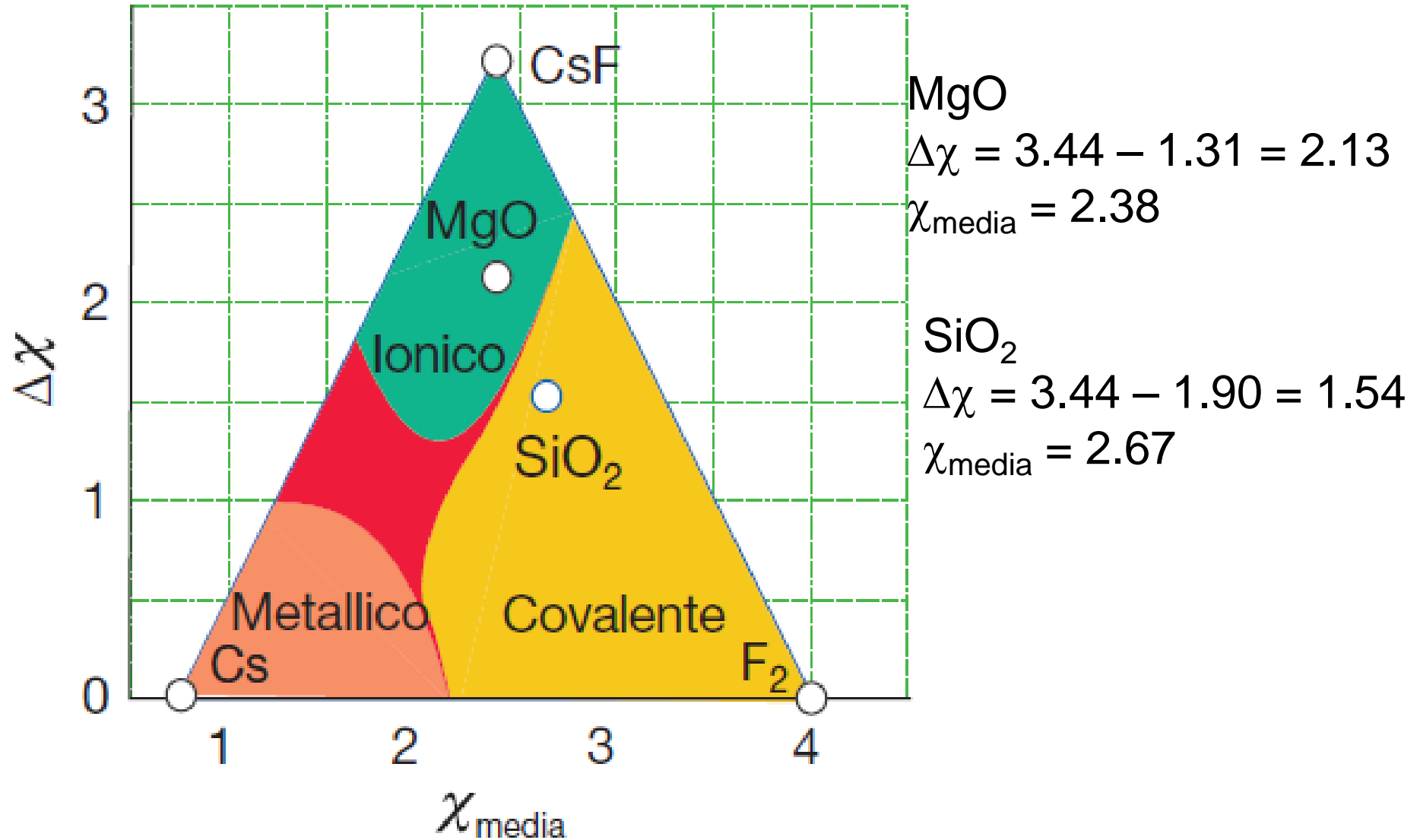
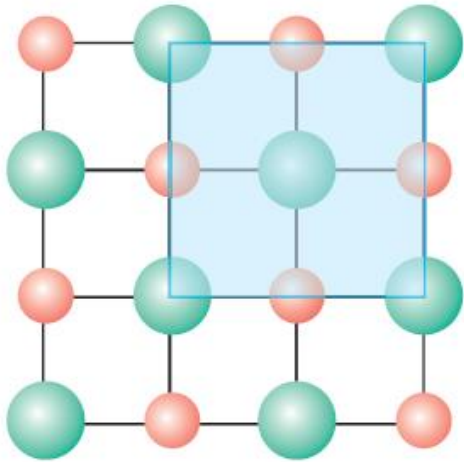


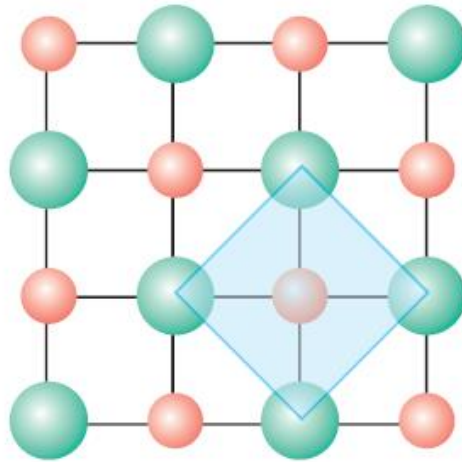
Triangolo di Ketelaar



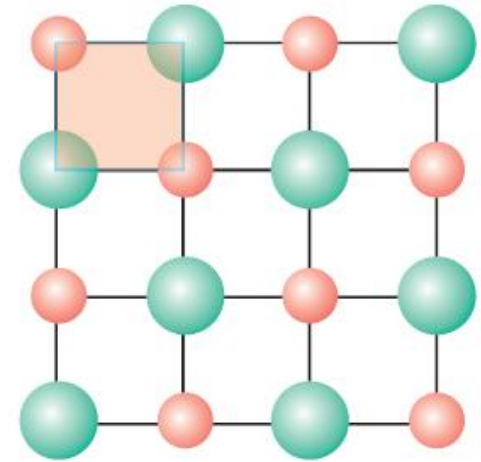
Celle unitarie bidimensionali



(a) Possibile cella unitaria



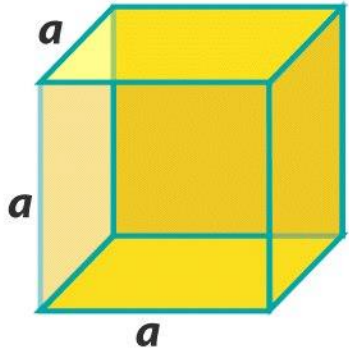
(b) Scelta preferita per la cella unitaria



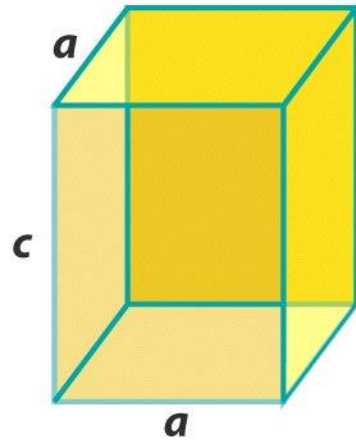
(c) Non è una cella unitaria

Preferita

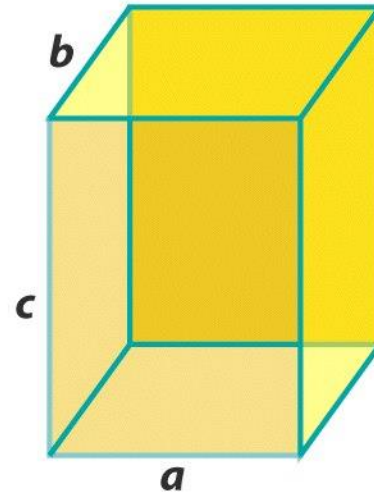
I 7 sistemi cristallini



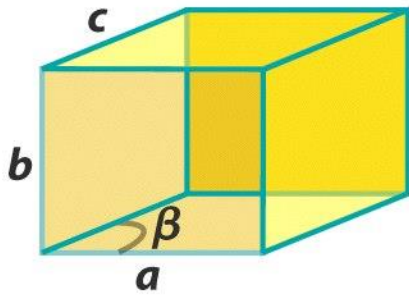
Cubic



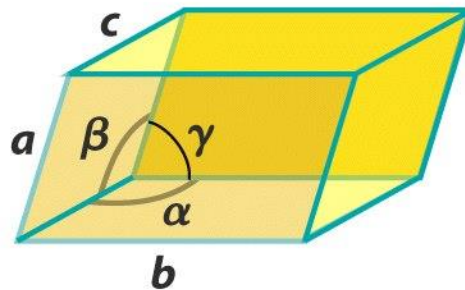
Tetragonal



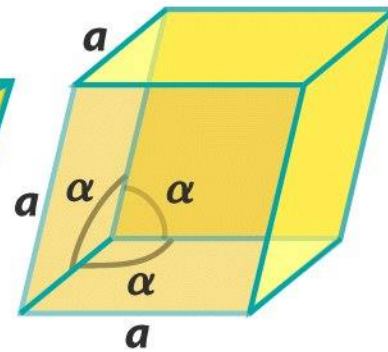
Orthorhombic



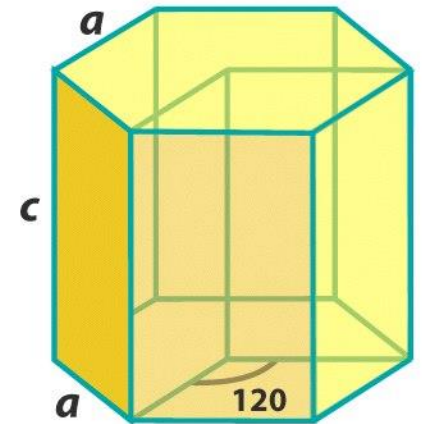
Monoclinic



Triclinic

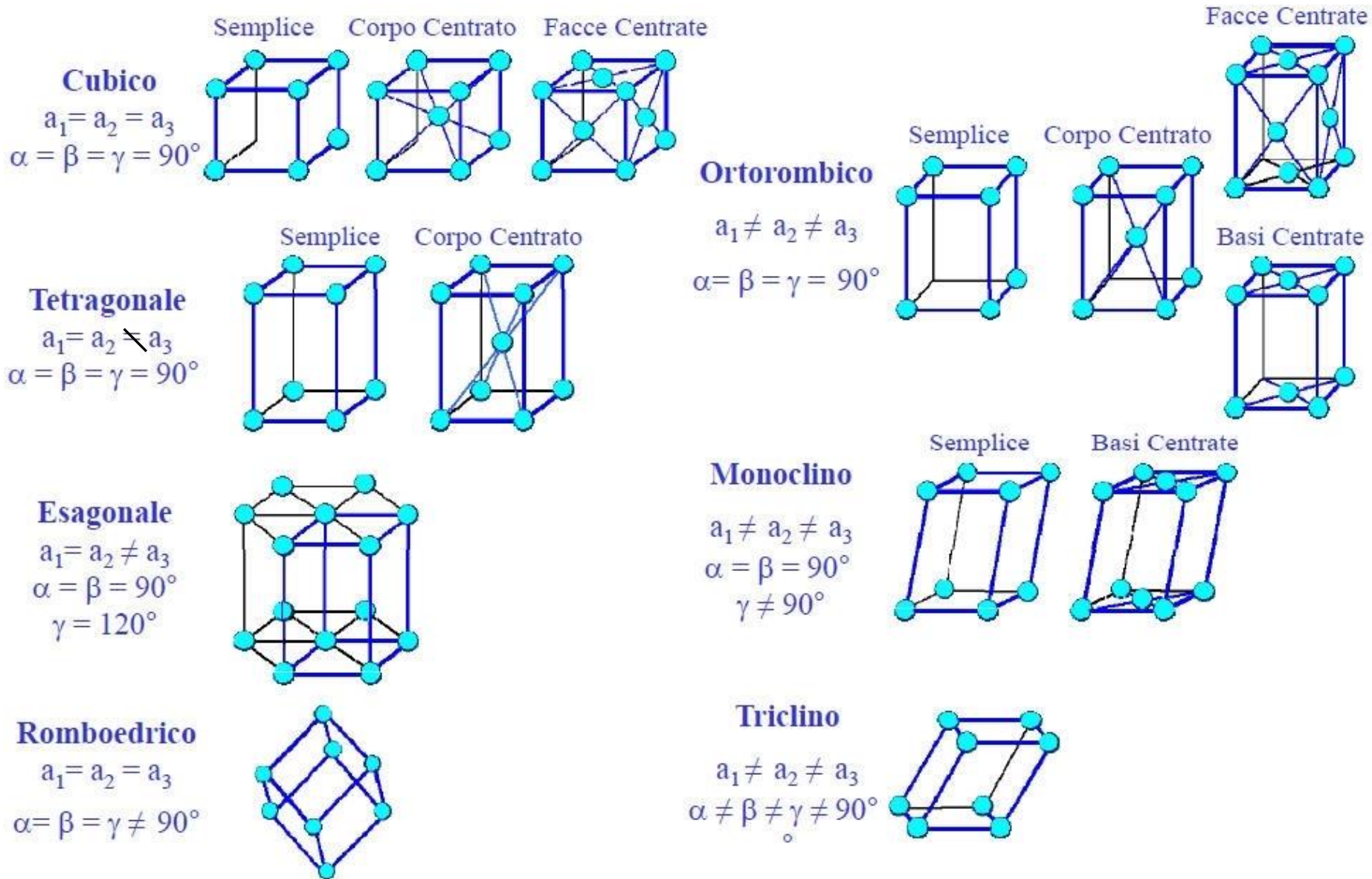


Trigonal

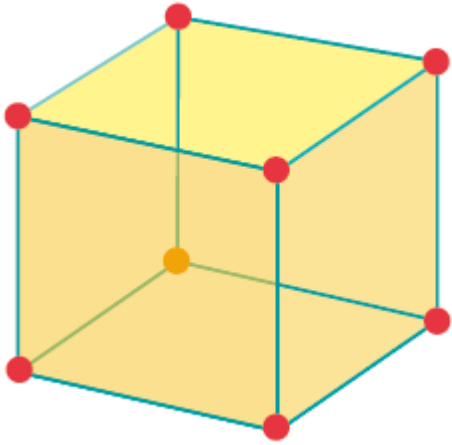


Hexagonal

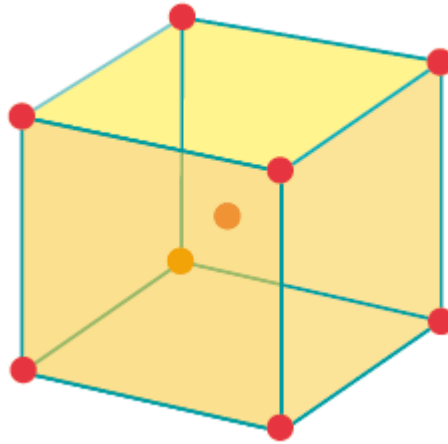
I 14 reticoli di Bravais



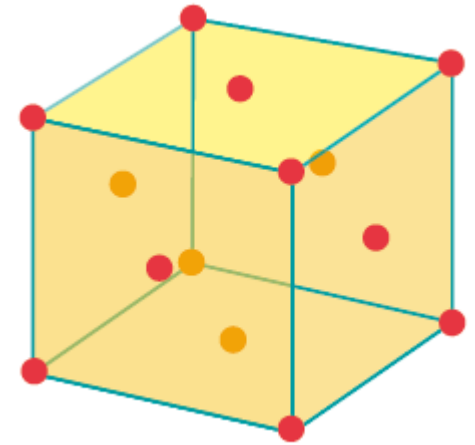
Celle unitarie cubiche



Cubica primitiva, P

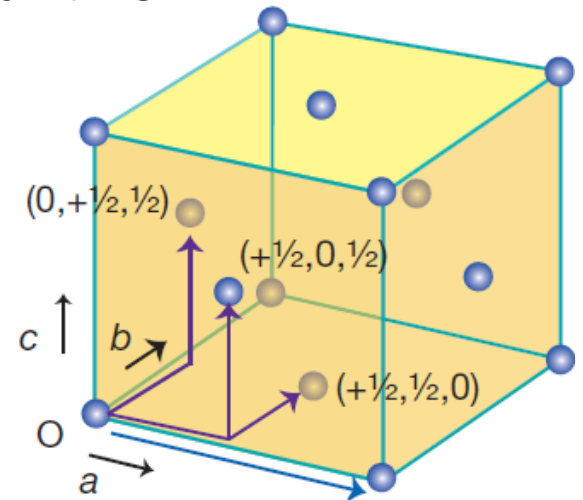
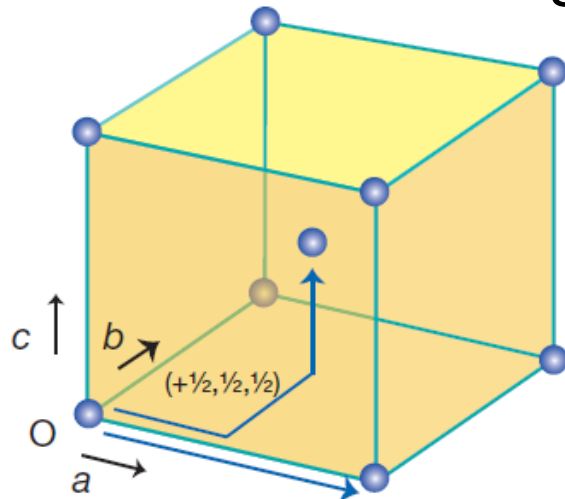
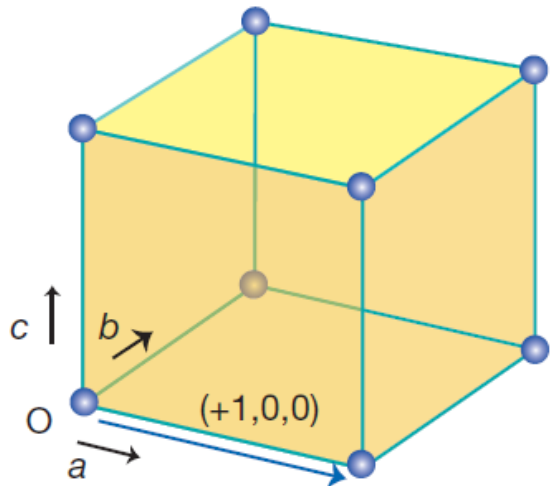


Cubica a corpo
centrato, I

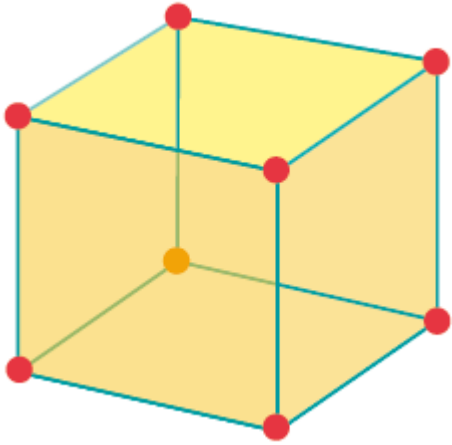


Cubica a facce
centrate, F

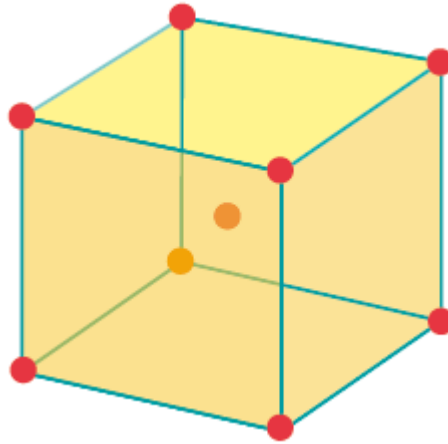
Simmetrie traslazionali aggiuntive



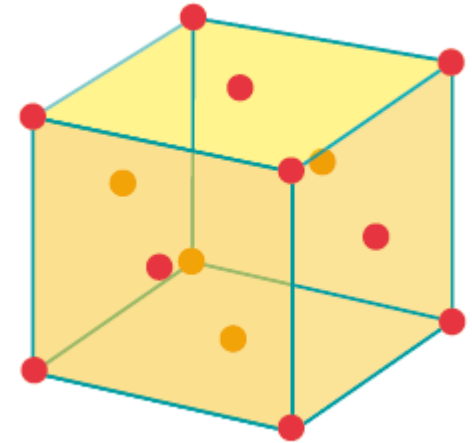
Proiezioni di celle unitarie cubiche



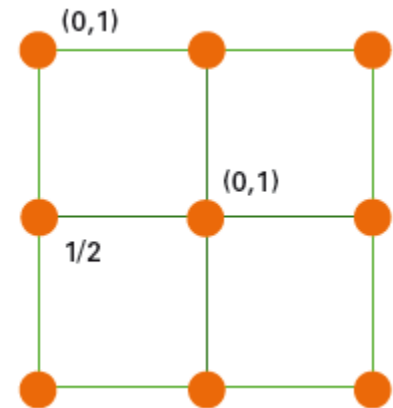
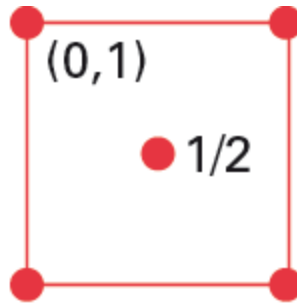
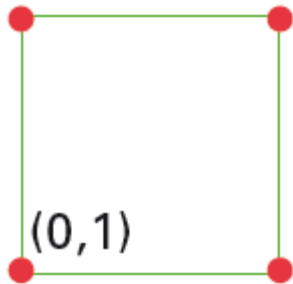
Cubica primitiva, P



Cubica a corpo
centrato, I

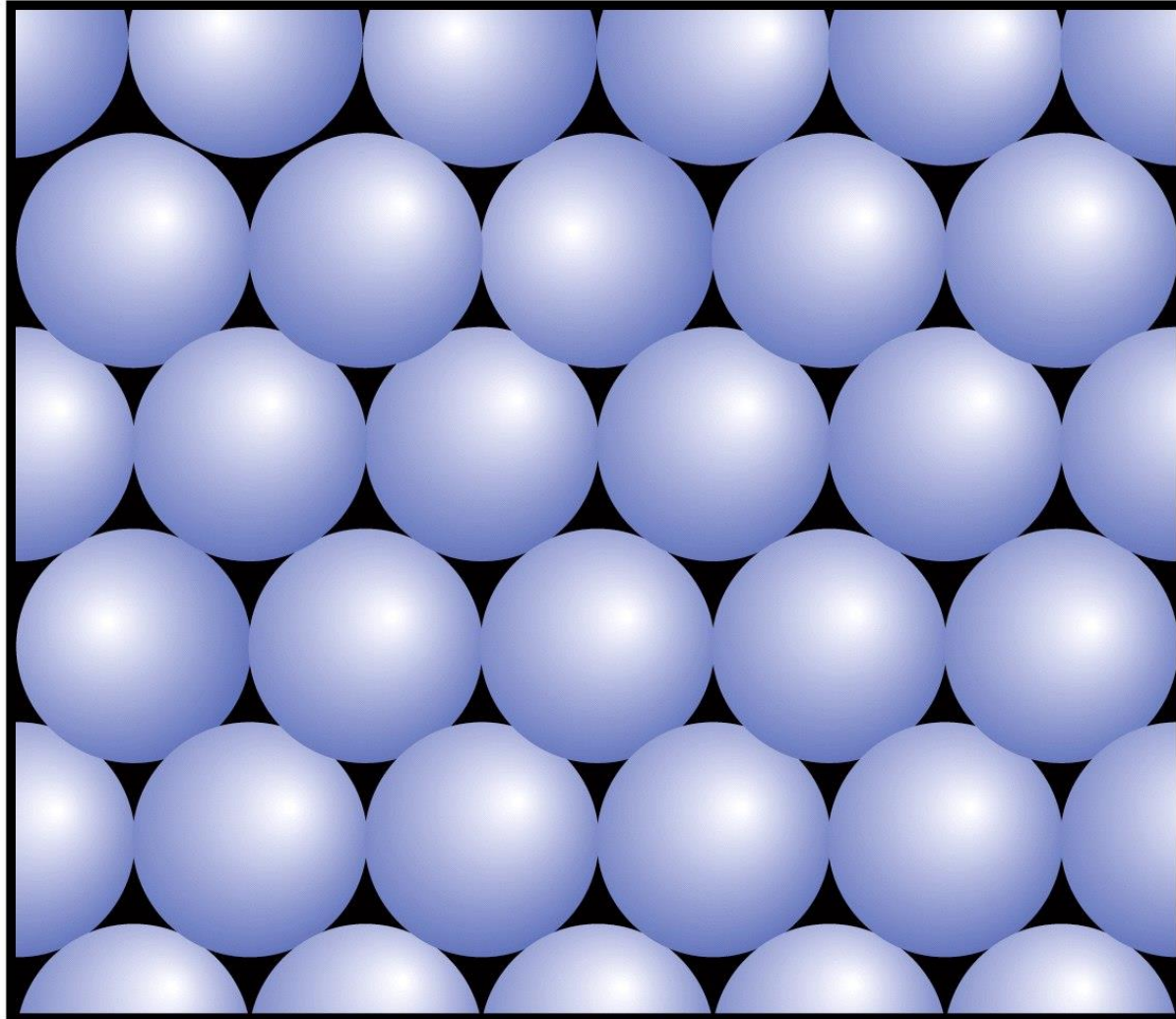


Cubica a facce
centrate, F

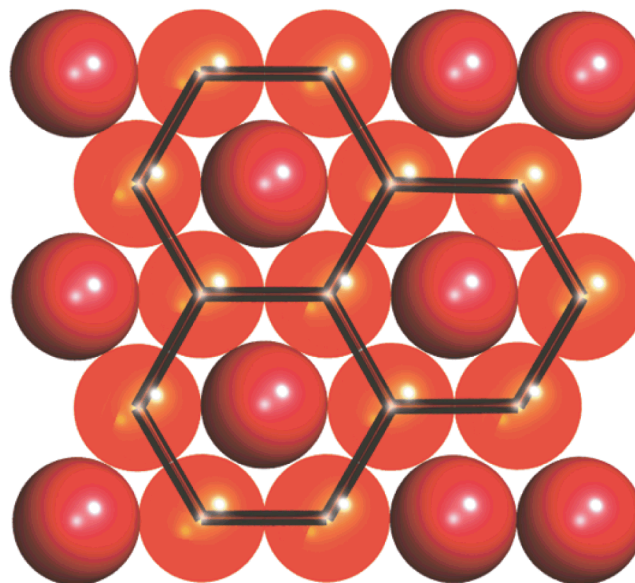


Coordinate frazionarie

Impaccamento compatto di sfere rigide

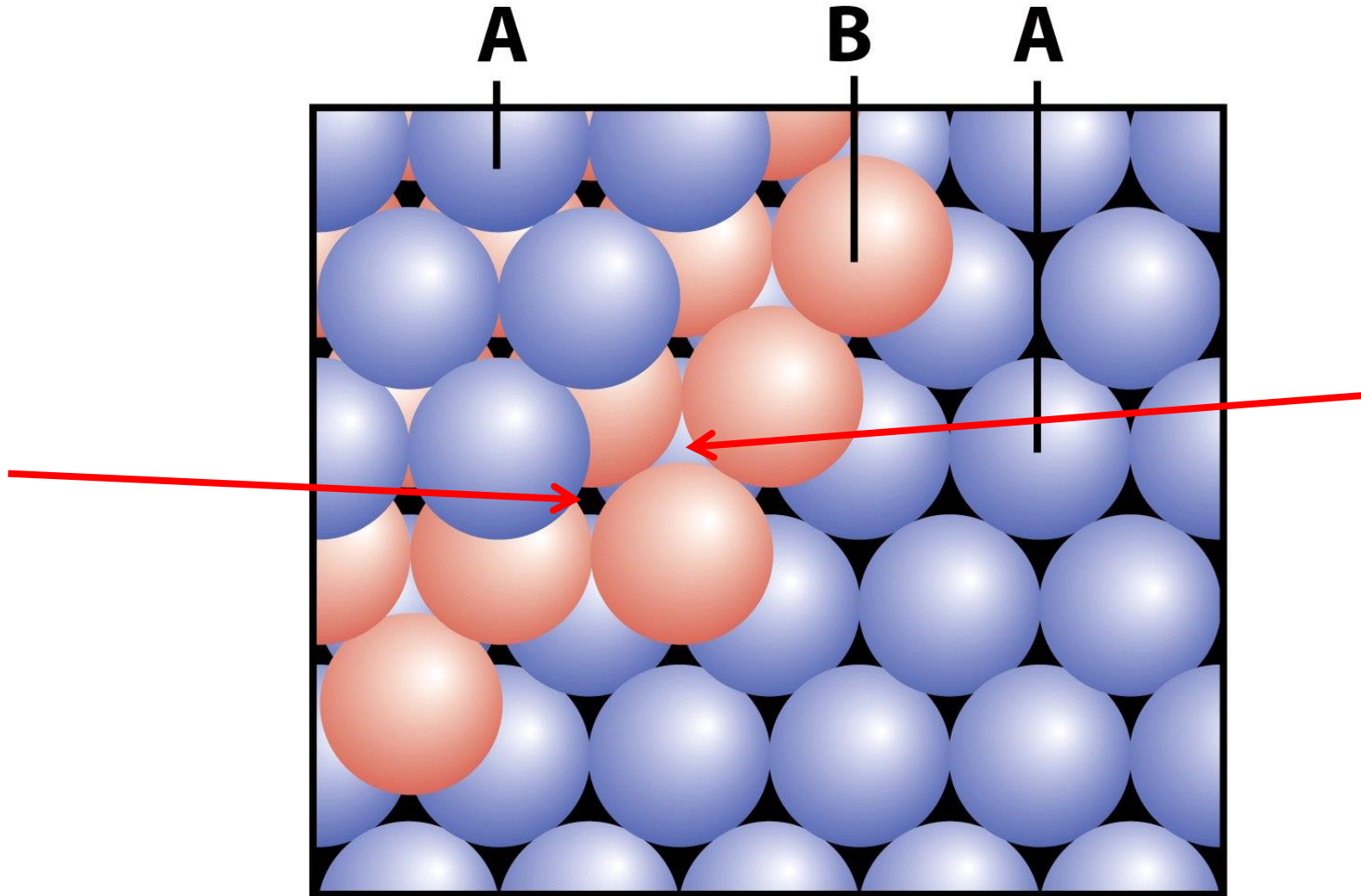


Strato di sfere a impaccamento compatto con evidenza
la coordinazione esagonale



Politipi a impaccamento compatto: ABAB....

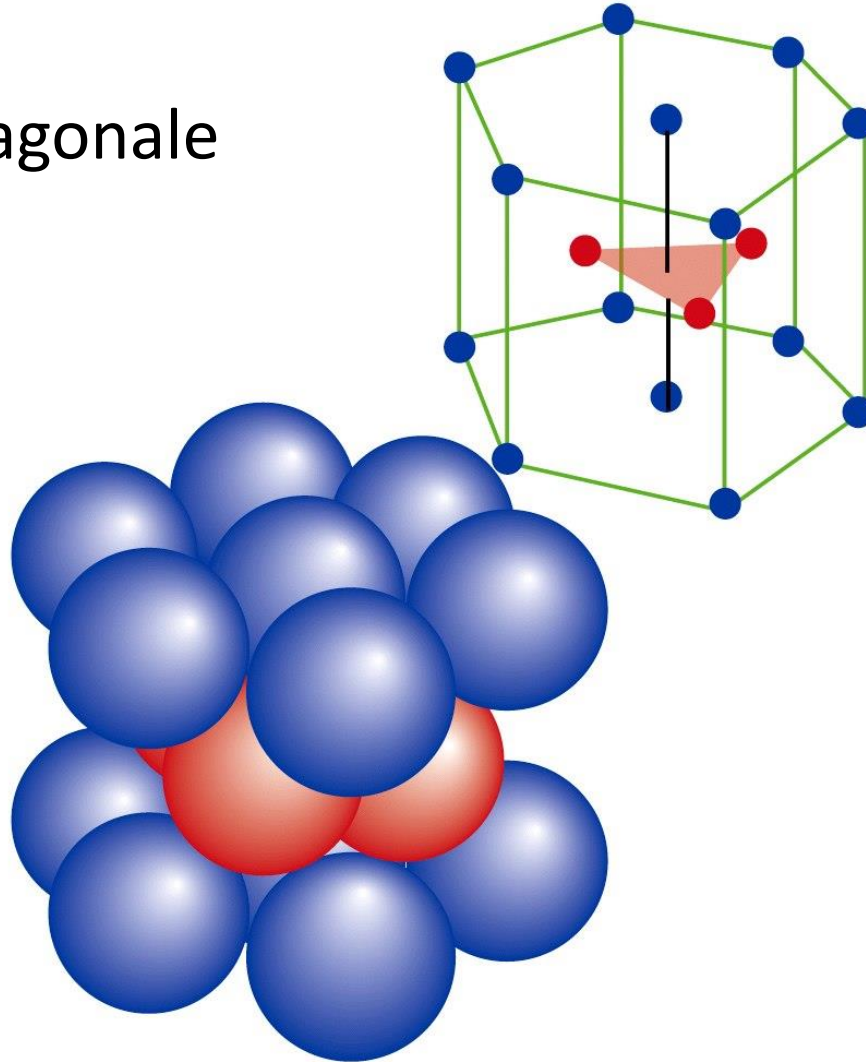
Esagonale compatto (*hcp*)



Impaccamento esagonale compatto (*hcp*)

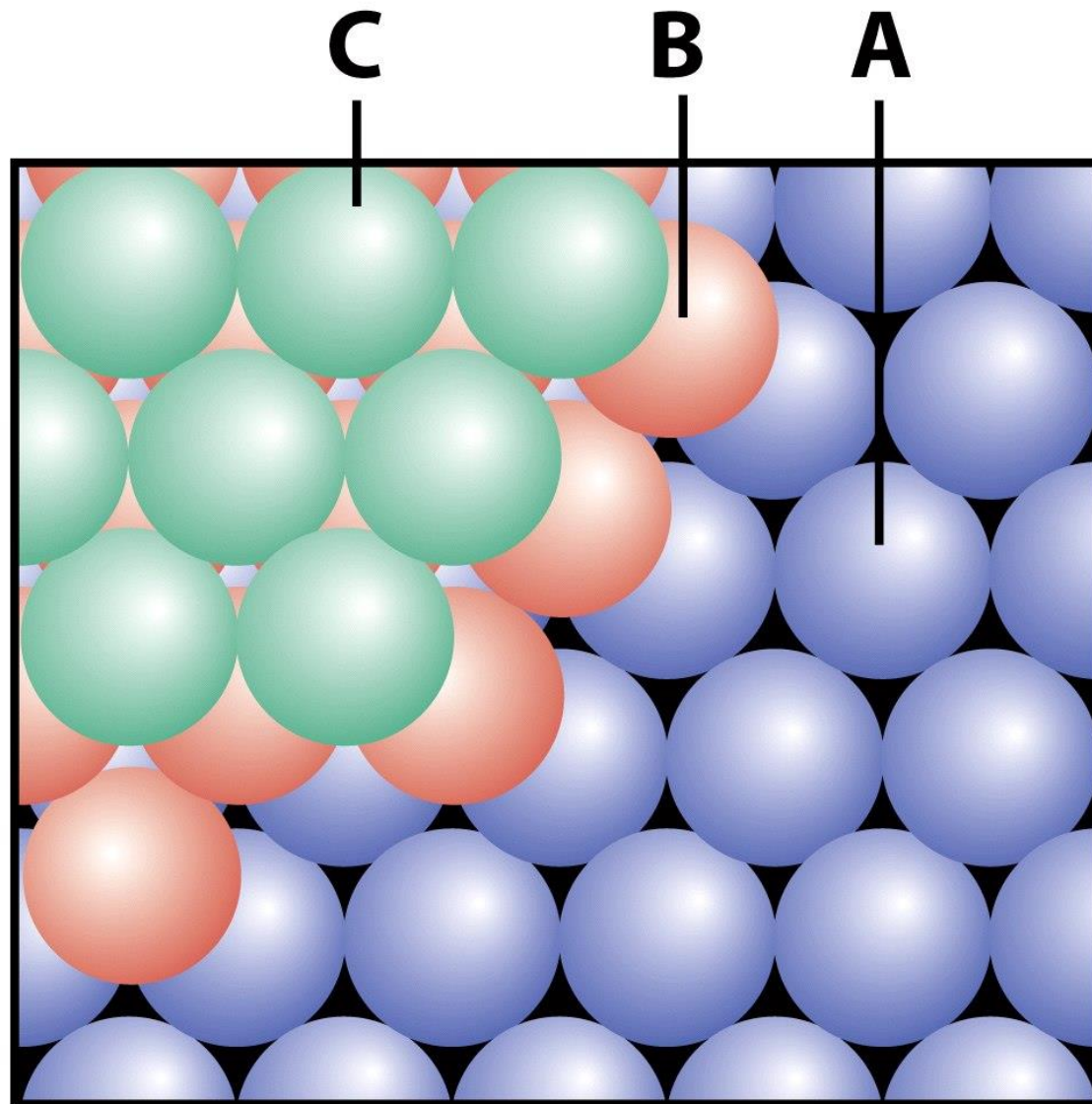
hexagonally close packed

Cella unitaria esagonale



Politipi a impaccamento compatto: ABCABC....

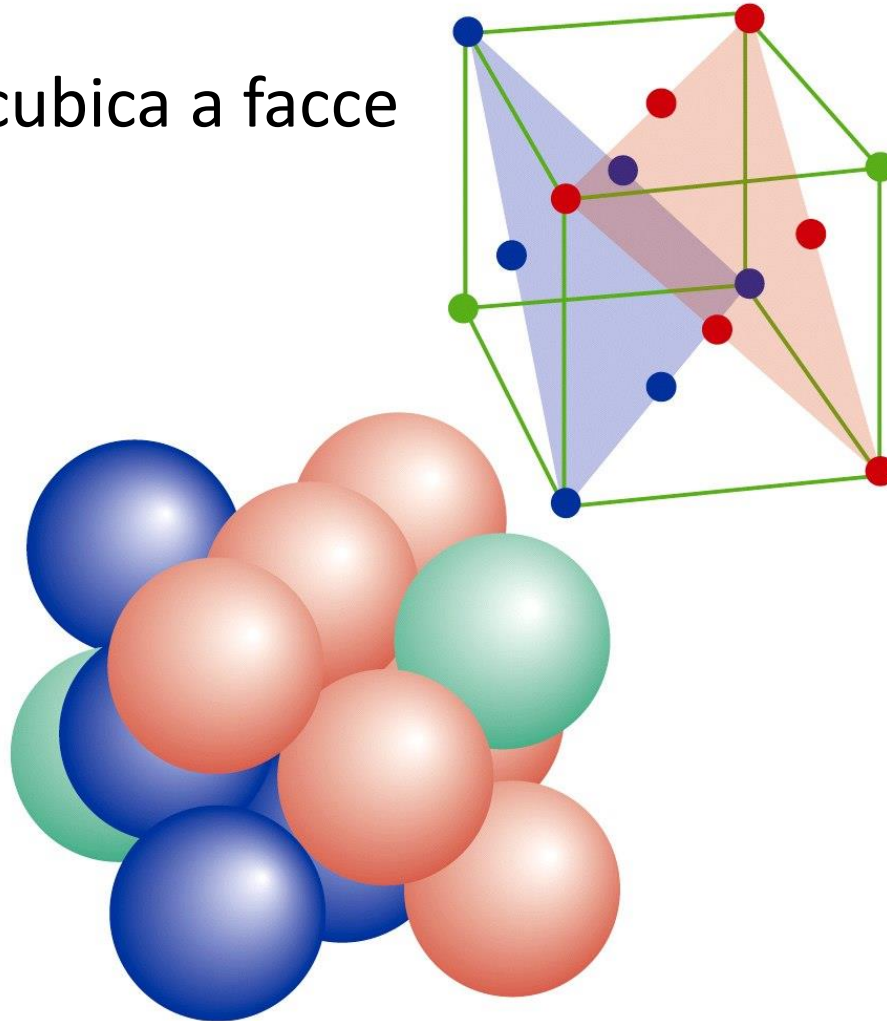
Cubico compatto (*ccp*)



Impaccamento cubico compatto (*ccp*)

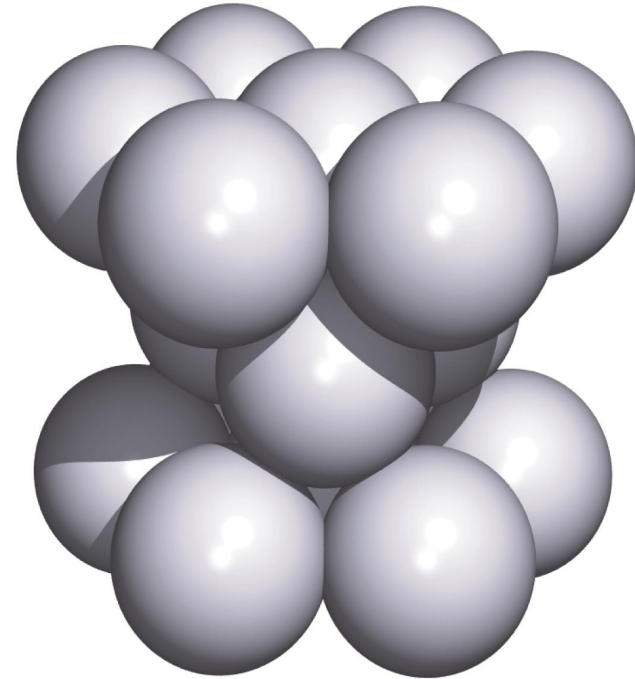
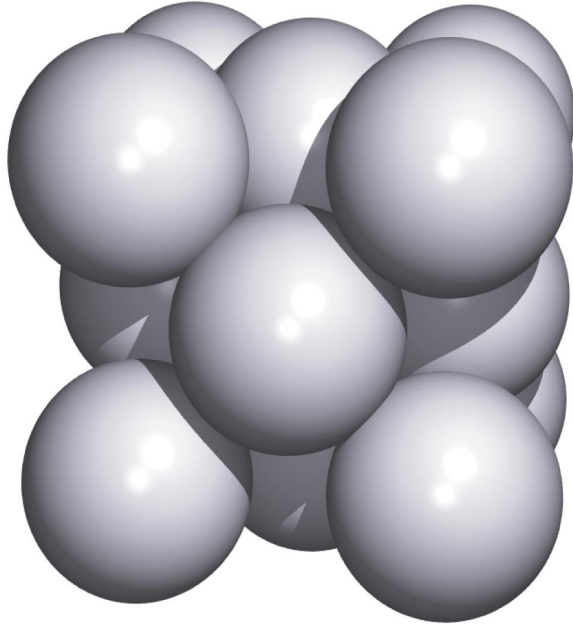
cubic close packed

Cella unitaria cubica a facce centrate (fcc)



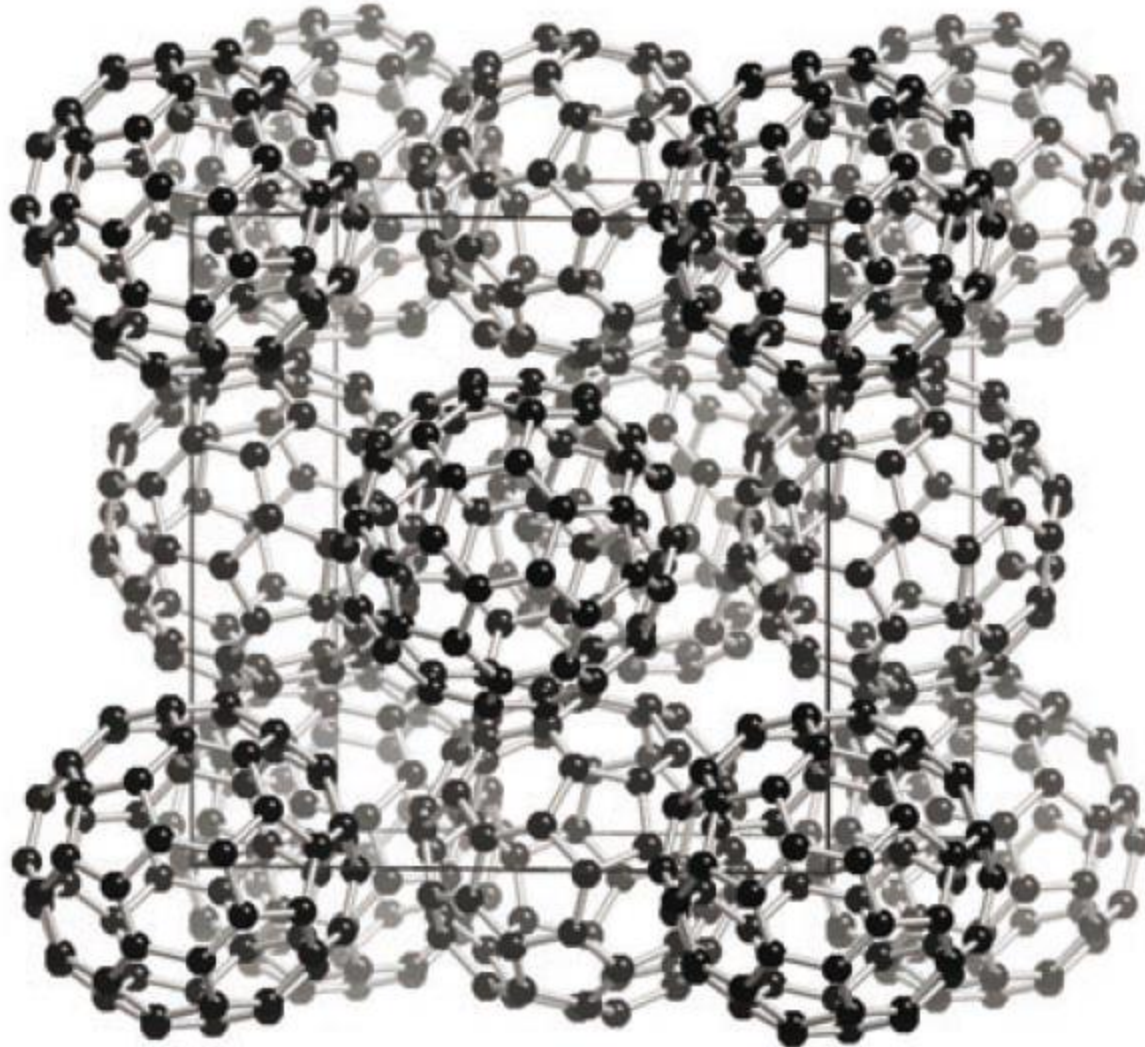
Celle unitarie fcc e hcp a confronto

Numero di coordinazione 12

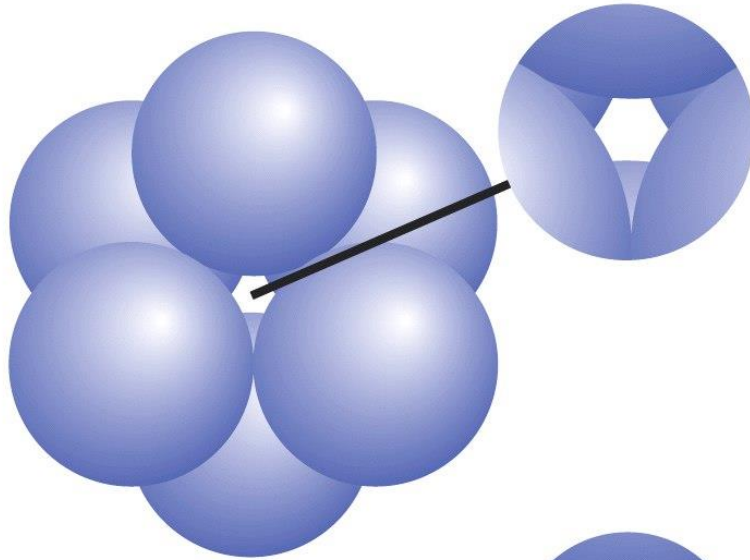


Spazio vuoto = 26%

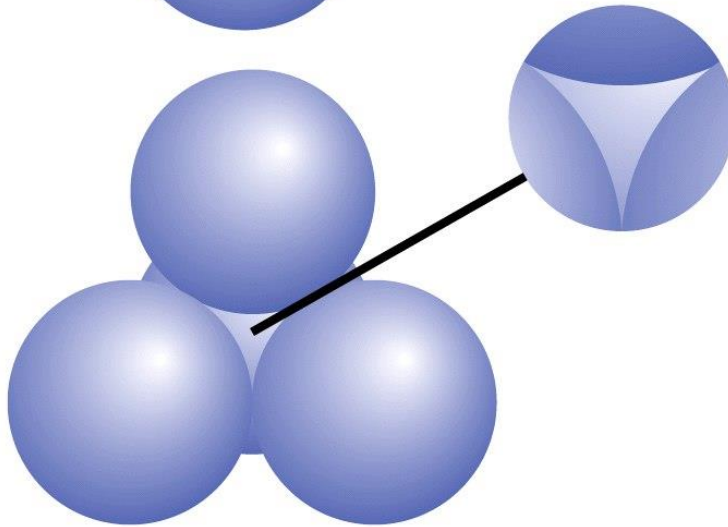
Arrangiamento ccp di C_{60}



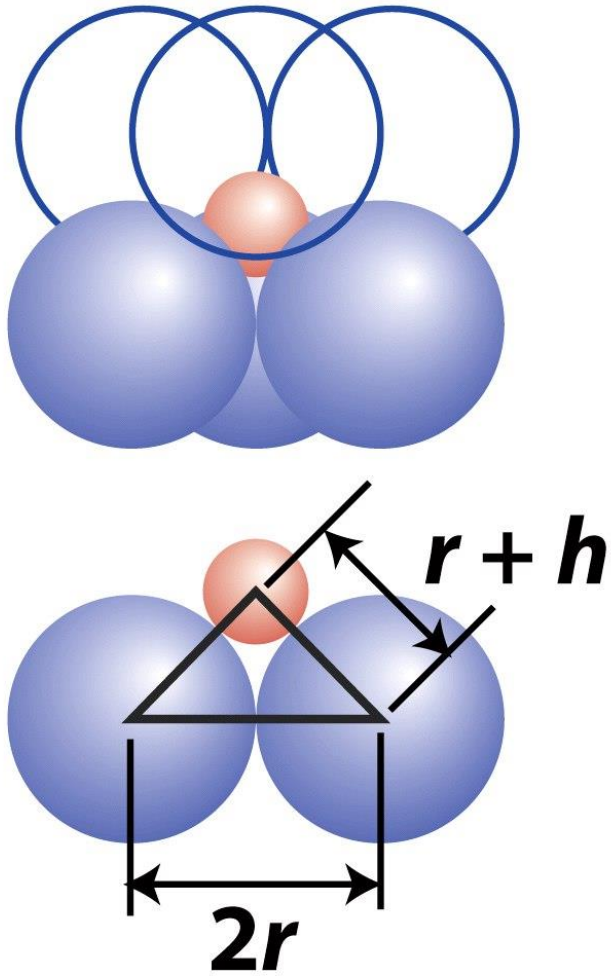
Interstizi negli impaccamenti compatti



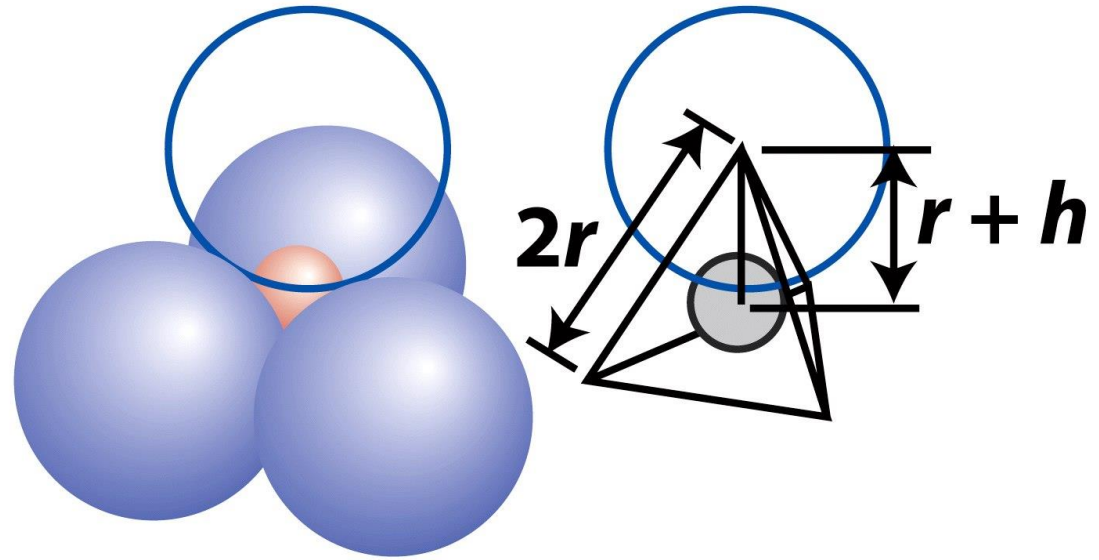
Interstizio ottaedrico
 $r_h = 0.414r$



Interstizio tetraedrico
 $r_h = 0.225r$

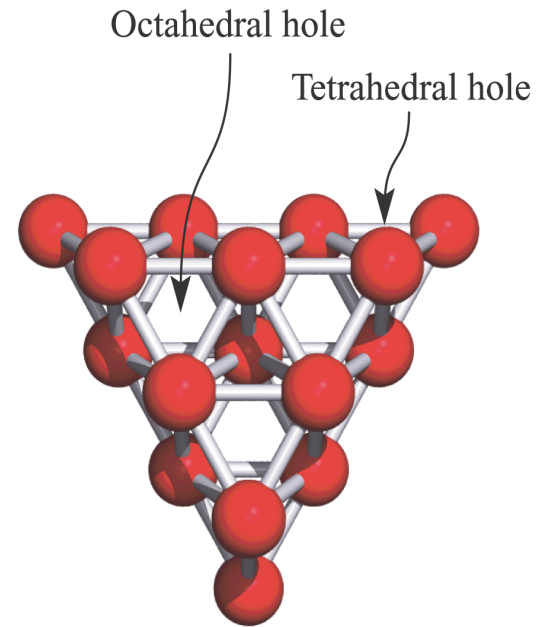
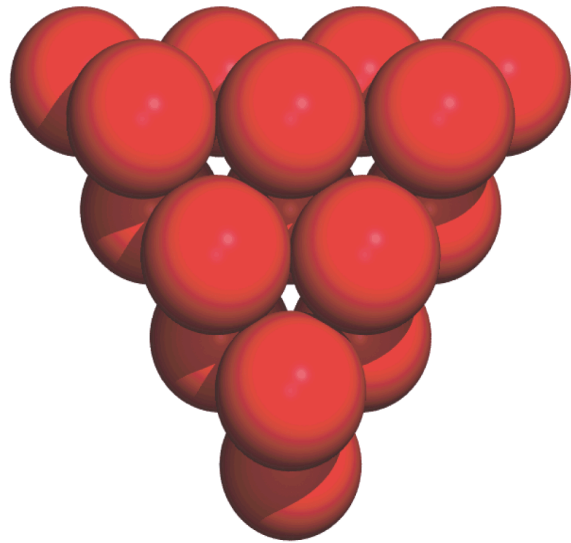


Interstizio ottaedrico
 $r_h = 0.414r$

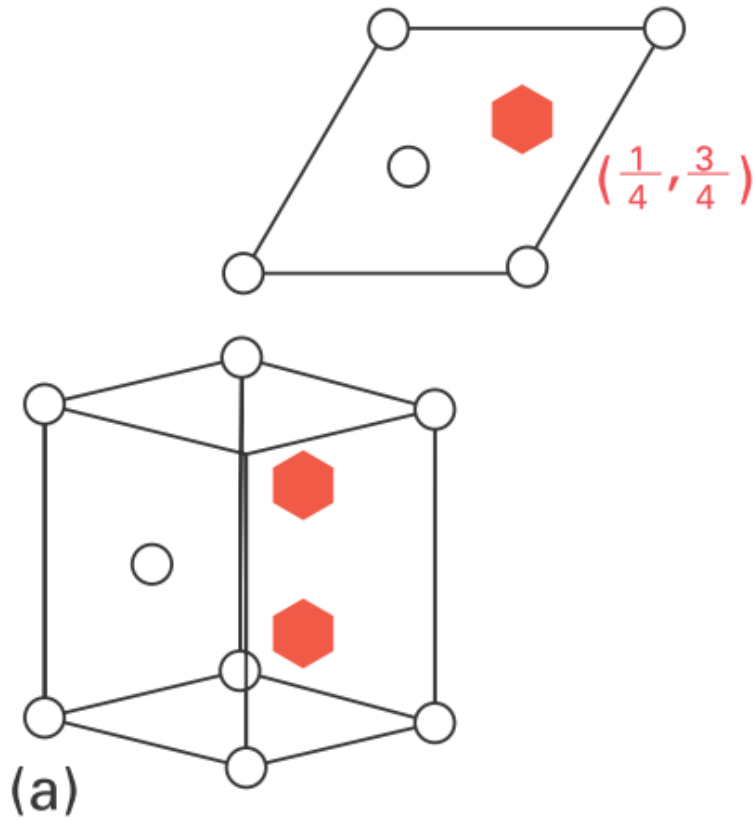


Interstizio tetraedrico
 $r_h = 0.225r$

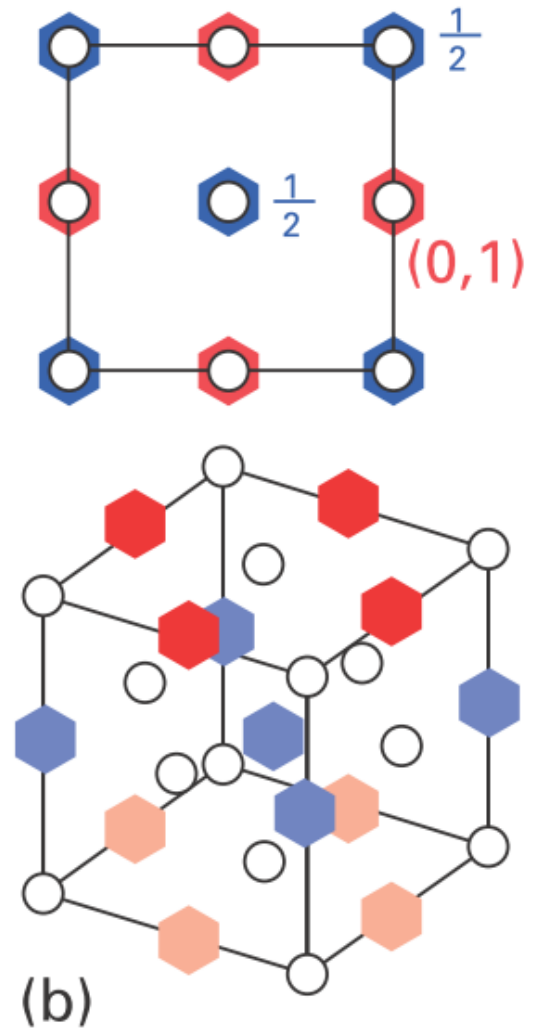
Interstizi ottaedrici e tetraedrici



Interstizi ottaedrici nelle strutture compatte

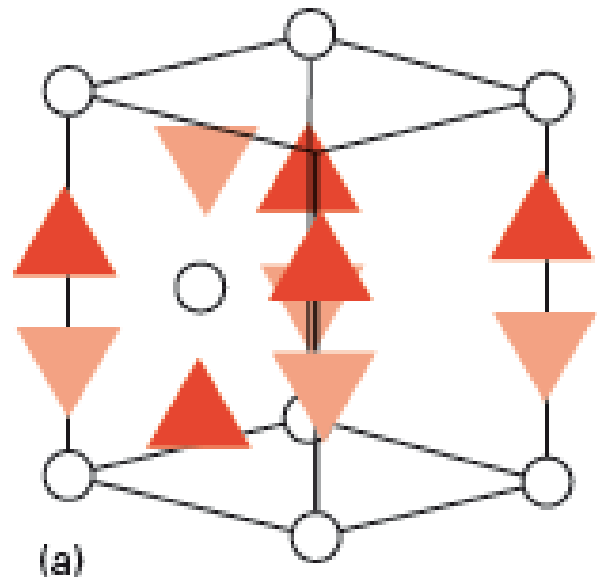
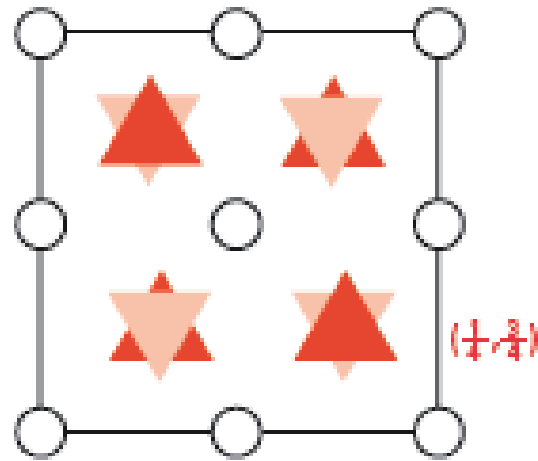
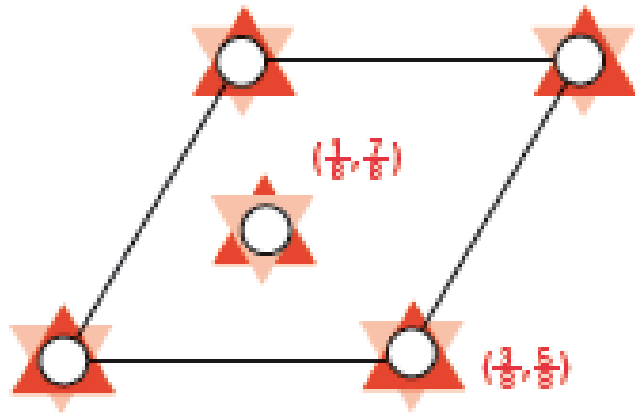


hcp



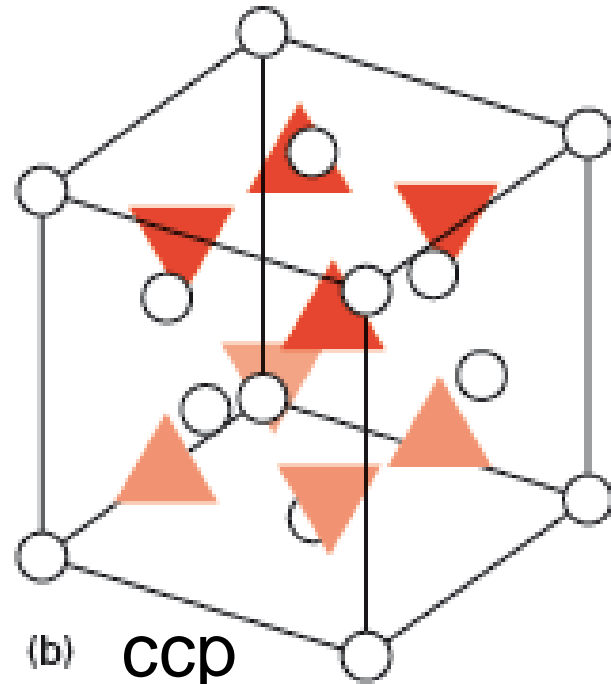
ccp

Interstizi tetraedrici nelle strutture compatte



(a)

hcp



(b)

ccp

Le strutture dei metalli

$$\rho_{\text{Os}} = 22,61 \text{ g cm}^{-3}$$

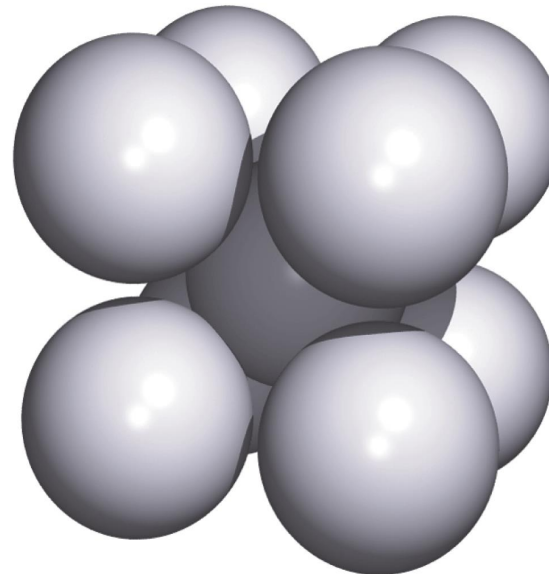
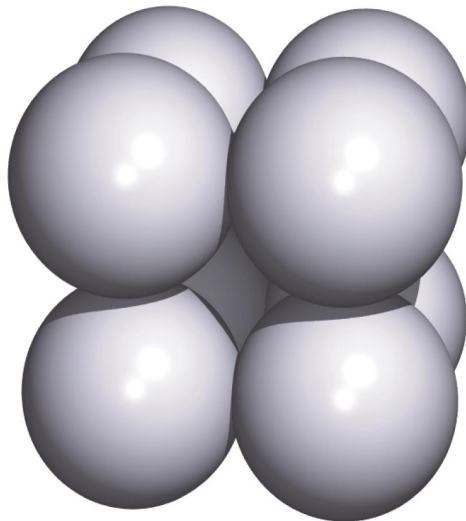
$$\rho_{\text{Pb}} = 11,3 \text{ g cm}^{-3}$$

Struttura cristallina	Elemento
Esagonale compatta (hcp)	Be, Ca, Co, Mg, Ti, Zn
Cubica compatta (ccp)	Ag, Al, Au, Cd, Cu, Ni, Pb, Pt
Cubica a corpo-centrato (bcc)	Ba, Cr, Fe, W, metalli alcalini
Cubica primitiva (cubica-P)	Po

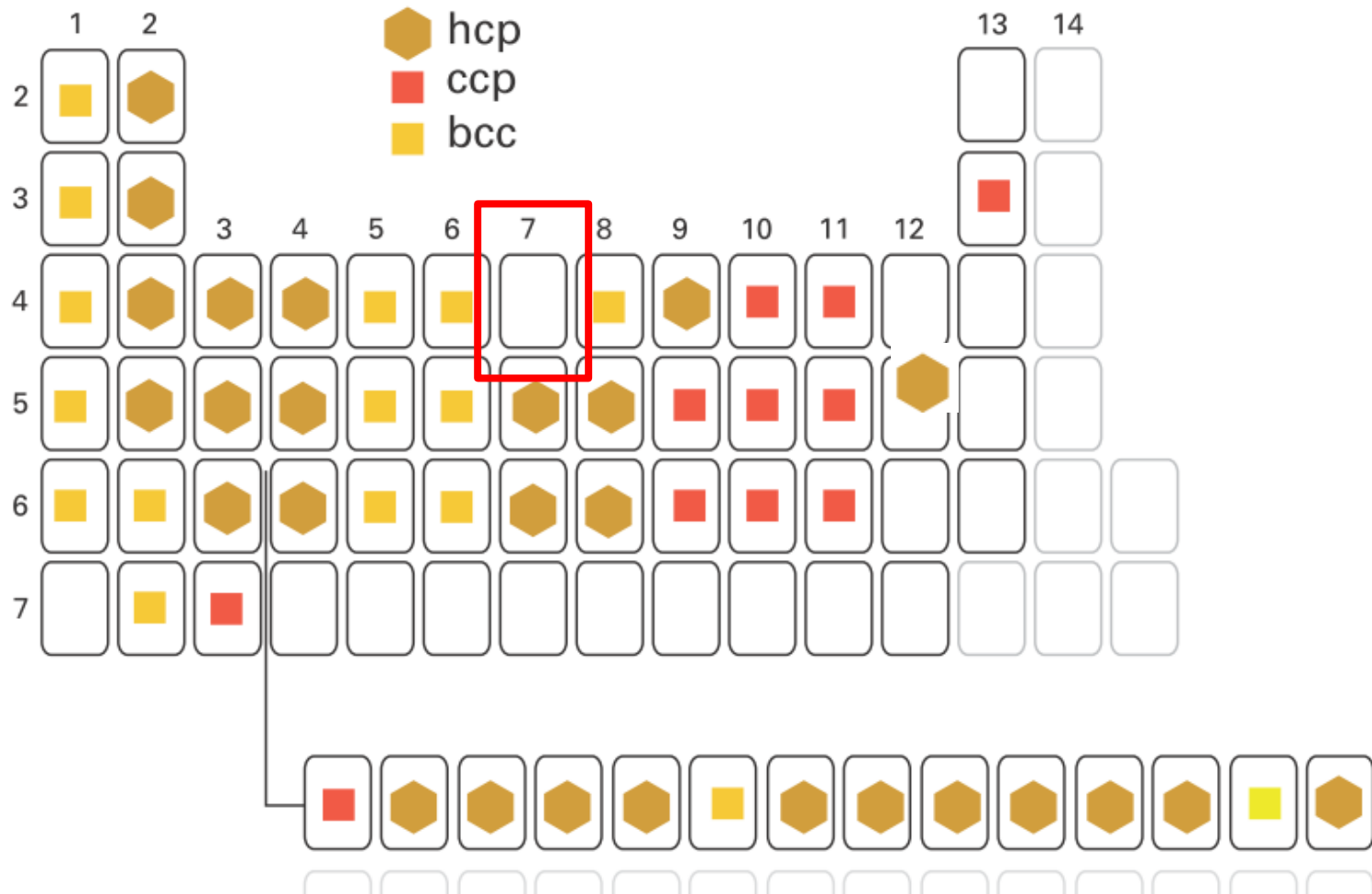
} 26% vuoto

32% vuoto

Cubica
primitiva

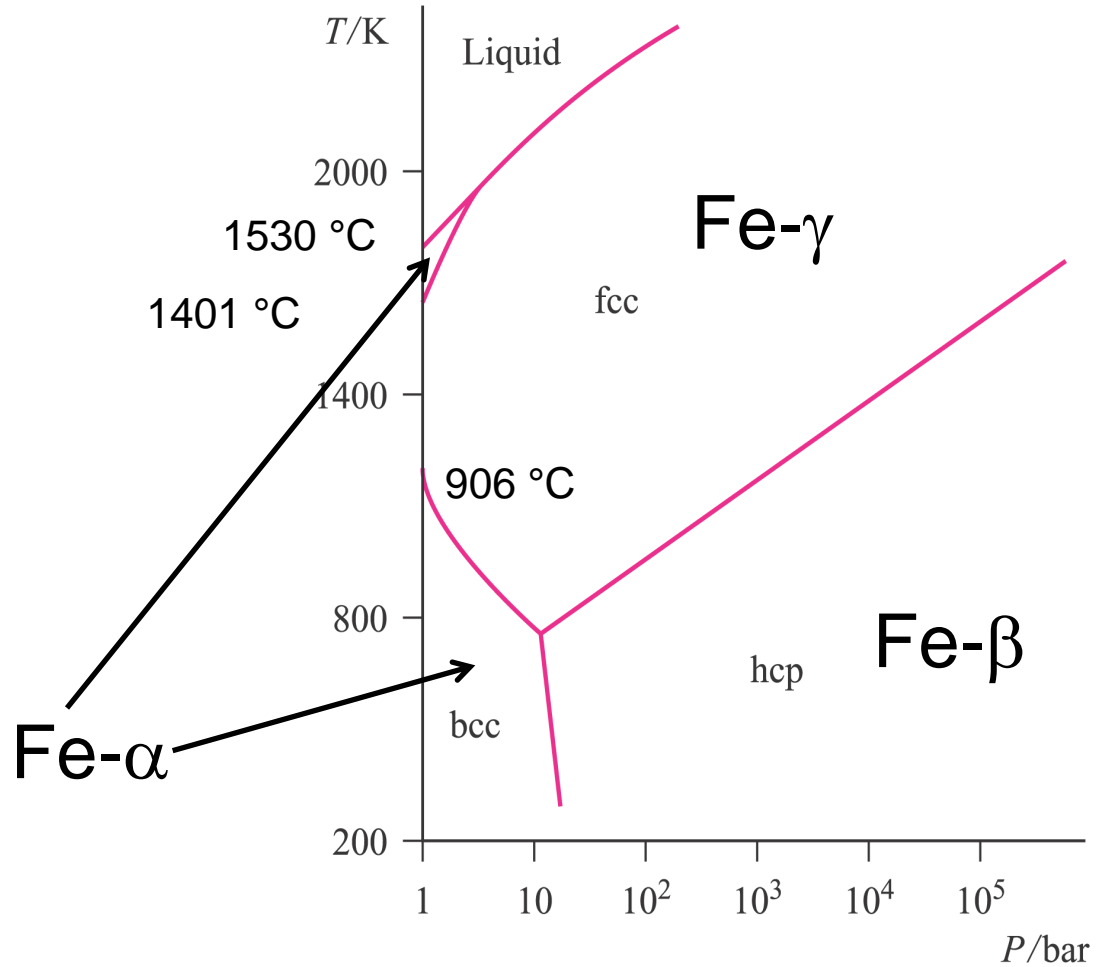


bcc



Nel Mn gli atomi descrivono un complesso reticolo cubico nel quale ci sono quattro interni coordinativi, con numeri di coordinazione 12, 13 o 16

Allotropia (polimorfismo) del ferro



Polimorfismo = la capacità di adottare forme cristalline diverse in condizioni di pressione e temperatura differenti

Allotropia dello stagno

A 298 K e 1 bar di pressione, l'allotropo termodinamicamente stabile è lo stagno bianco (β -Sn), ma abbassando la temperatura a 286 K si ha la lenta transizione all'allotropo stagno grigio (α -Sn). Alla transizione tra i due allotropi, $\beta \rightarrow \alpha$, corrisponde una variazione del numero di coordinazione da 6 a 4, e lo stagno grigio adotta un reticolo come quello del diamante. Di conseguenza nella transizione $\beta \rightarrow \alpha$ la densità dello stagno diminuisce da 7.31 a 5.75 g·cm⁻³ (mentre solitamente i polimorfi stabili a più basse temperature hanno una densità maggiore)

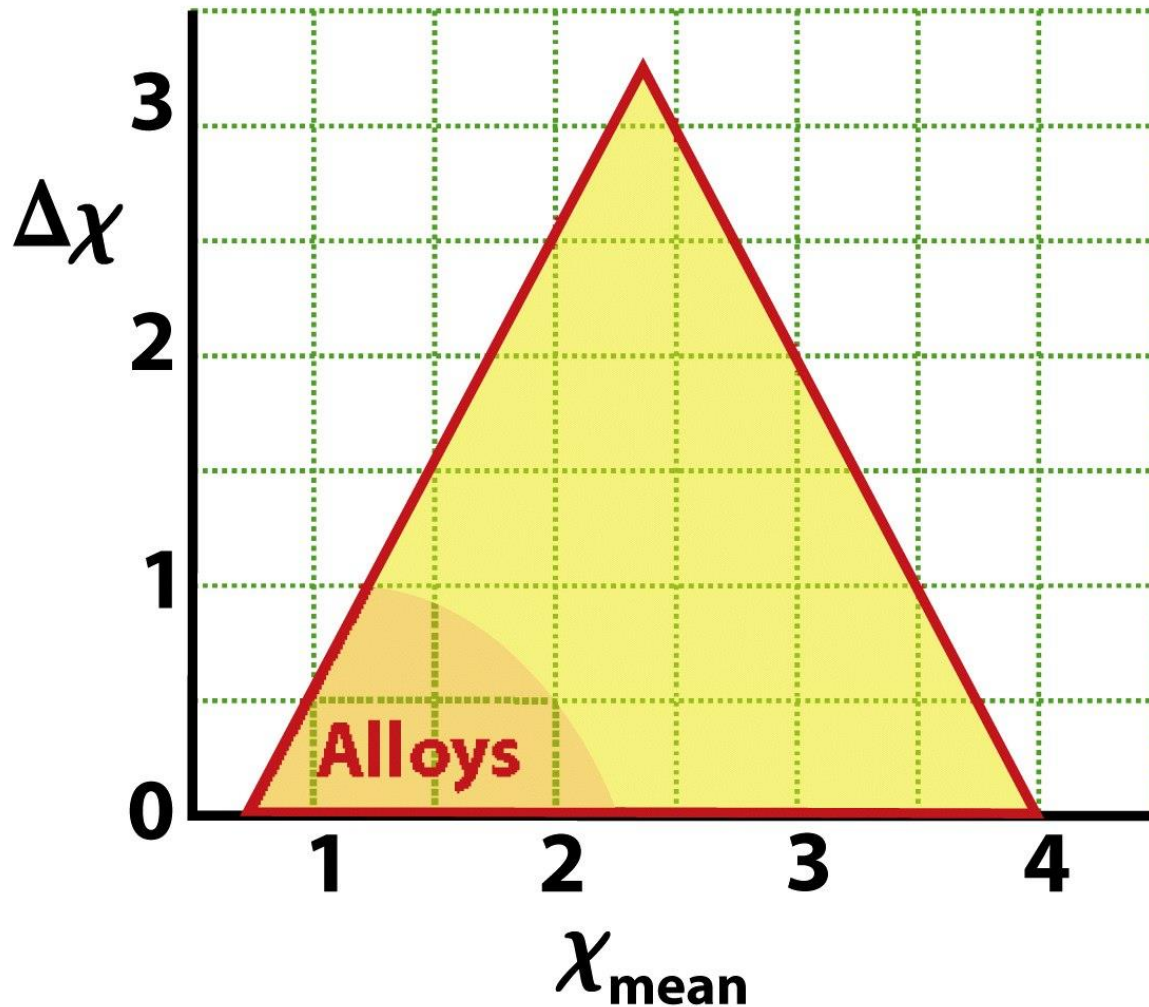
Correzione di Goldschmidt dei raggi atomici

Numero di coordinazione	Raggio relativo
12	1
8	0,97
6	0,96
4	0,88

Correzione di Goldschmidt = raggio metallico (ipotetico) in una struttura a impaccamento compatto con coordinazione 12.

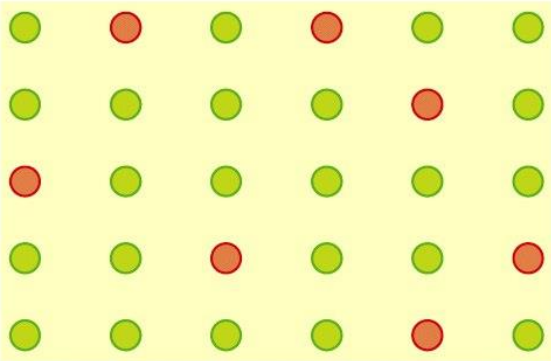
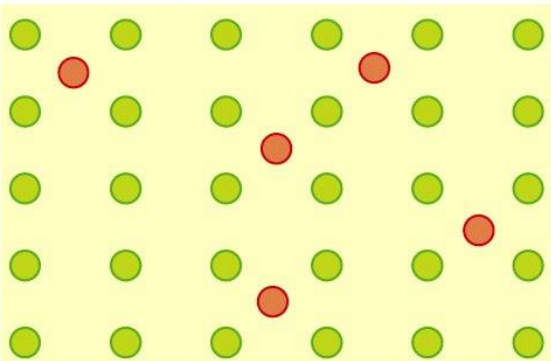
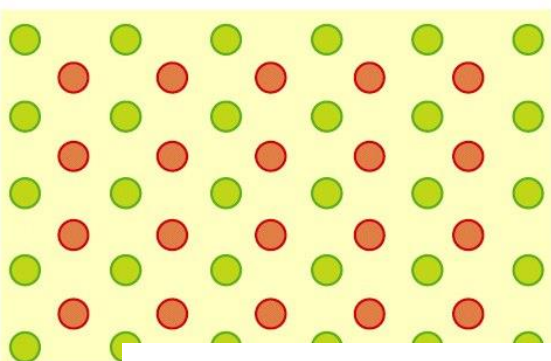
Il raggio atomico empirico di Na è 185 pm per la struttura bcc, con numero di coordinazione 8. Per riportarlo alla coordinazione 12 si moltiplica questo raggio per $1/0,97 = 1,03$ e si ottiene 191 pm.

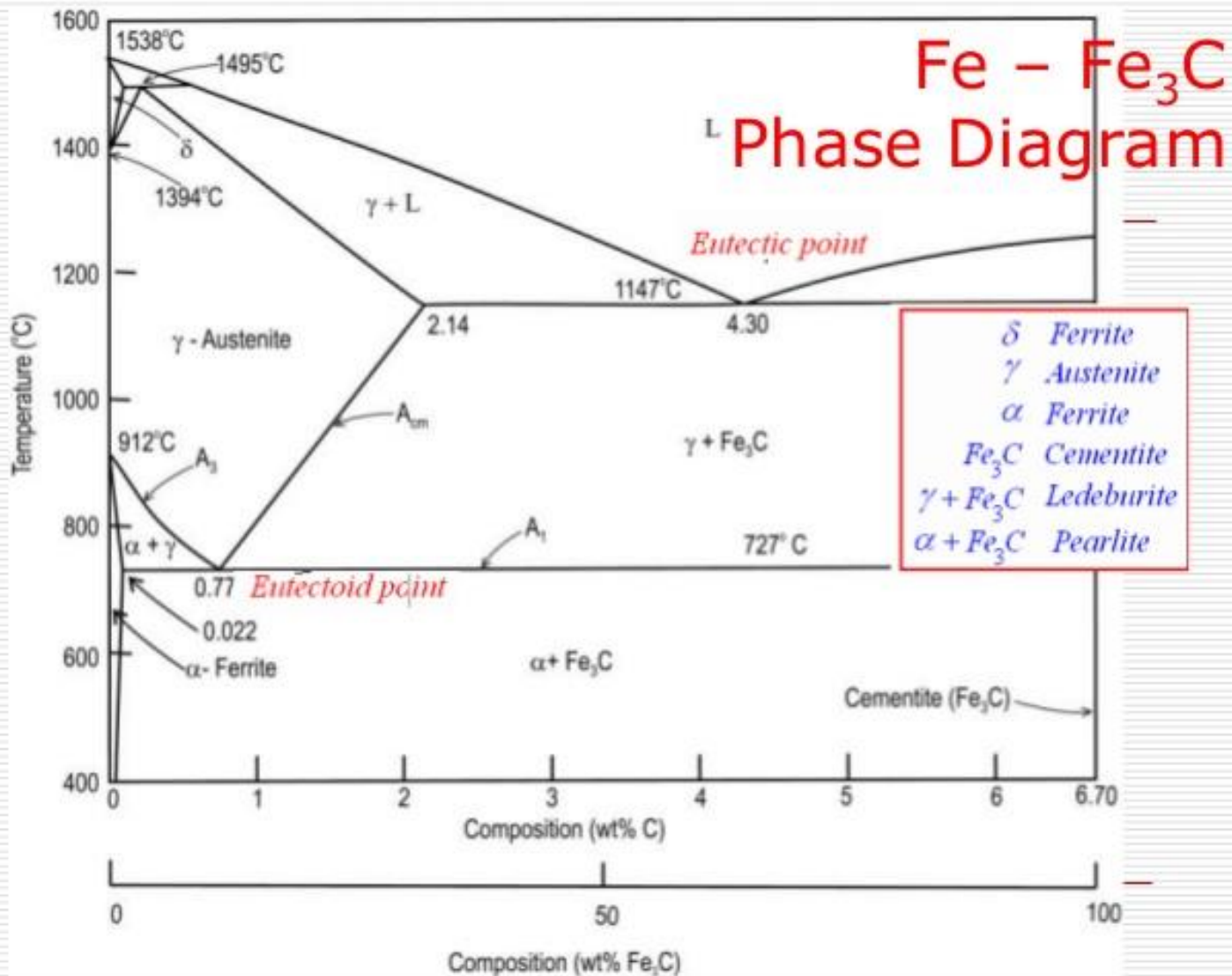
Leghe metalliche



La maggior parte delle leghe semplici può essere classificata come “sostituzionale” oppure come “interstiziale”

Leghe metalliche

- (a)  Soluzioni solide **sostituzionali**
 $\Delta r < 15\%$
(e.g. Cu/Ni, Cu/Sn/Pb (85/10/5, bronzo),
 $\text{Cu}_{1-x}/\text{Zn}_x$, $0 < x < 0.38$ (ottoni α), acciai inox)
- (b)  Soluzioni solide **interstiziali** (con nonmetalli) o composti non-stechiometrici
 $r < 0.414R$
e.g. Fe/C (acciai al carbonio, $0.2 < \text{C}\% < 1.6$)
- (c)  Composti interstiziali
 $r < 0.414R$
e.g. WC

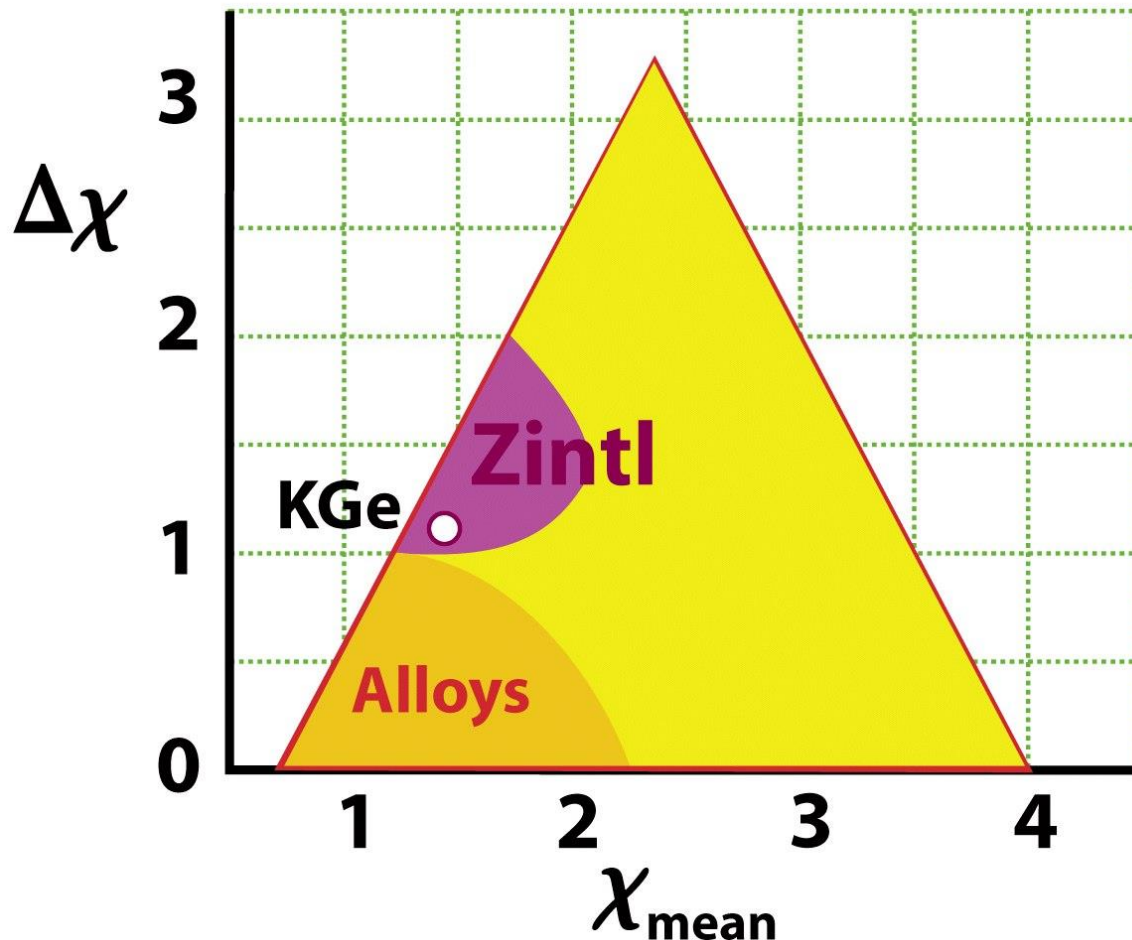


Nelle soluzioni solide interstiziali la struttura cristallina originale del metallo viene mantenuta

Composti intermetallici e *fasi di Zintl*

ottone- β (CuZn), *alnico*, LaNi_5 , *Nitinol*, MgZn_2 , Cu_3Au , NaTl ,
 $\text{Na}_5\text{Zn}_{21}$

La struttura è diversa da quella di entrambi i componenti metallici



Struttura della *fase di Zintl* K_4Ge_4

