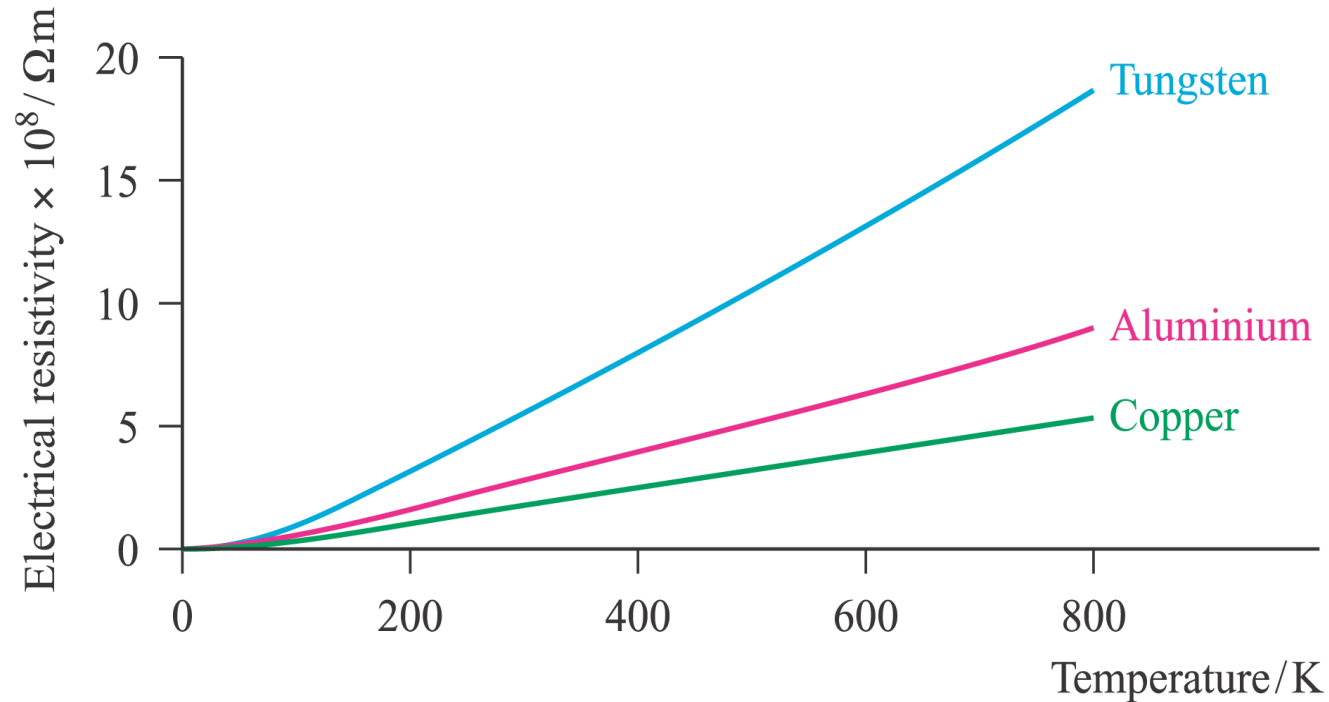
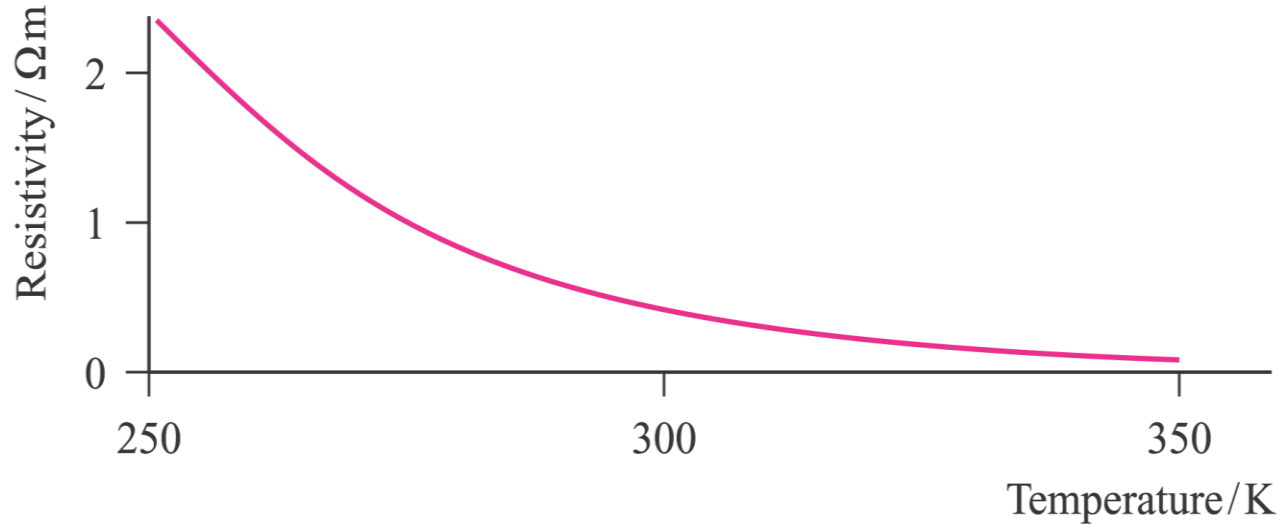


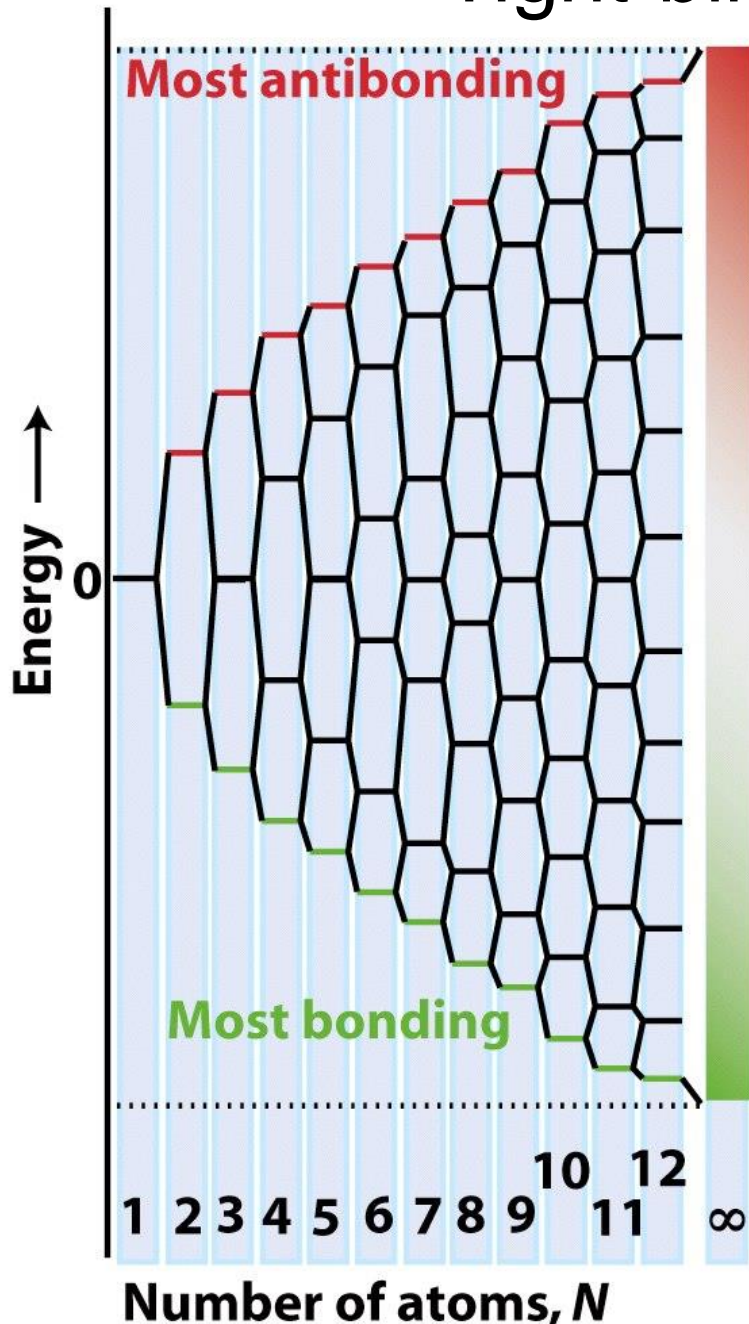
# Resistività di alcuni metalli in funzione della temperatura



# Resistività del semiconduttore Ge in funzione della temperatura



# Tight-binding approximation

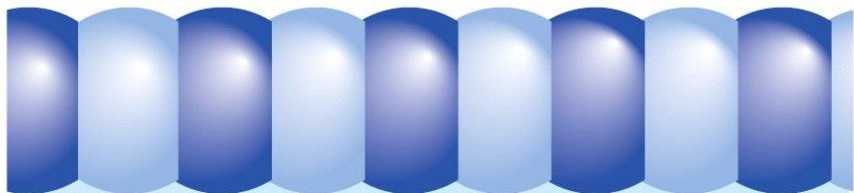


L'ampiezza complessiva della banda rimane **finita** anche se  $N$  si approssima all'infinito

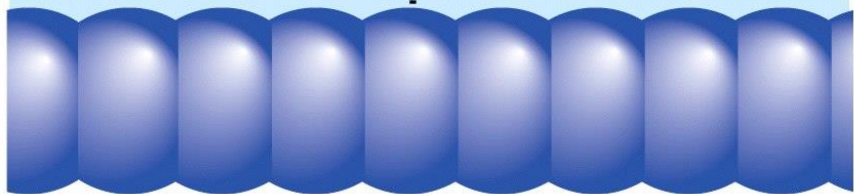
Maggiore è il grado di sovrapposizione tra orbitali atomici adiacenti e più grande è l'ampiezza della banda

# Banda s

**Most antibonding**



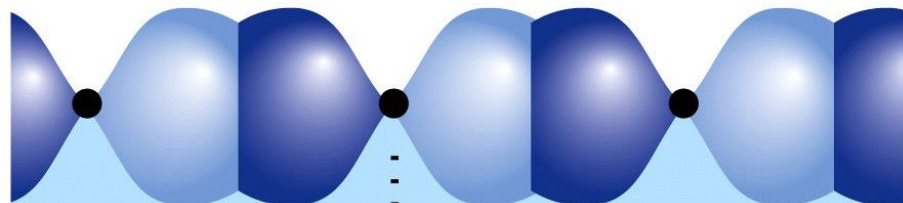
**Intermediate orbitals**



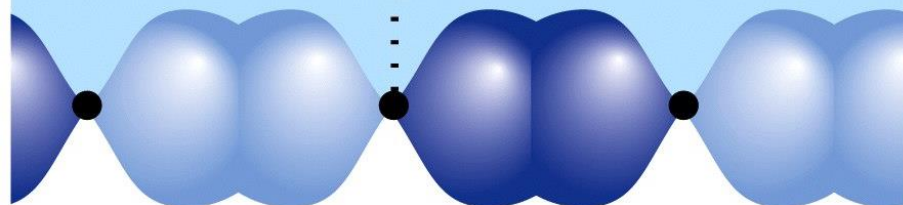
**Most bonding**

# Banda p

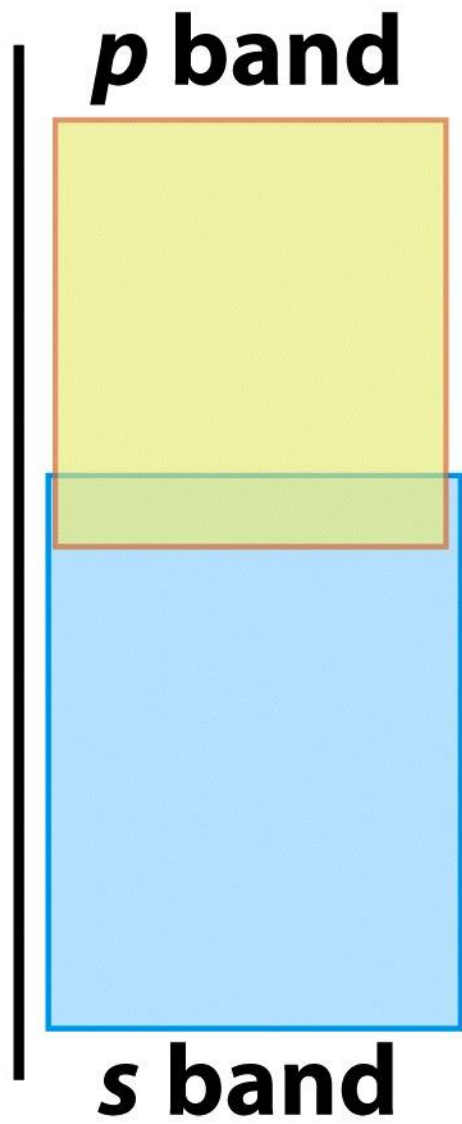
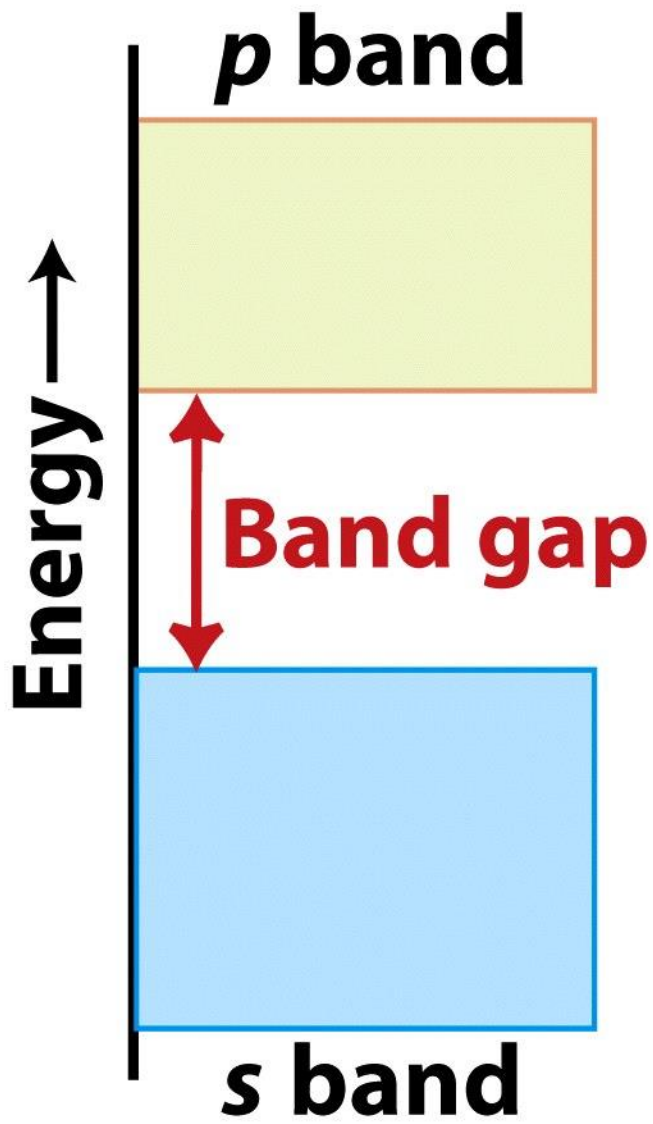
**Most antibonding**



**Intermediate orbitals**

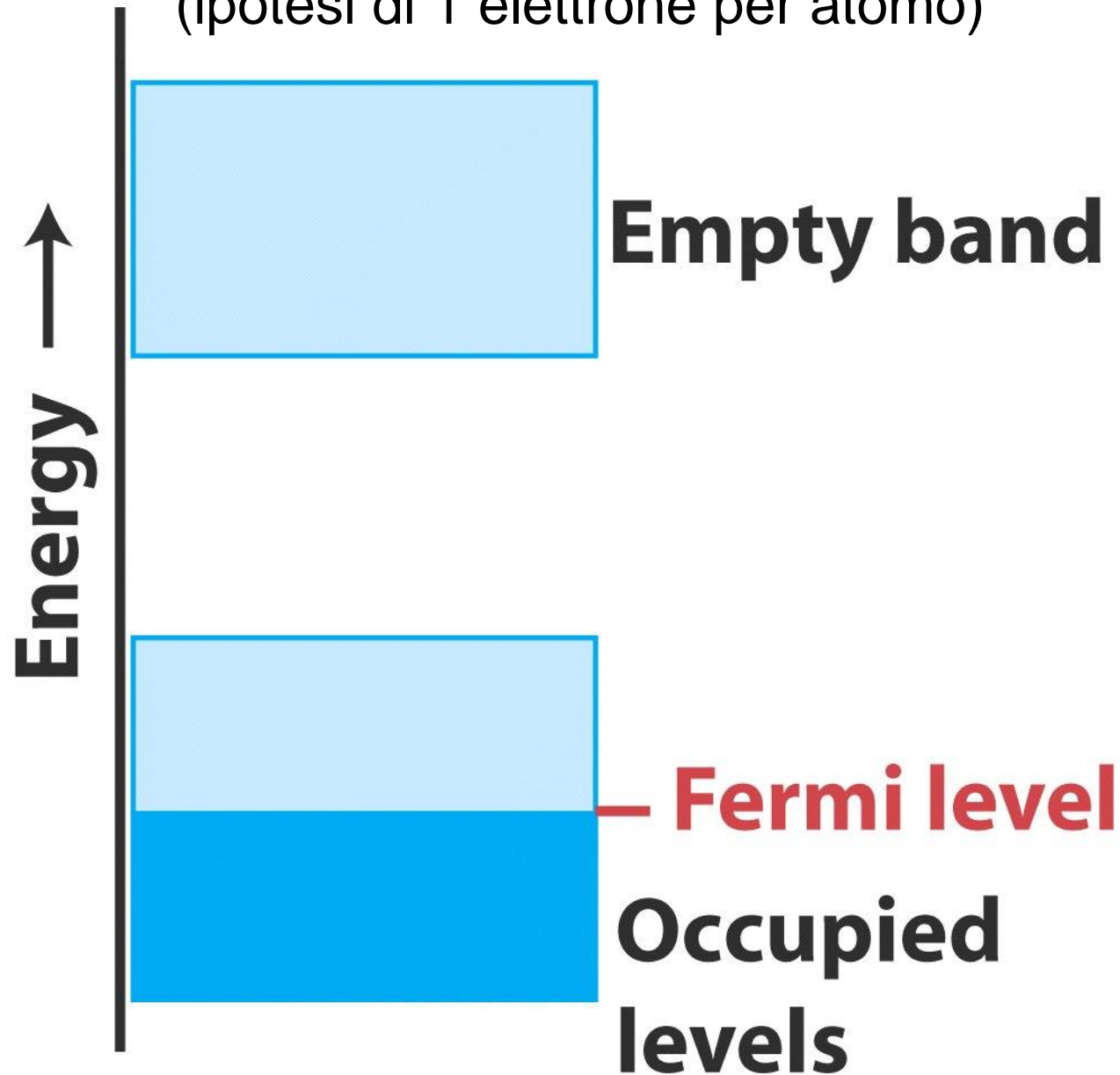


**Most bonding**

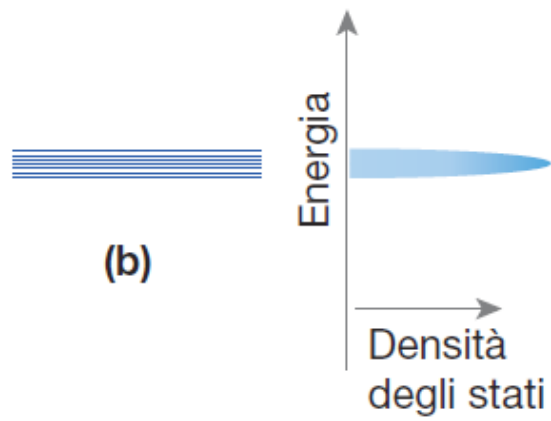
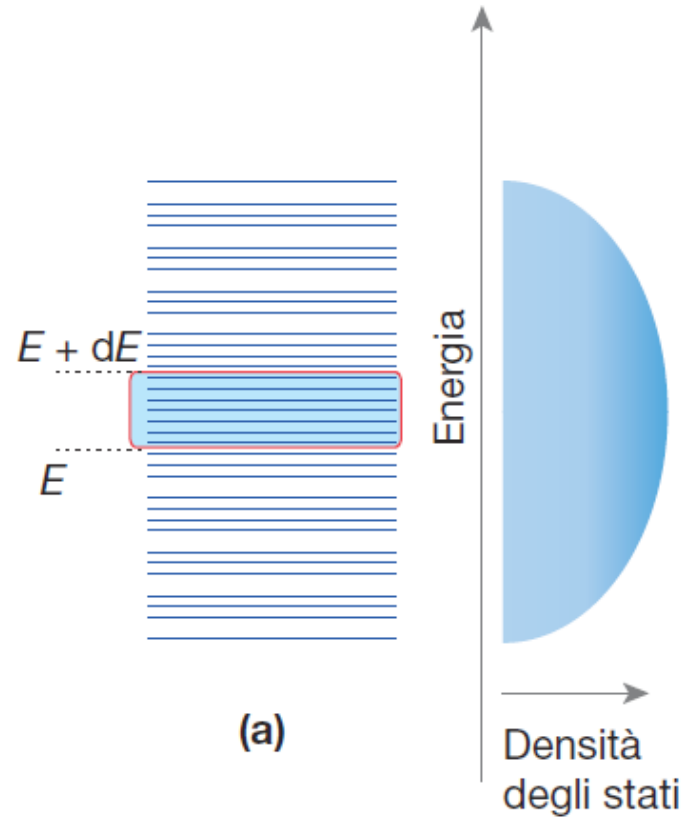


# Solido conduttore metallico

(ipotesi di 1 elettrone per atomo)

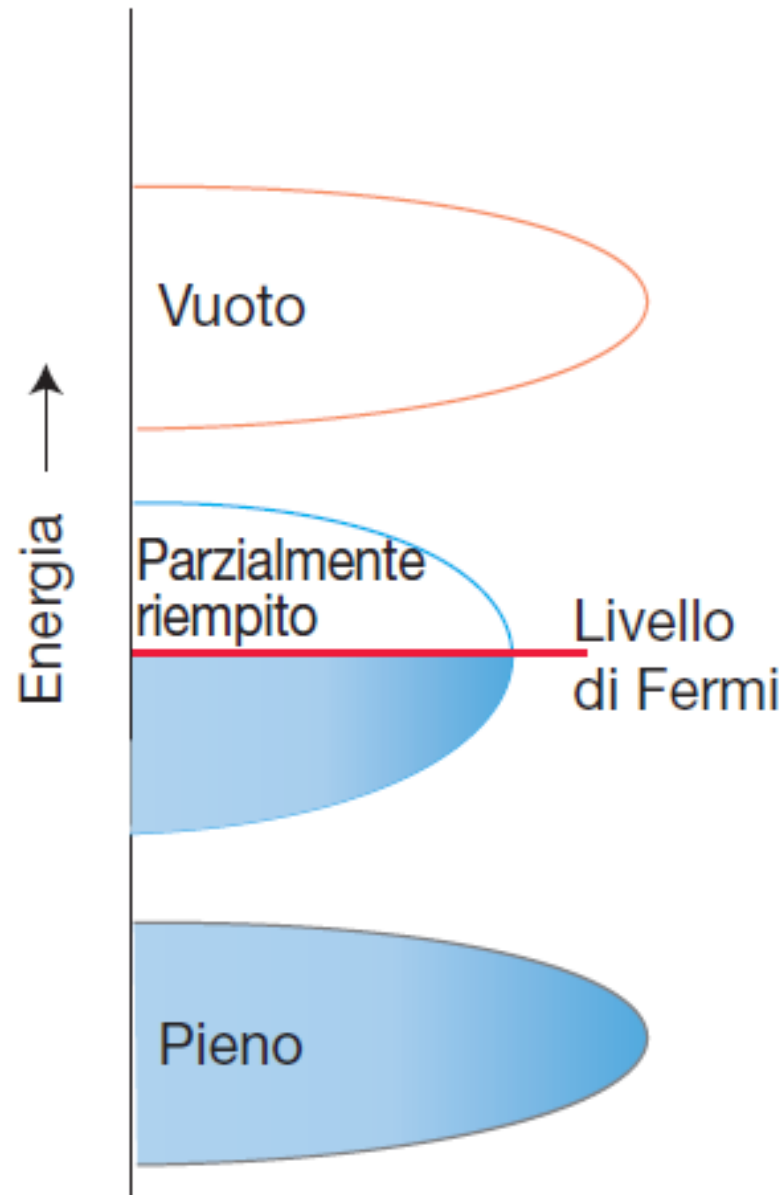


# Densità degli stati elettronici

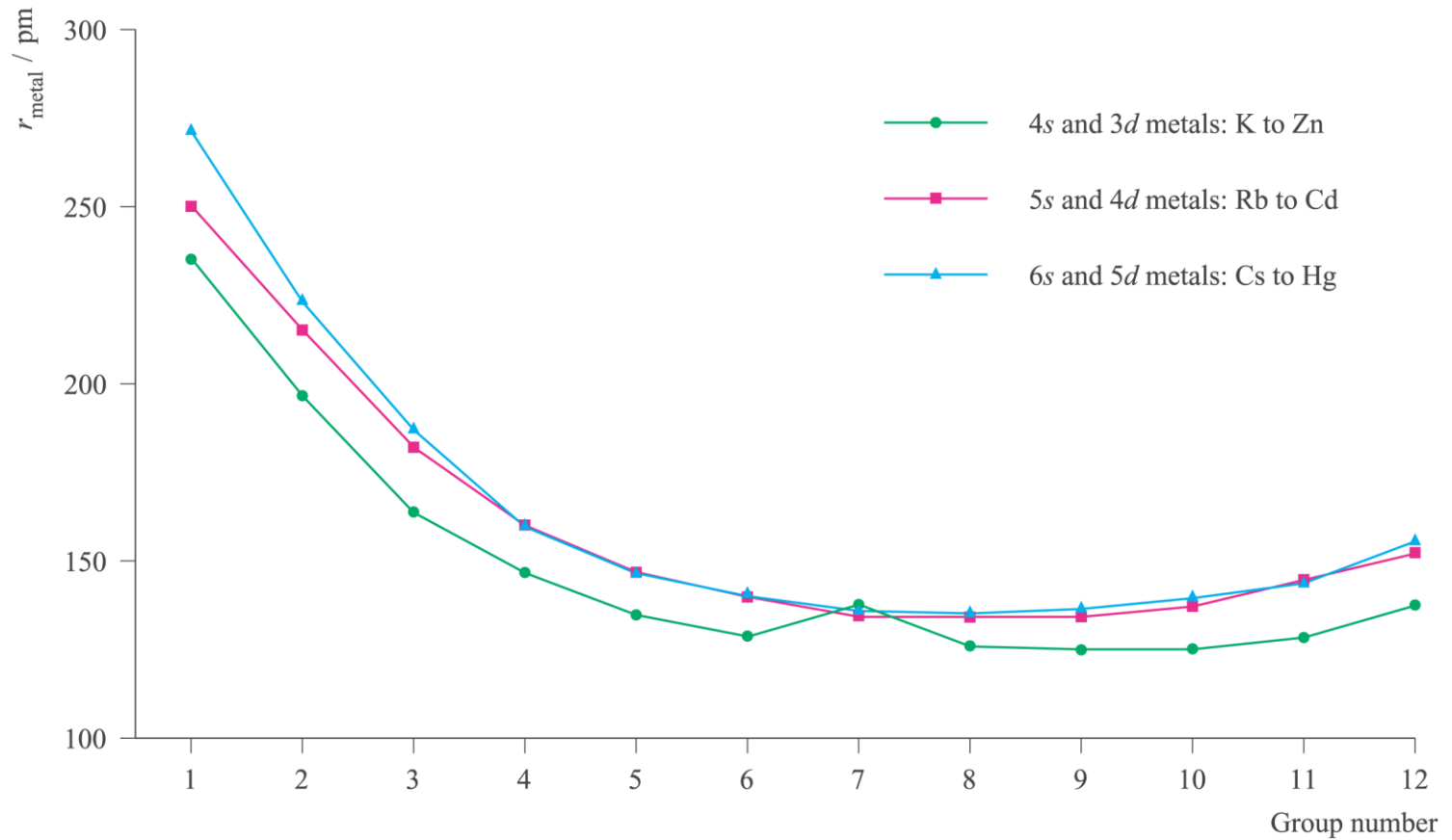




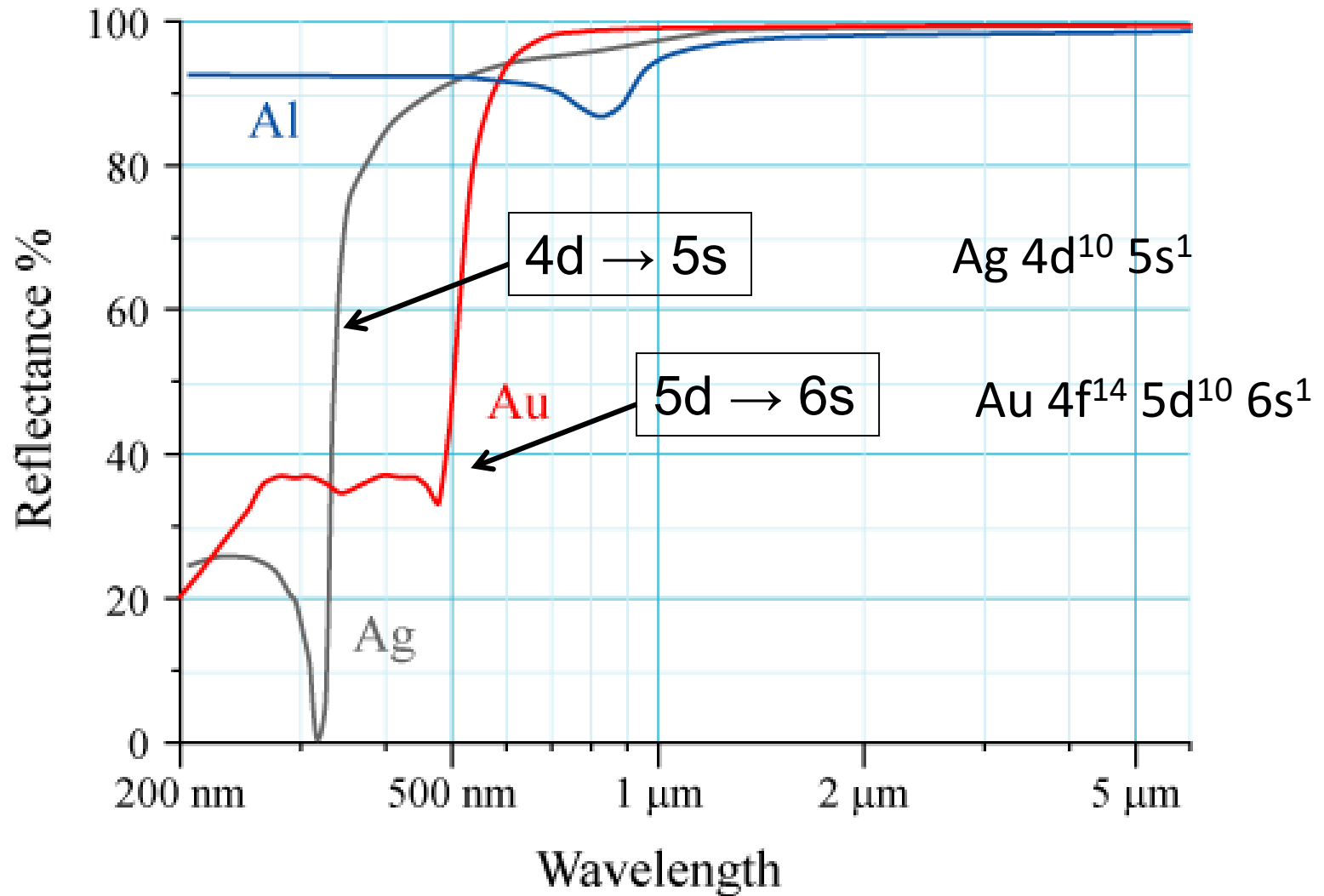
# Tipiche densità di stati in un metallo



# Raggio metallico



# Effetti relativistici e colore dell'oro

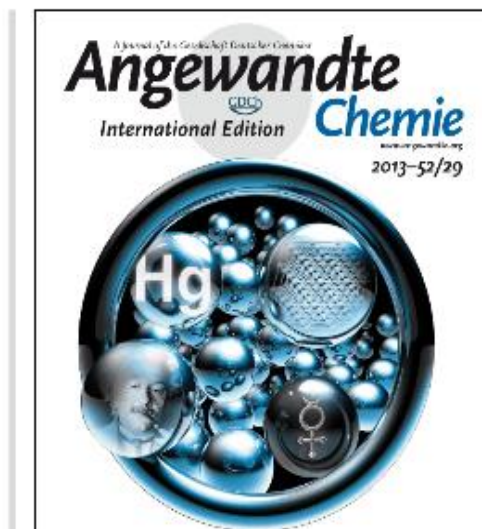
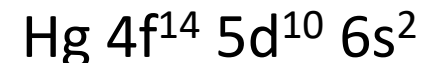


# Perché il mercurio è liquido

Cover Picture: Evidence for Low-Temperature Melting of Mercury owing to Relativity (Angew. Chem. Int. Ed. 29/2013)

Dr. Florent Calvo, Dr. Elke Pahl, Dr. Michael Wormit, Prof. Dr. Peter Schwerdtfeger

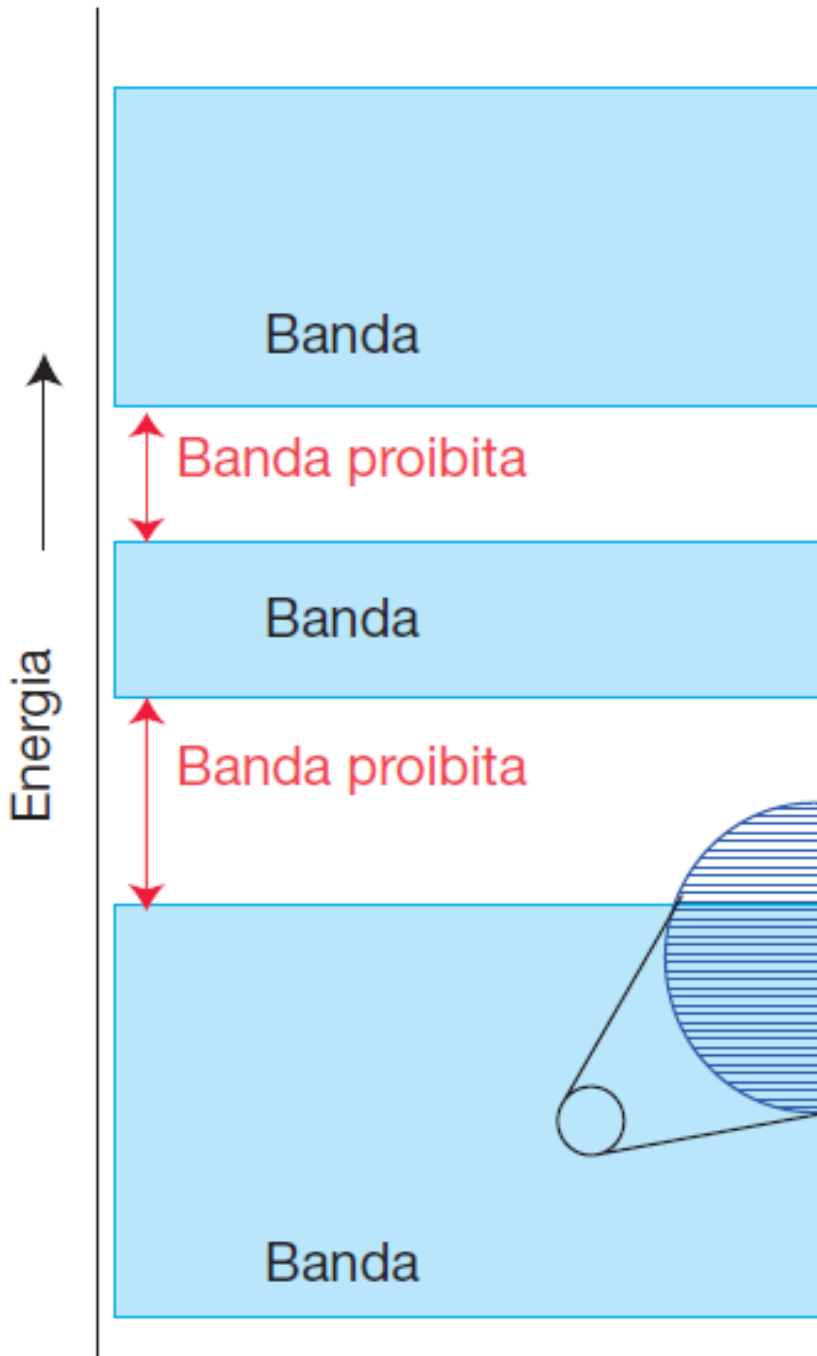
Pages: 7323 | First Published: 21 June 2013



*The generalized theory of relativity* gives a correct explanation of the residual motion of the perihelion of planet mercury. As F. Calvo, P. Schwerdtfeger, et al. show in their Communication on page 7583 ff., the special theory of relativity has furnished an even more remarkable result. It gives the correct explanation as to why mercury is the only liquid metal at room temperature, as demonstrated by parallel-tempering Monte Carlo simulations (Picture: Cameron Smorenburg).

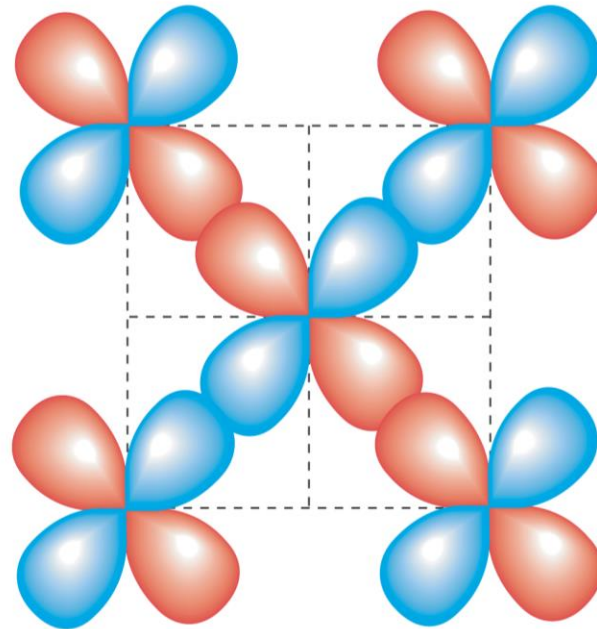
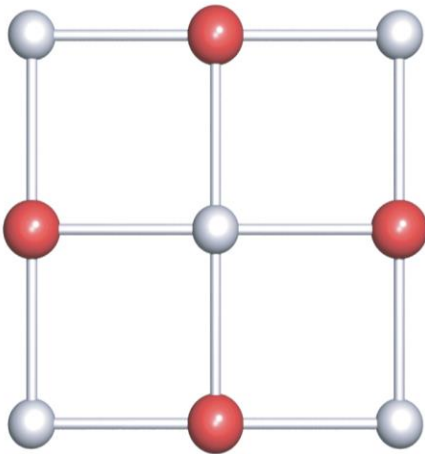
<https://www.youtube.com/watch?v=NtnsHtYYKf0>

L. J. Norrby Why is mercury liquid *J. Chem. Ed.* **1991**, *68*, 110.

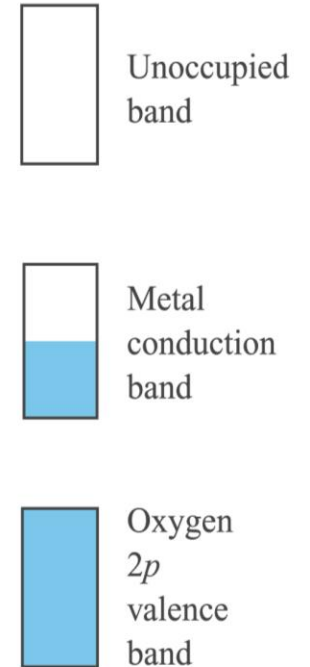


per qualsiasi solido si può generare un diagramma a bande, che viene costruito usando gli **orbitali di frontiera** di tutti gli atomi presenti.

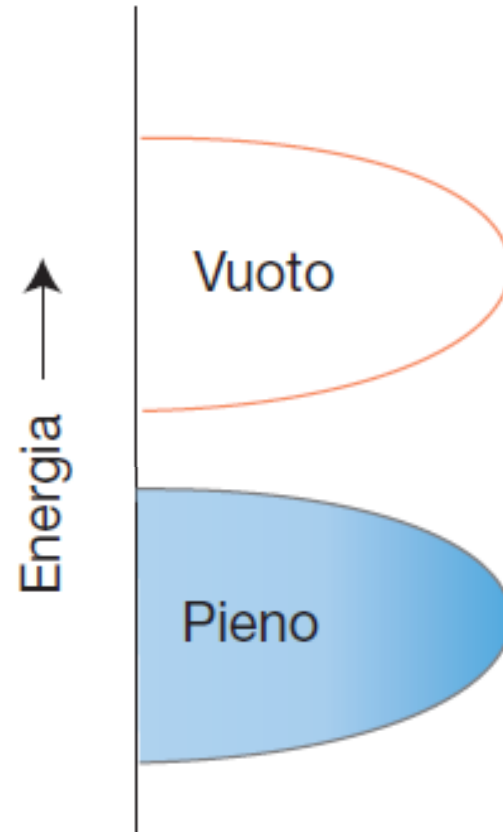
# TiO, un ossido metallico conduttore



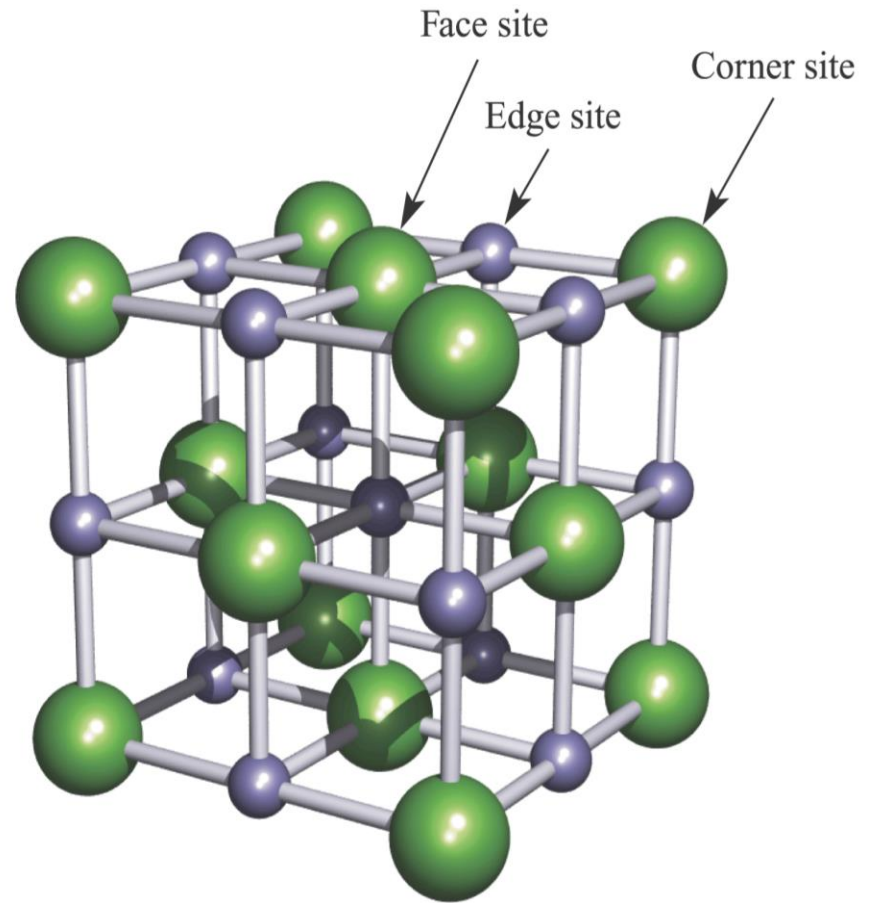
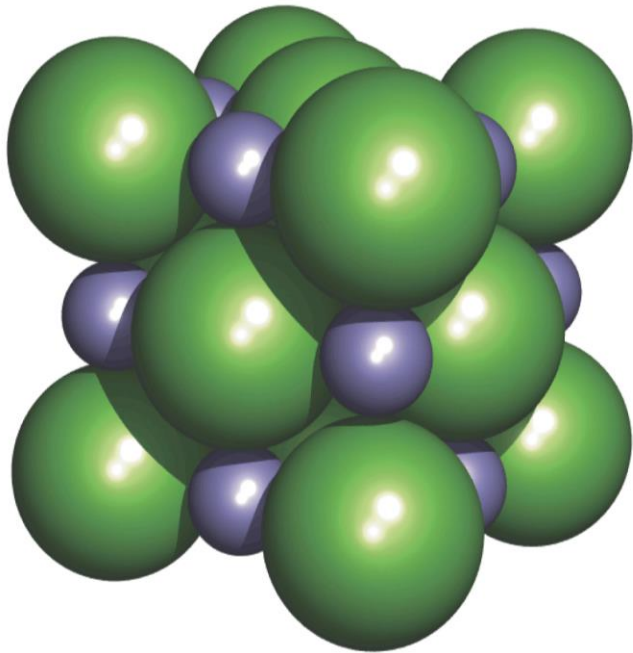
Energy ↑



# Tipiche densità di stati in un semiconduttore/isolante

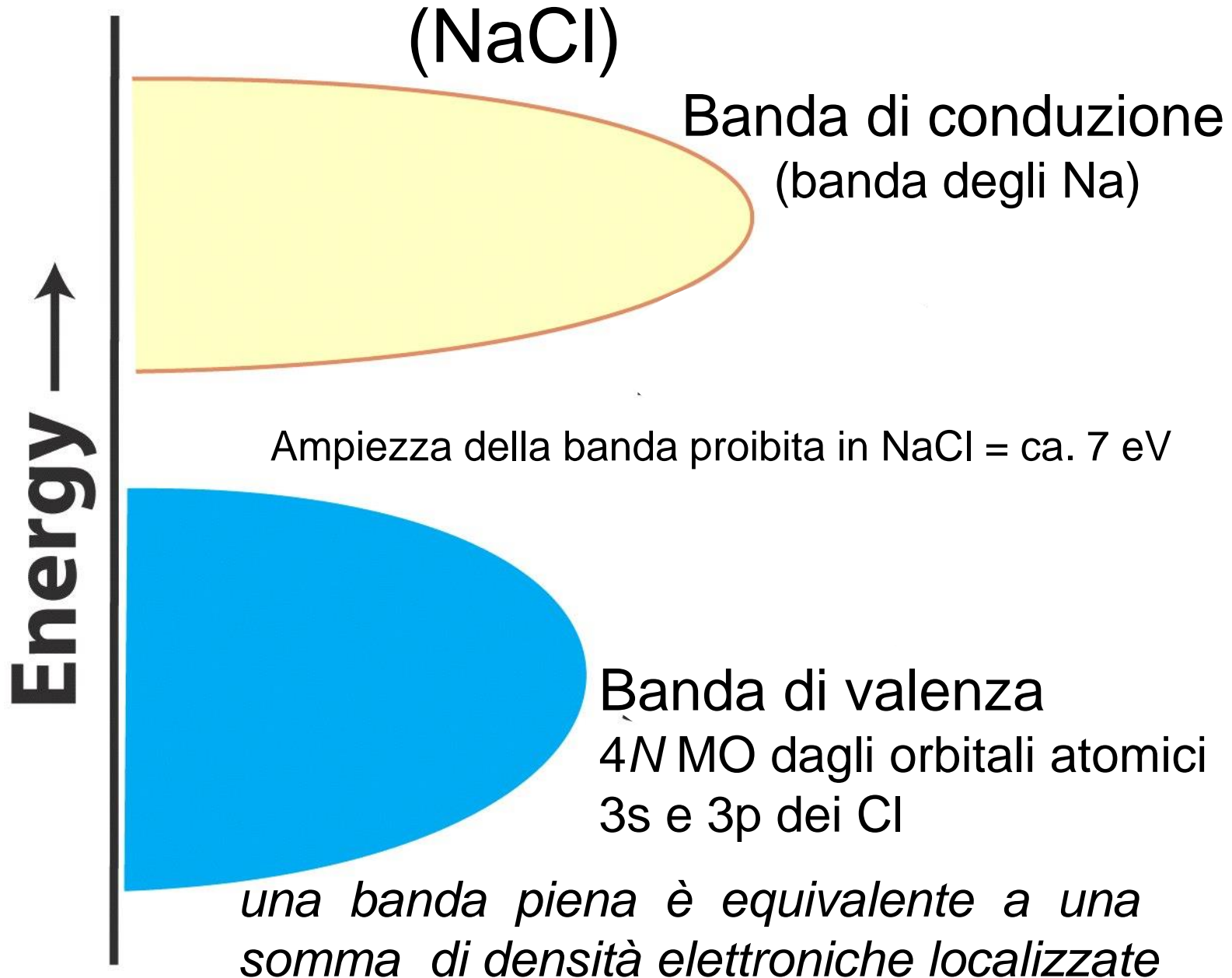


# NaCl





# Tipiche densità di stati in un isolante



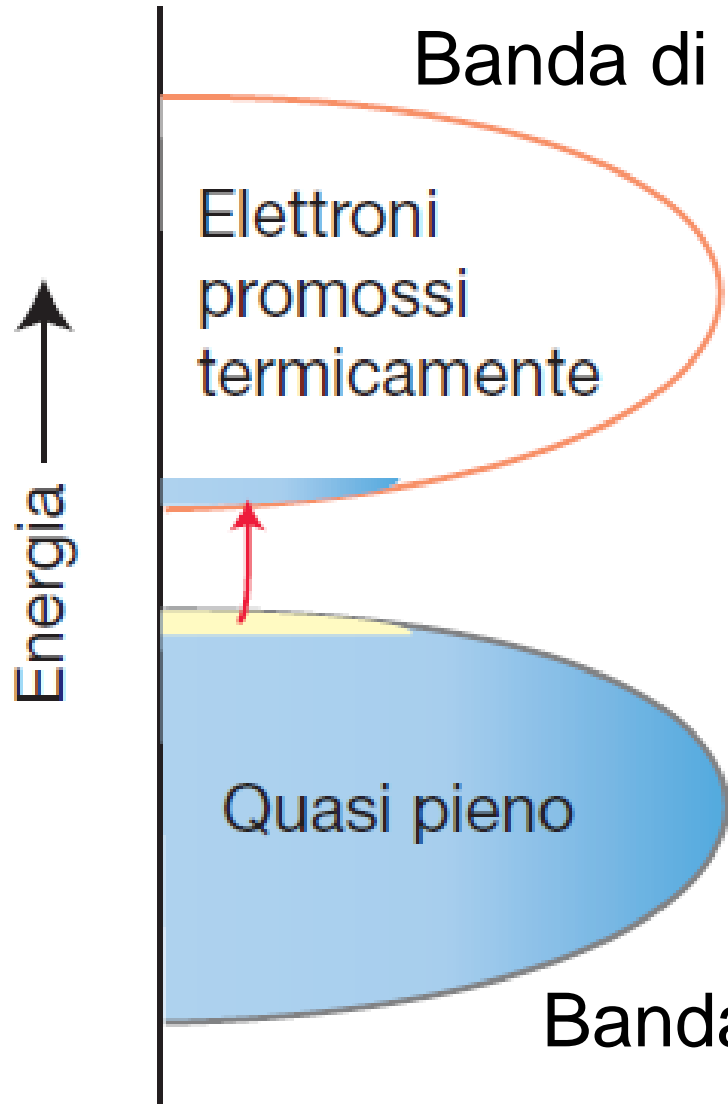
# Alcune ampiezze di bande proibite

<b>Materiale</b>	<b><math>E_g</math>/eV</b>
Carbone (diamante)	5,47
Carburo di silicio	3,00
Silicio	1,11
Germanio	0,66
Arseniuro di gallio	1,35
Arseniuro di indio	0,36

*La linea di divisione tra isolanti e semiconduttori dipende dalle dimensioni della banda proibita e dalla temperatura*

# Semiconduttore intrinseco

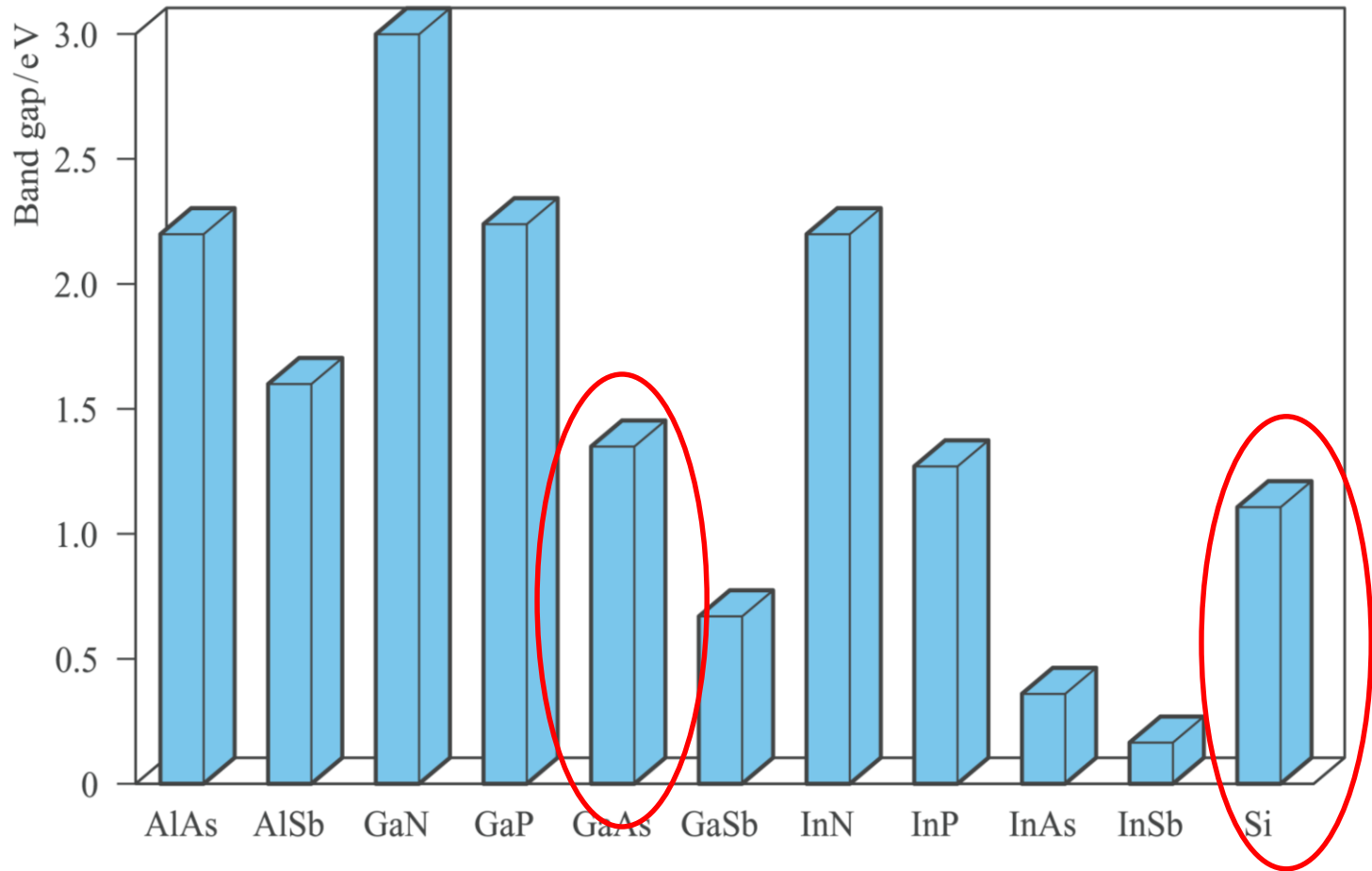
*andamento di tipo Arrhenius della conducibilità con la temperatura*



$$\sigma = \sigma_0 e^{-E_g/2kT}$$

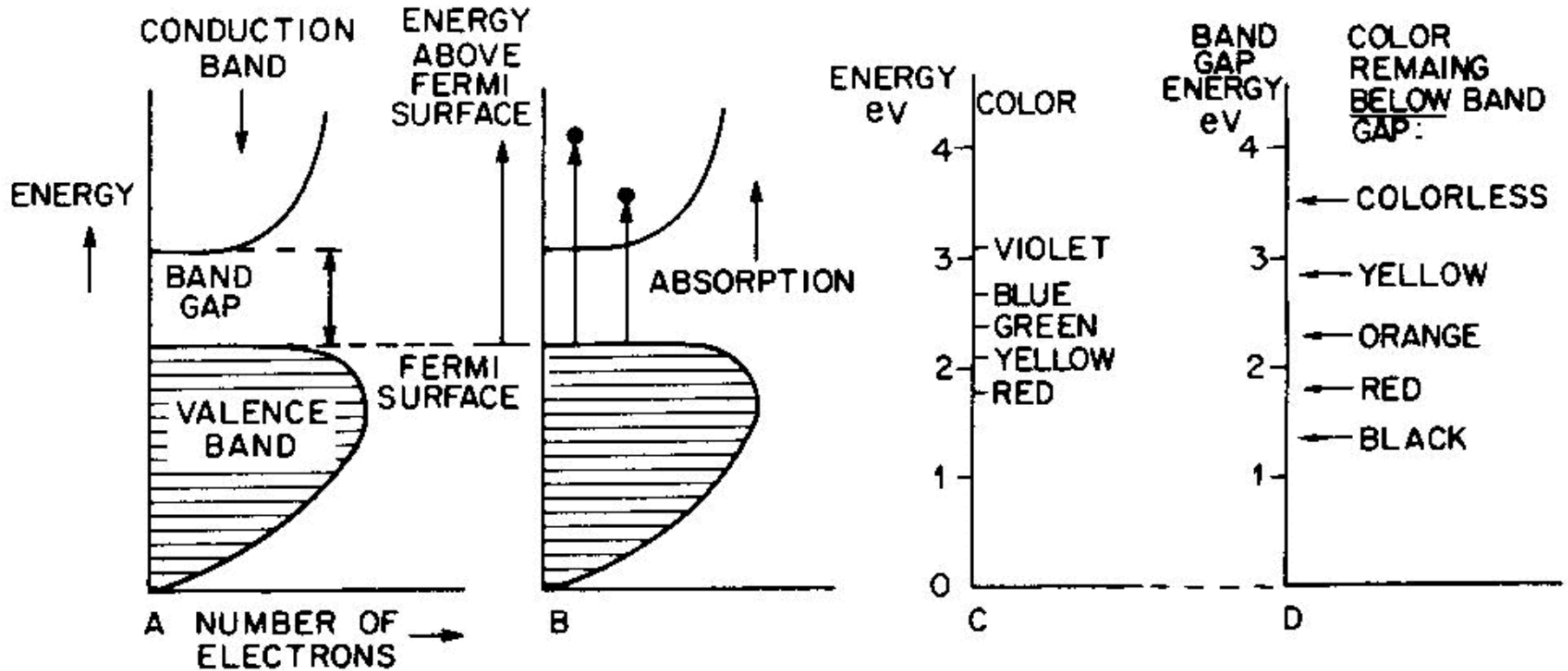
sia le lacune che gli elettroni promossi sono liberi di muoversi e conducono la corrente elettrica

# Bande proibite in **semiconduttori III – V** (o 13 – 15) vs silicio

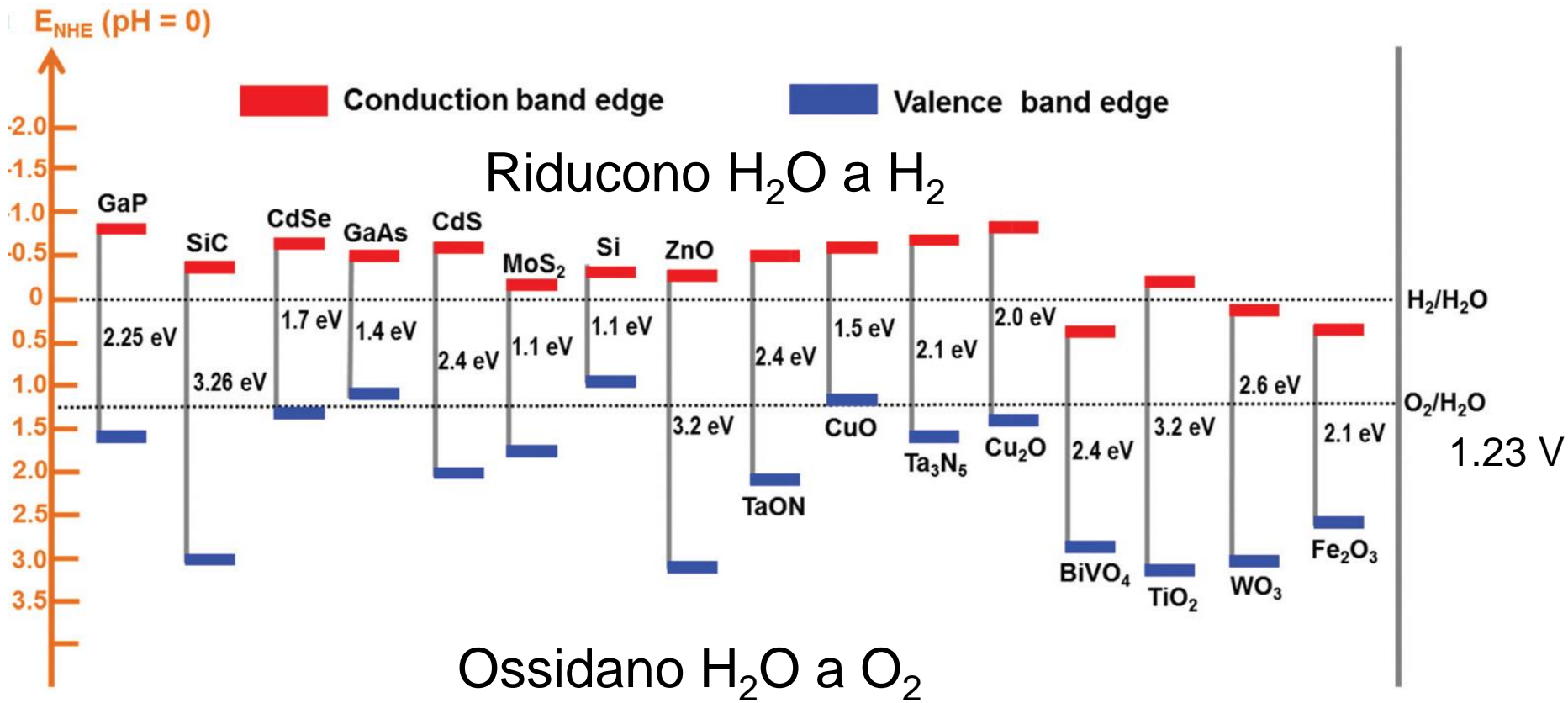


L'arseniuro di gallio ha una maggiore mobilità elettronica rispetto al silicio

La promozione di elettroni dalla banda proibita a quella di valenza può essere indotta dalla luce



*e.g. la galena,  $PbS$ , è grigio-nera poiché il band gap è solo 0.4 eV, cioè assorbe tutto l'intervallo della luce visibile.*



# Luce emessa dai LED (*light emitting diodes*) in funzione della composizione

$x$ in $\text{GaAs}_{1-x}\text{P}_x$	Substrate	$\lambda$ / nm	Observed colour or region of spectrum
0.10	GaAs	780	Infrared
0.39	GaAs	660	Red
0.55	GaP	650	Red
0.65	GaP	630	Orange
0.75	GaP	610	Orange
0.85	GaP	590	Yellow

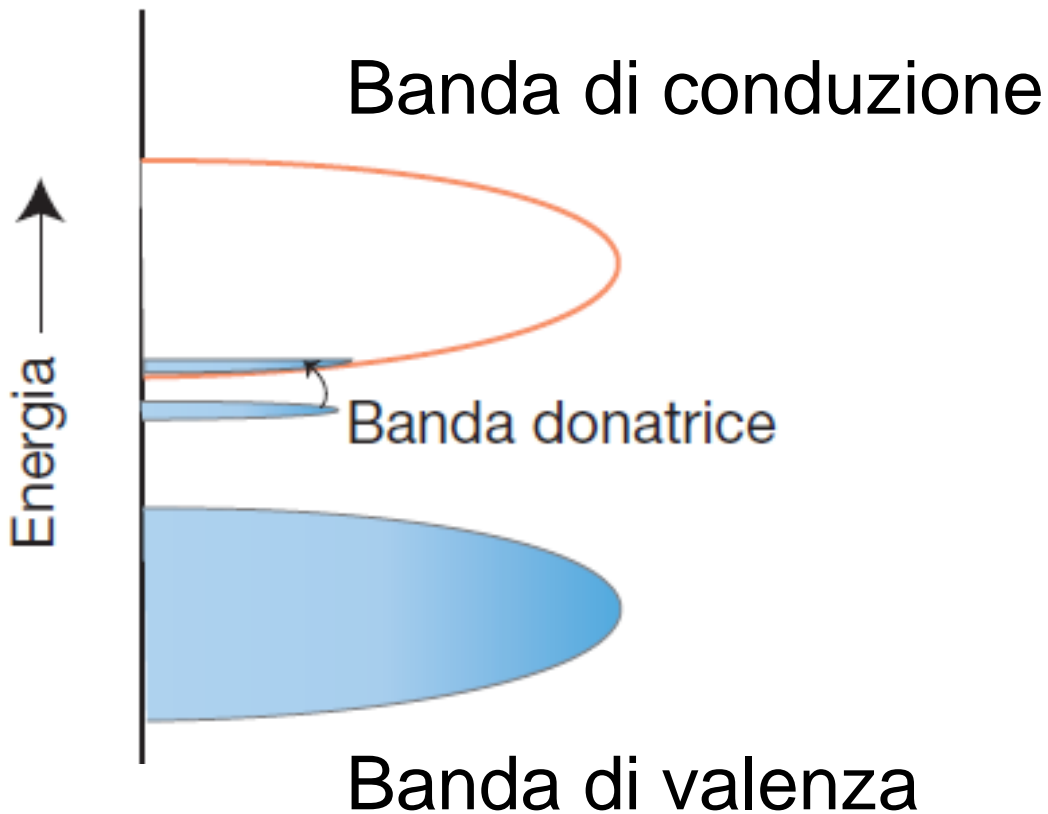
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# Semiconduttori estrinseci

(drogaggio sostitutivo)

## Tipo n

e.g. Si drogato con As



## Tipo p

e.g. Si drogato con Ga

