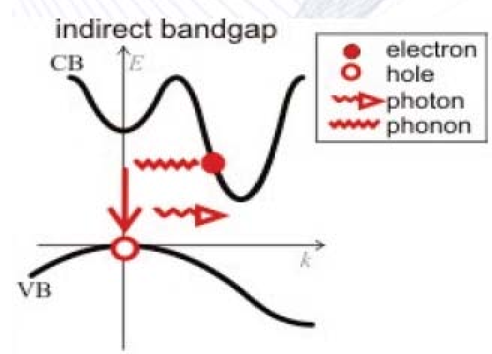
GAP directo

GAP indirecto









Concentración de portadores en diferentes tipos de semiconductores

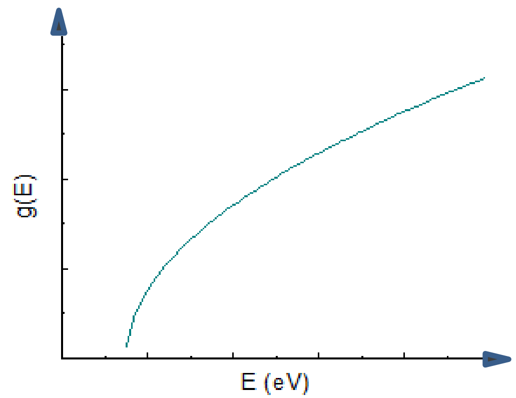
Semiconductor	Concentración de portadores	
tipo *n*	$n \approx N_D$	$p \approx n_i^2/N_D$
tipo *p*	$p \approx N_A$	$n \approx n_i^2/N_A$
(*) tipo *n* ($N_D > N_A$)	$n \approx N_D - N_A$	$p \approx n_i^2/N_D - N_A$
(*) tipo *p* ($N_A > N_D$)	$p \approx N_A - N_D$	$n \approx n_i^2/N_A - N_D$
(*) Compensado ($N_A = N_D$)	$n = p = n_i$	

(*) $|N_A - N_D| >> n_i$

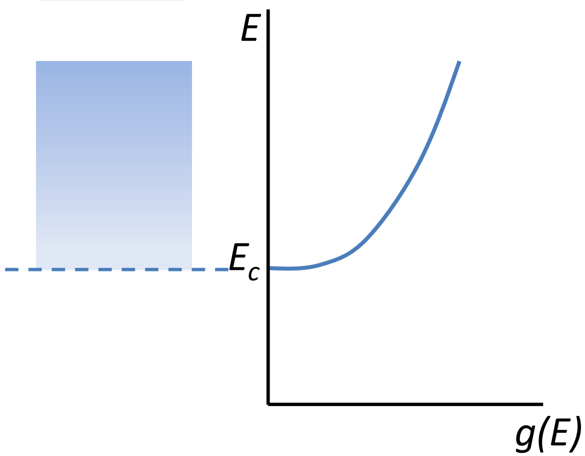
Función densidad de estados

$$g(E) = \frac{4\pi(2m)^{3/2}}{h^3} E^{1/2}$$

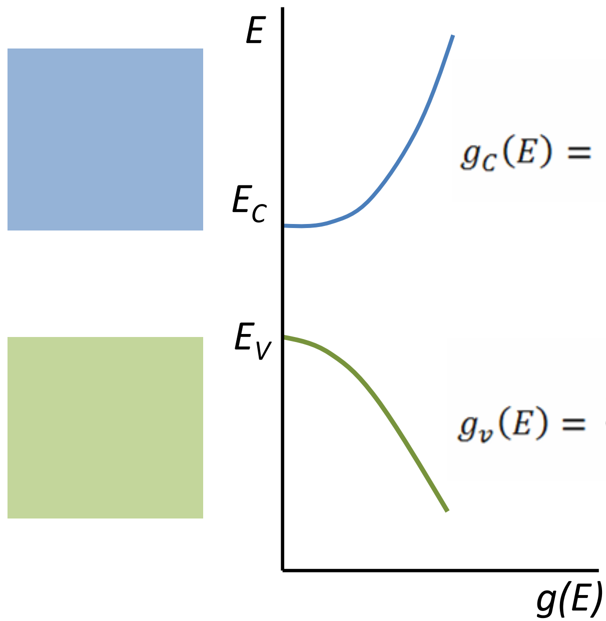
(3D)



METAL



SEMICONDUCTOR

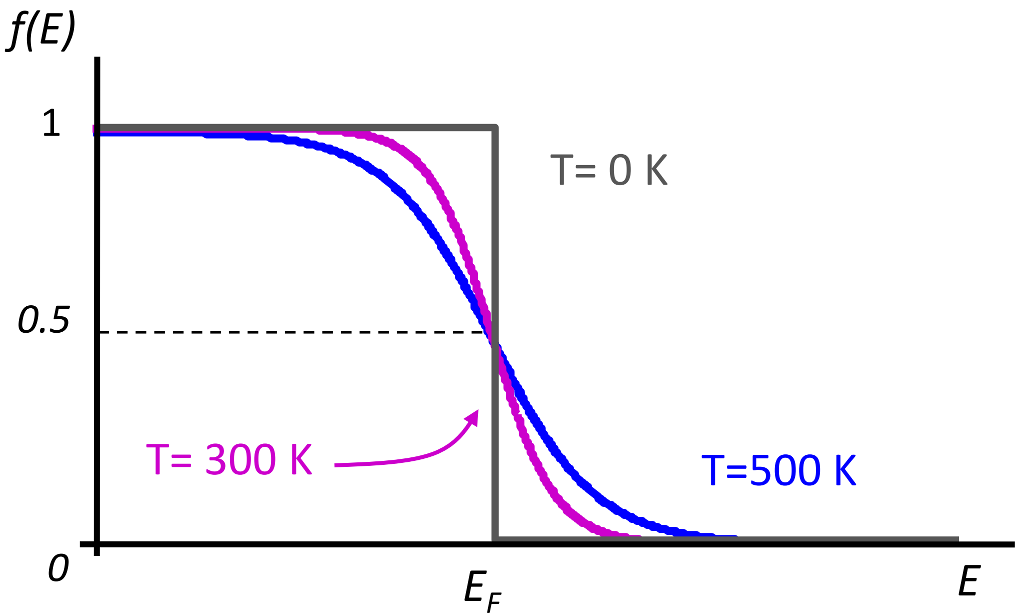


$$g_c(E) = \frac{4\pi(2m_e^*)^{3/2}}{h^3}(E - E_c)^{1/2}$$

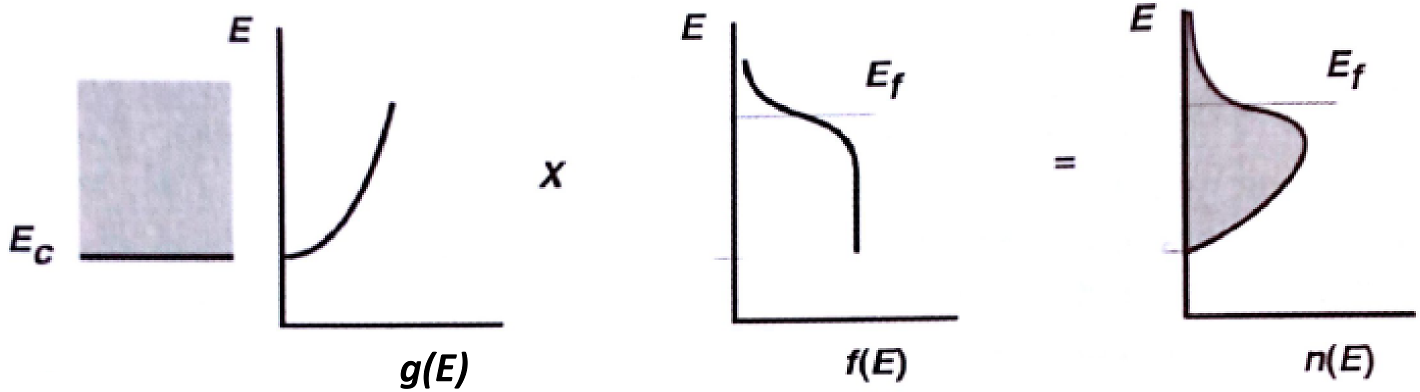
$$g_v(E) = \frac{4\pi(2m_h^*)^{3/2}}{h^3}(E_v - E)^{1/2}$$

Función de probabilidad de Fermi-Dirac

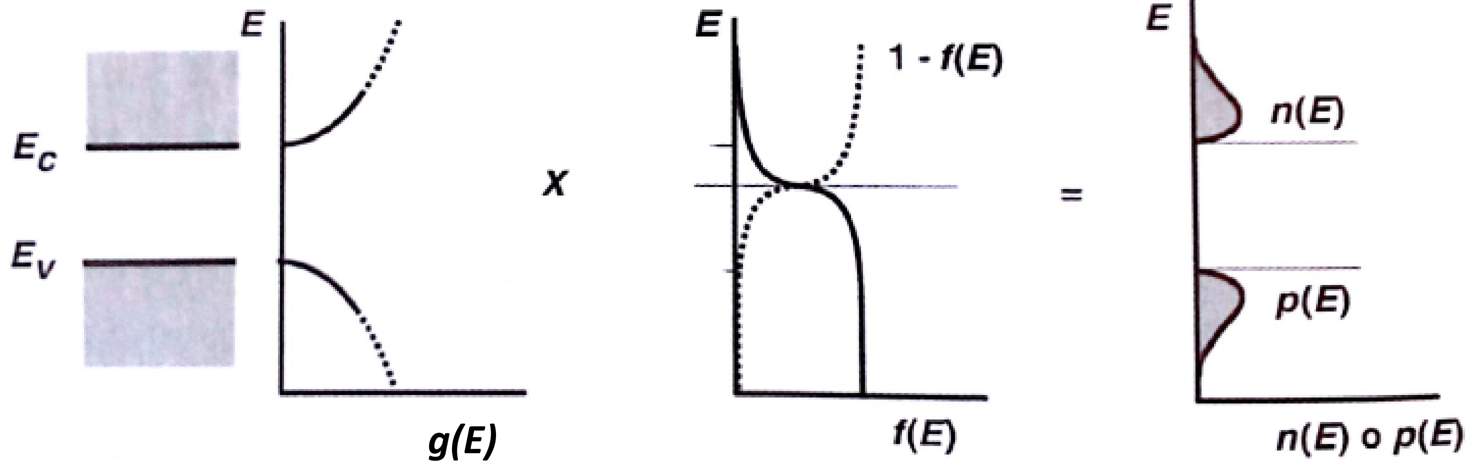
$$f(E) = \frac{1}{1 + \exp\left(\frac{E - E_F}{KT}\right)}$$



METAL



SEMICONDUCTOR



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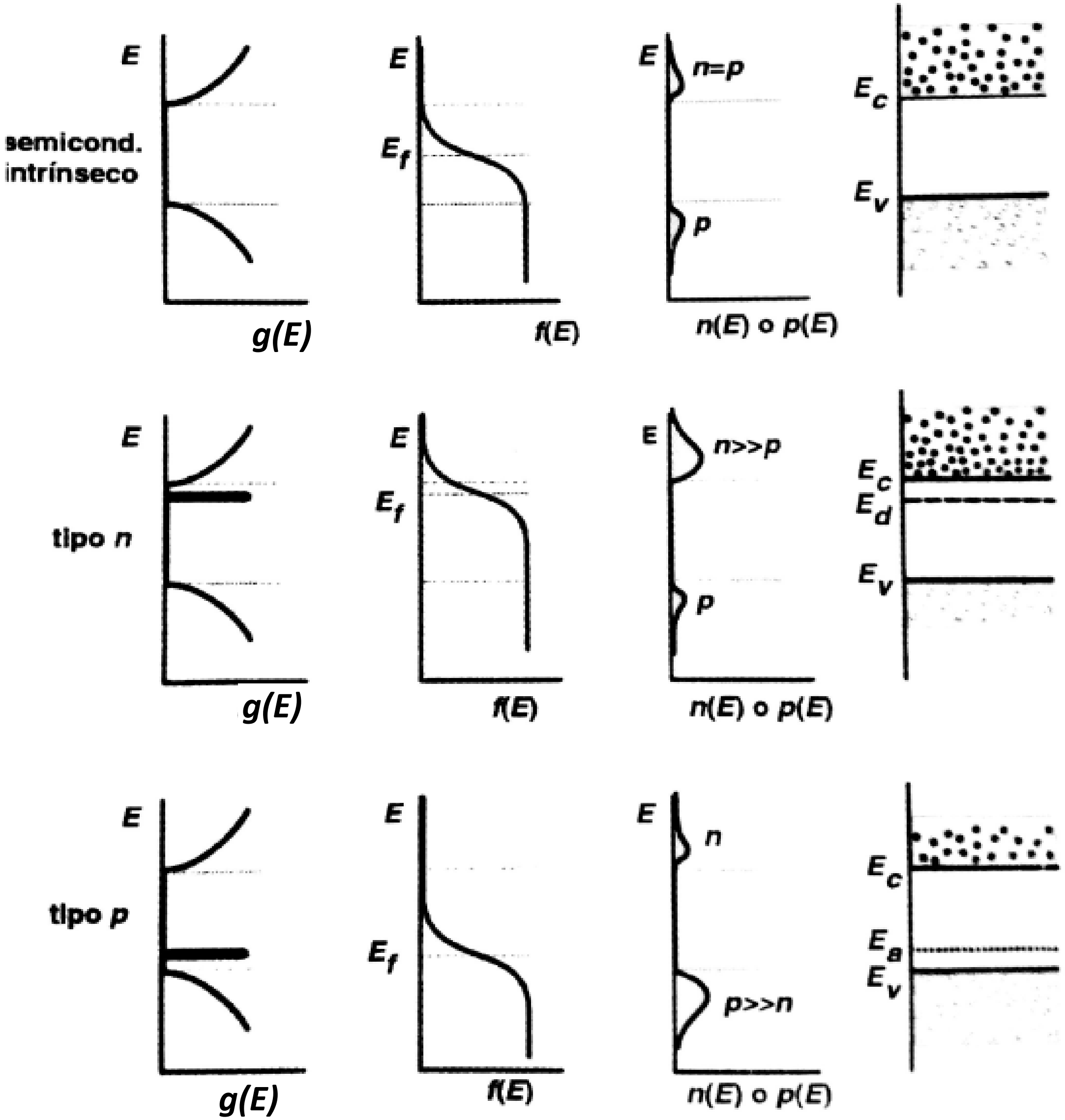

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