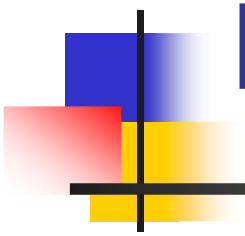


Estruturas Cerâmicas

- Cristais
- Defeitos
- Vidros

Caráter da ligação química

Table 12.1 For Several Ceramic Materials, Percent Ionic Character of the Interatomic Bonds

Material	*Percent Ionic Character*
CaF_2	89
MgO	73
NaCl	67
Al_2O_3	63
SiO_2	51
Si_3N_4	30
ZnS	18
SiC	12

Cerâmicas iônicas - Nc

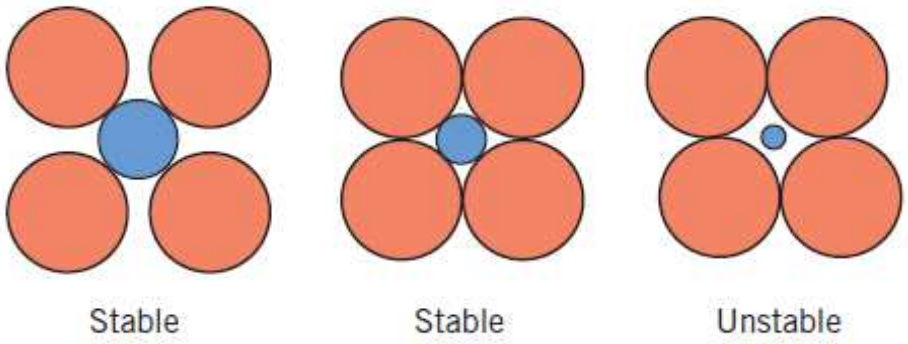
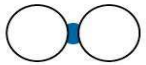
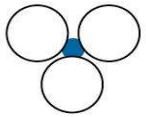
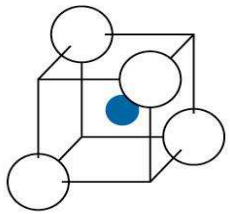
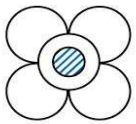
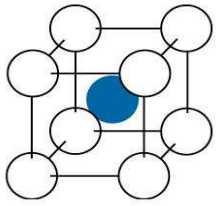


Figure 12.1 Stable and unstable anion–cation coordination configurations. Red circles represent anions; blue circles denote cations.

Estabilidade do arranjo iônico

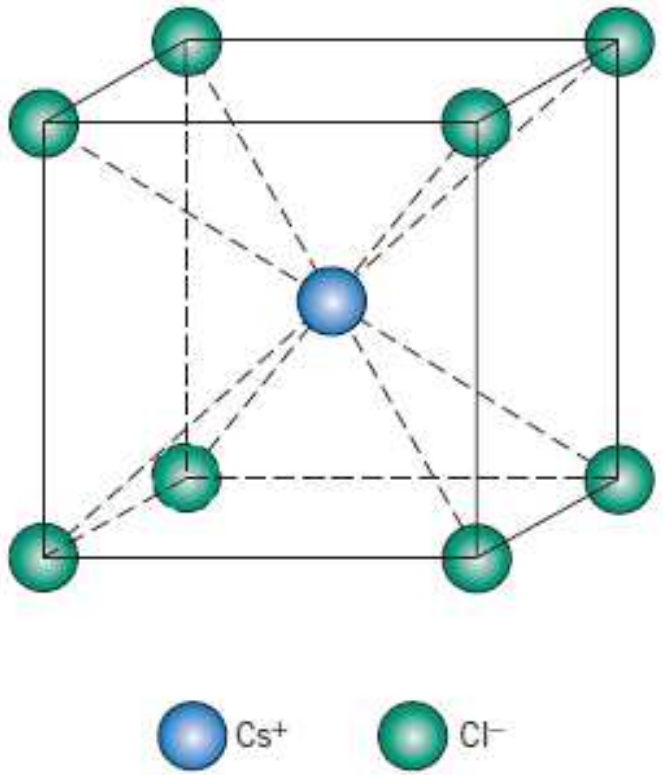
Cerâmicas iônicas - Nc

TABLE 3-6 ■ ***The coordination number and the radius ratio***

Coordination Location of Number	Interstitial	Radius Ratio	Representation
2	Linear	0–0.155	
3	Center of triangle	0.155–0.225	
4	Center of tetrahedron	0.225–0.414	
6	Center of octahedron	0.414–0.732	
8	Center of cube	0.732–1.000	

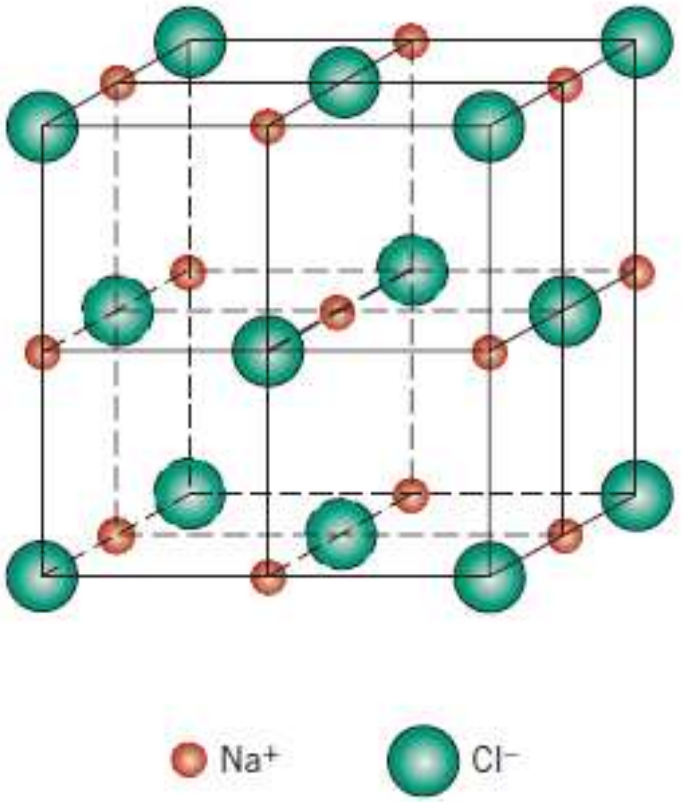
Cloreto de Césio

- CsCl
  - NC = 8
  - Estrutura CS
  - Ânions nos pontos da rede
  - Cátions no interstício cúbico da rede



Sal de cozinha

- NaCl
  - NC = 6
  - Estrutura CFC (clique aqui)
  - Ânions nos pontos da rede
  - Cátions nos interstícios octaédricos da rede



NaCl

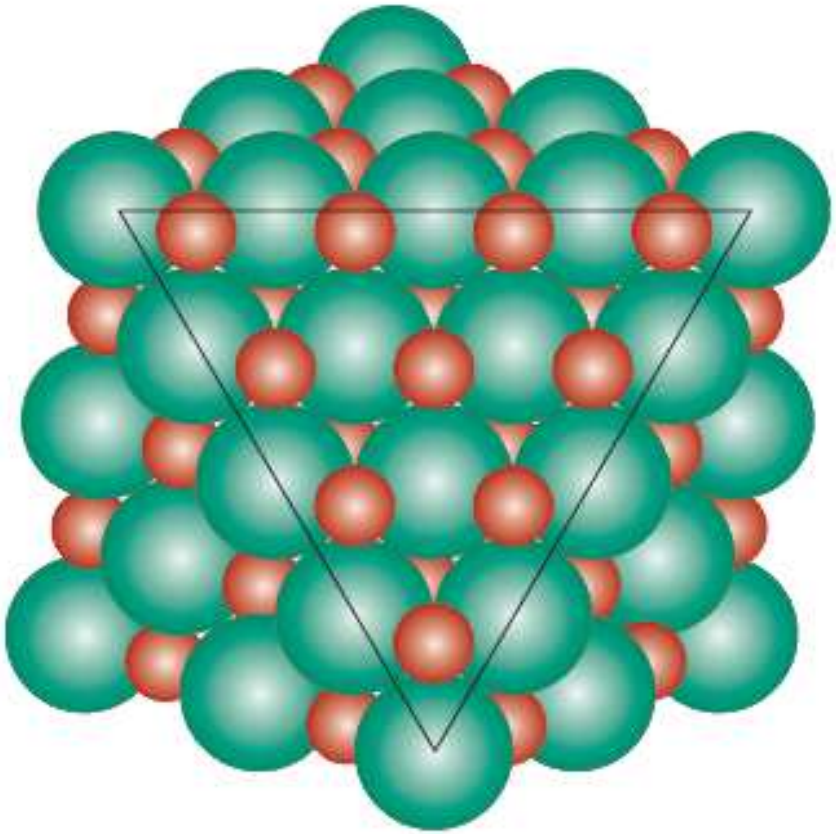
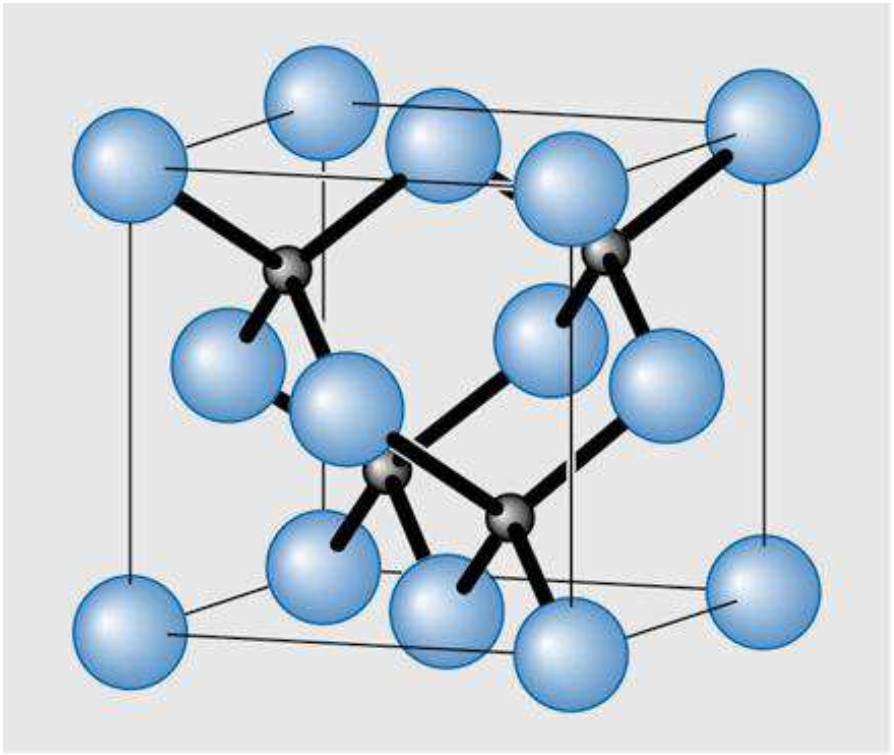
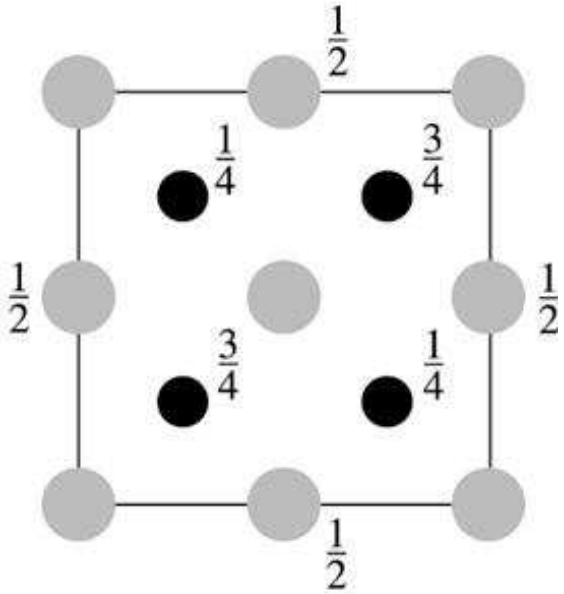


Figure 12.8 A section of the rock salt crystal structure from which a corner has been removed. The exposed plane of anions (green spheres inside the triangle) is a {111}-type plane; the cations (red spheres) occupy the interstitial octahedral positions.

GaAs, ZnS, SiC

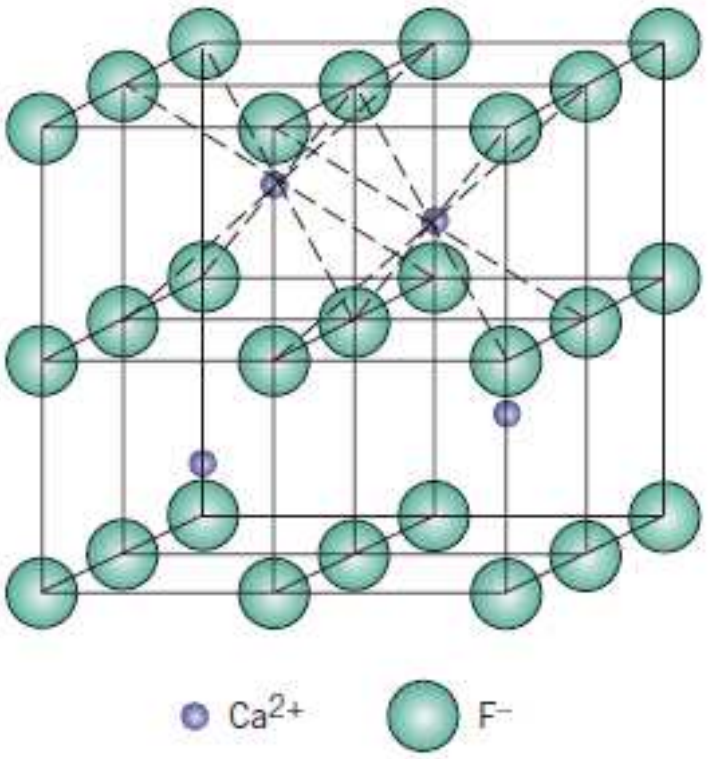


(a)



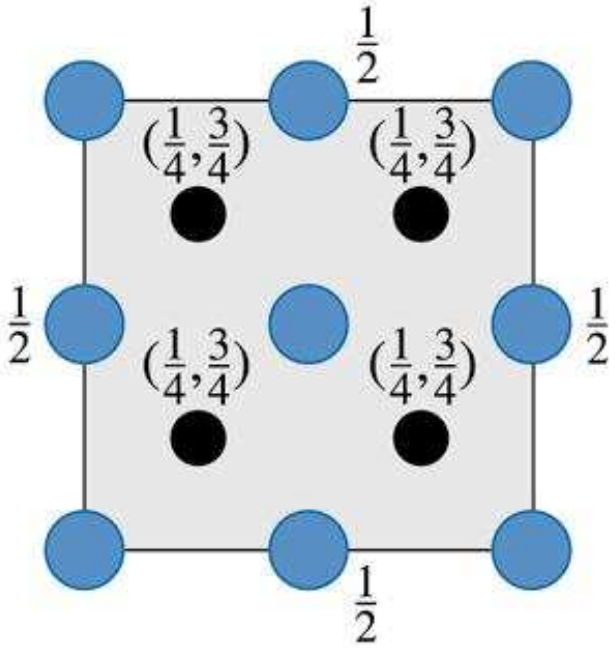
(b)

Fluorita (CaF_2)



Flourite cell

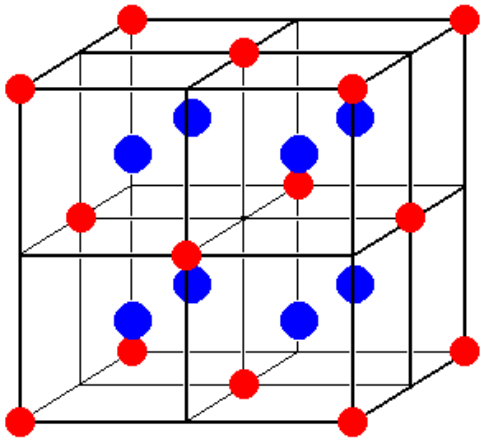
(a)



Plan view

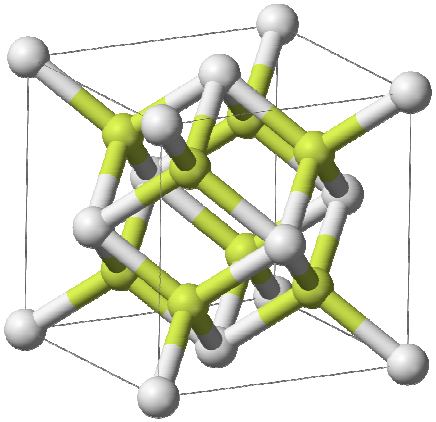
(b)

Fluorita (CaF_2)

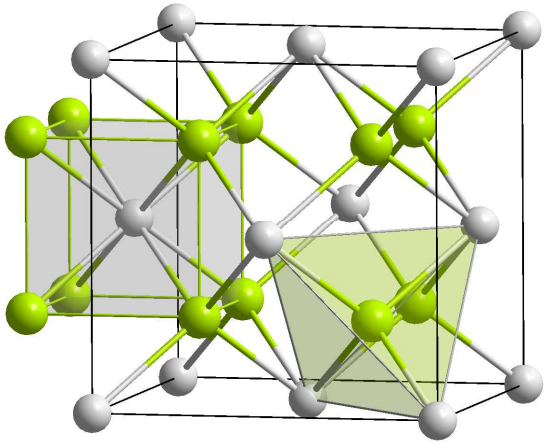


Ca^{++}

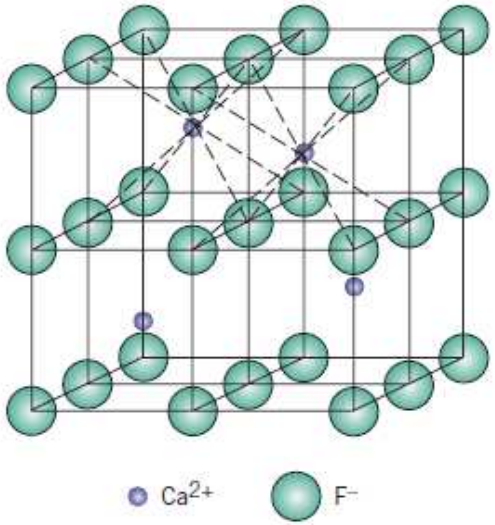
F^-



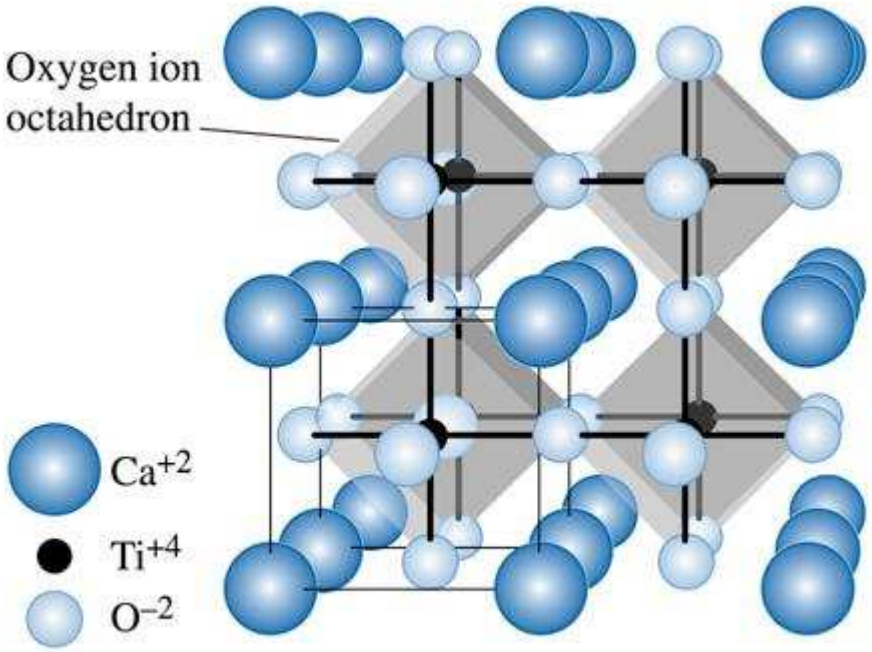
CaF_2



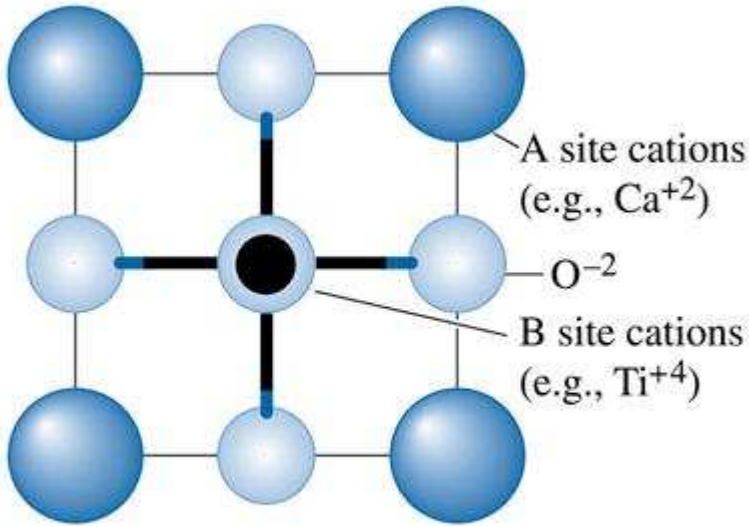
equivalentes



Perovskita, $BaTiO_3$



Perovskite



Perovskite, plan view

Arranjos compactos de ânions (CFC e HCP)

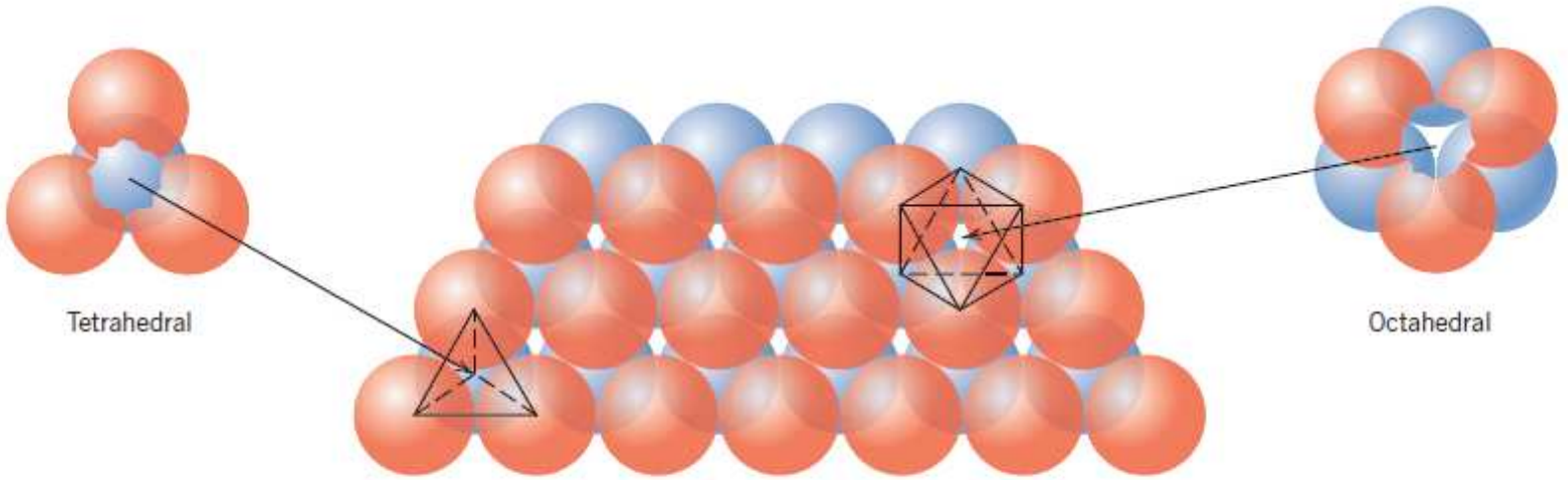
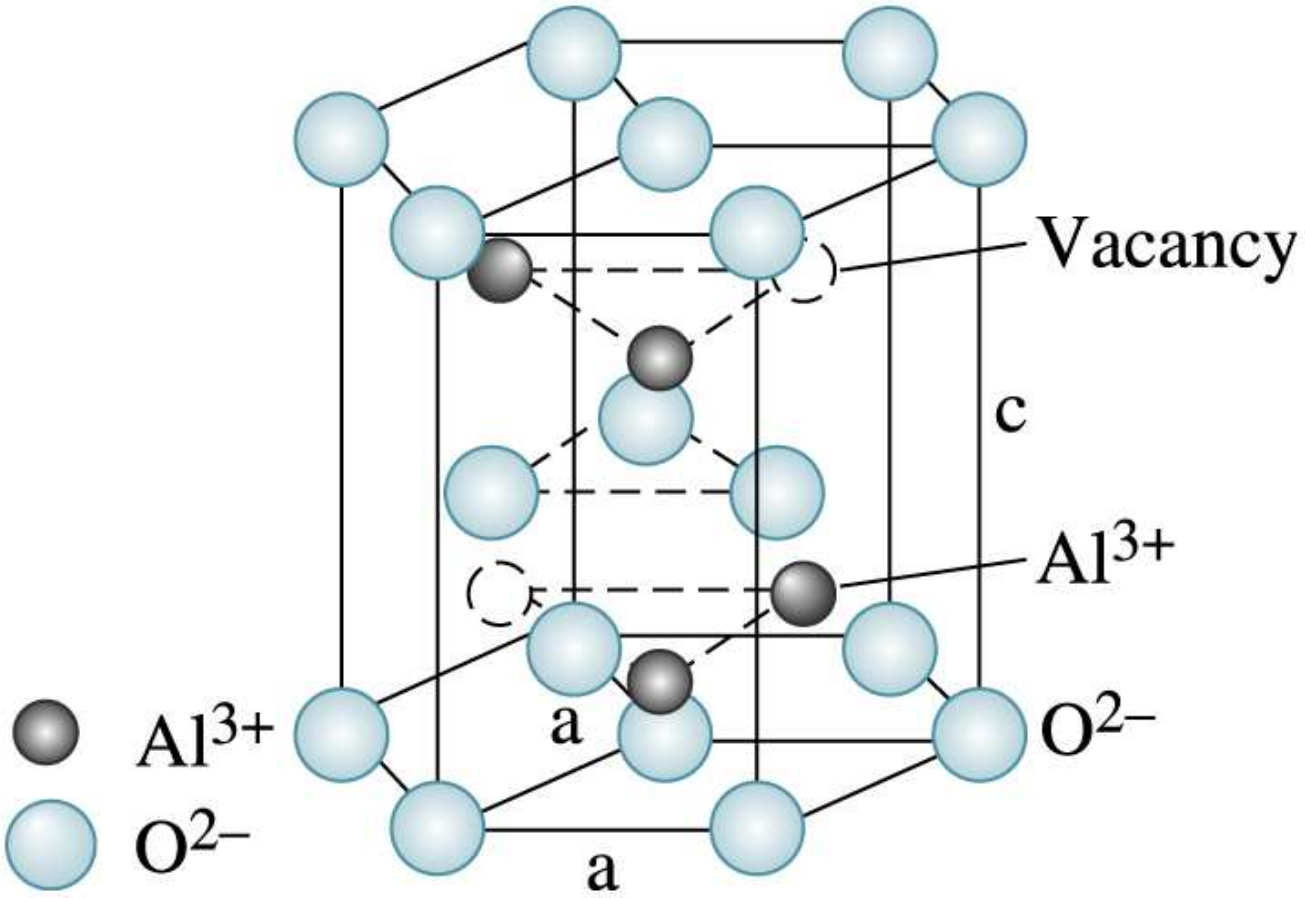


Figure 12.7 The stacking of one plane of close-packed (orange) spheres (anions) on top of another (blue spheres); the geometries of tetrahedral and octahedral positions between the planes are noted. (From W. G. Moffatt, G. W. Pearsall, and J. Wulff, *The Structure and Properties of Materials*, Vol. I, *Structure*. Copyright © 1964 by John Wiley & Sons, New York. Reprinted by permission of John Wiley & Sons, Inc.)

Alumina



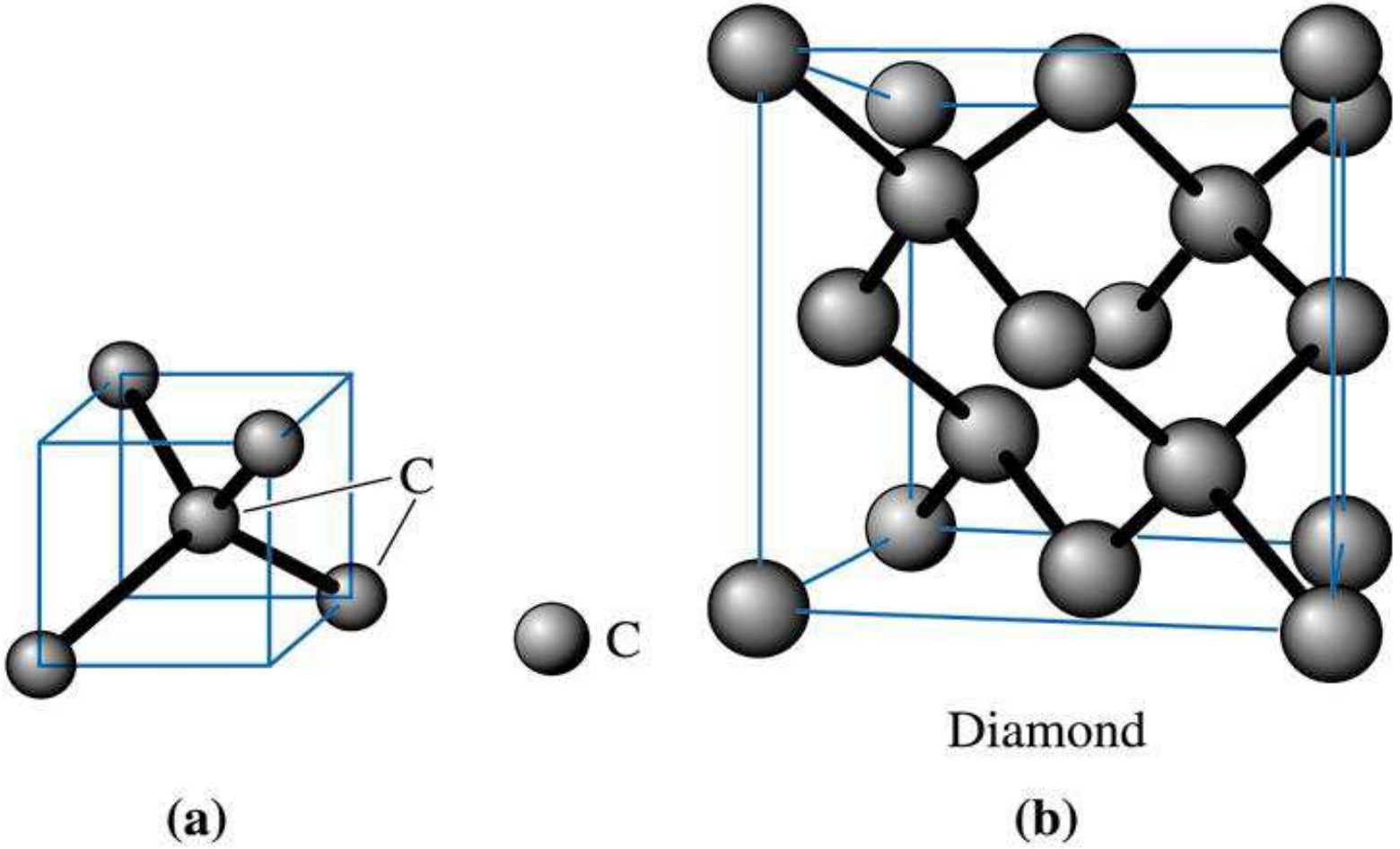
Resumo das estruturas mais simples

Table 12.4 **Summary of Some Common Ceramic Crystal Structures**

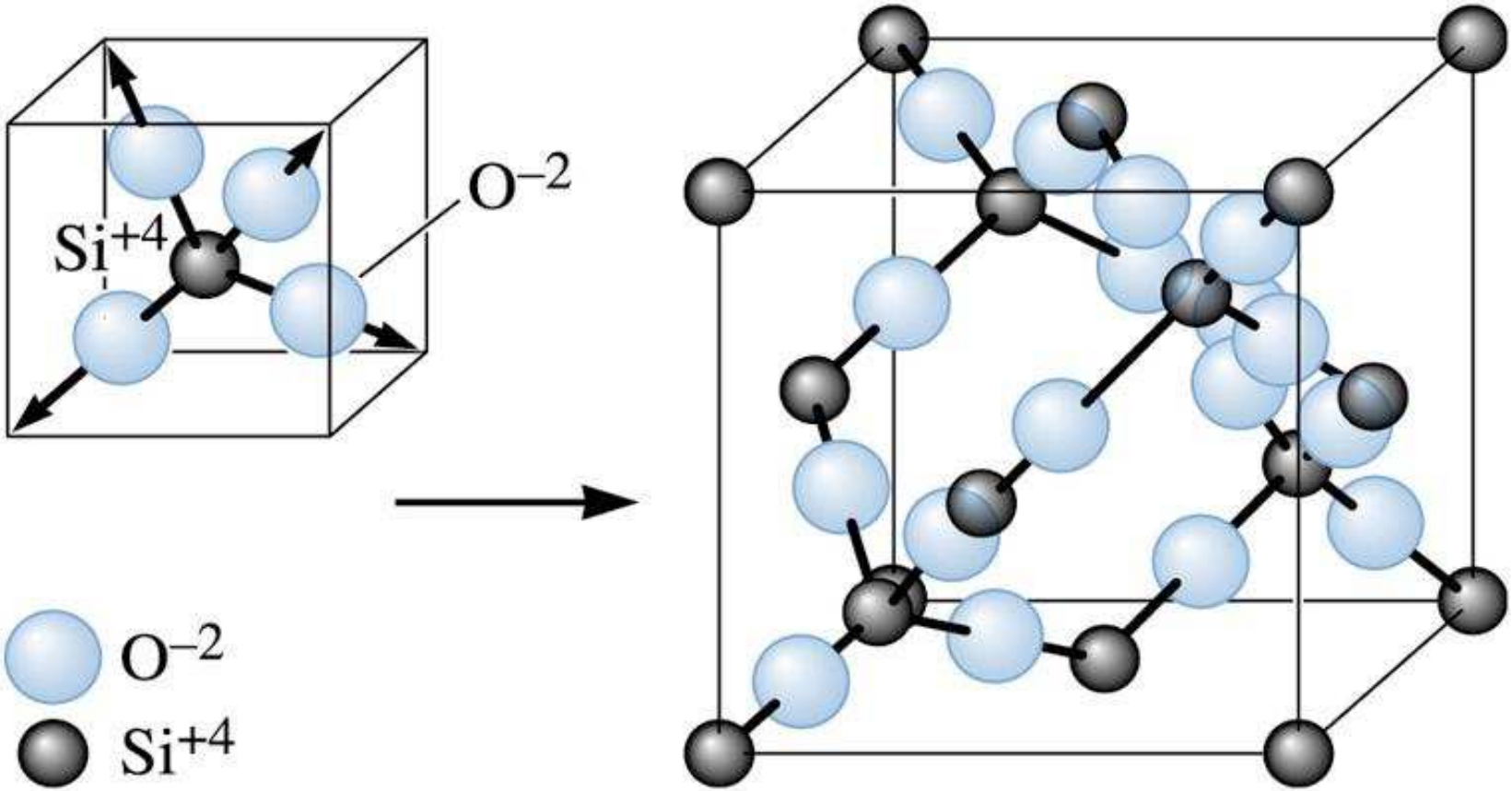
Structure Name	*Structure Type*	*Anion Packing*	*Coordination Numbers*		*Examples*
			Cation	*Anion*	
Rock salt (sodium chloride)	AX	FCC	6	6	NaCl, MgO, FeO
Cesium chloride	AX	Simple cubic	8	8	CsCl
Zinc blende (sphalerite)	AX	FCC	4	4	ZnS, SiC
Fluorite	AX_2	Simple cubic	8	4	CaF_2, UO_2, ThO_2
Perovskite	ABX_3	FCC	12(A) 6(B)	6	$BaTiO_3$, $SrZrO_3$, $SrSnO_3$
Spinel	AB_2X_4	FCC	4(A) 6(B)	4	$MgAl_2O_4$, $FeAl_2O_4$

Source: W. D. Kingery, H. K. Bowen, and D. R. Uhlmann, *Introduction to Ceramics*, 2nd edition. Copyright © 1976 by John Wiley & Sons, New York. Reprinted by permission of John Wiley & Sons, Inc.

Diamante (covalente)

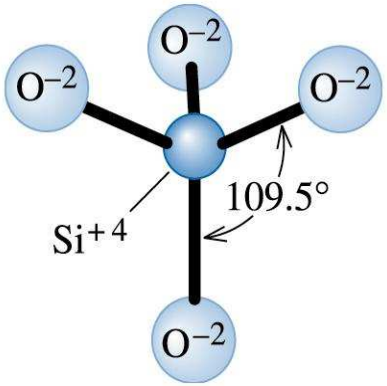


Cristobalita (coval. + iônica)



Tecto-silicato

Silicatos



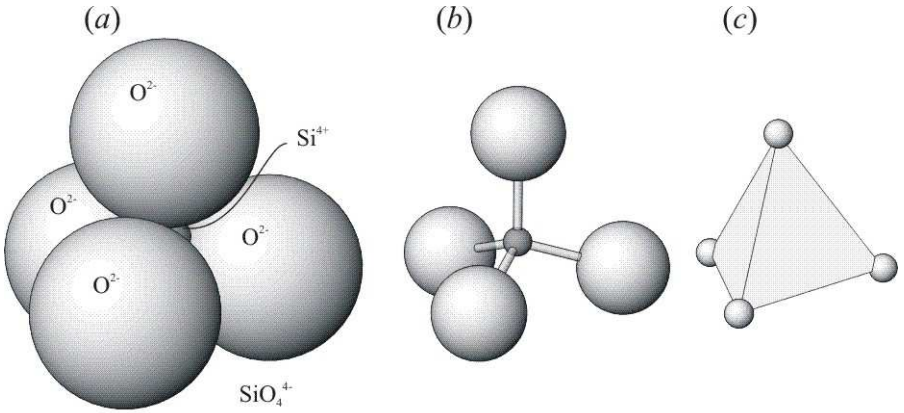


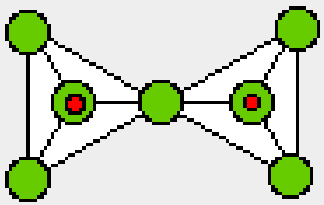
Figure 11.1

Unidade básica

$(SiO_4)^{4-}$

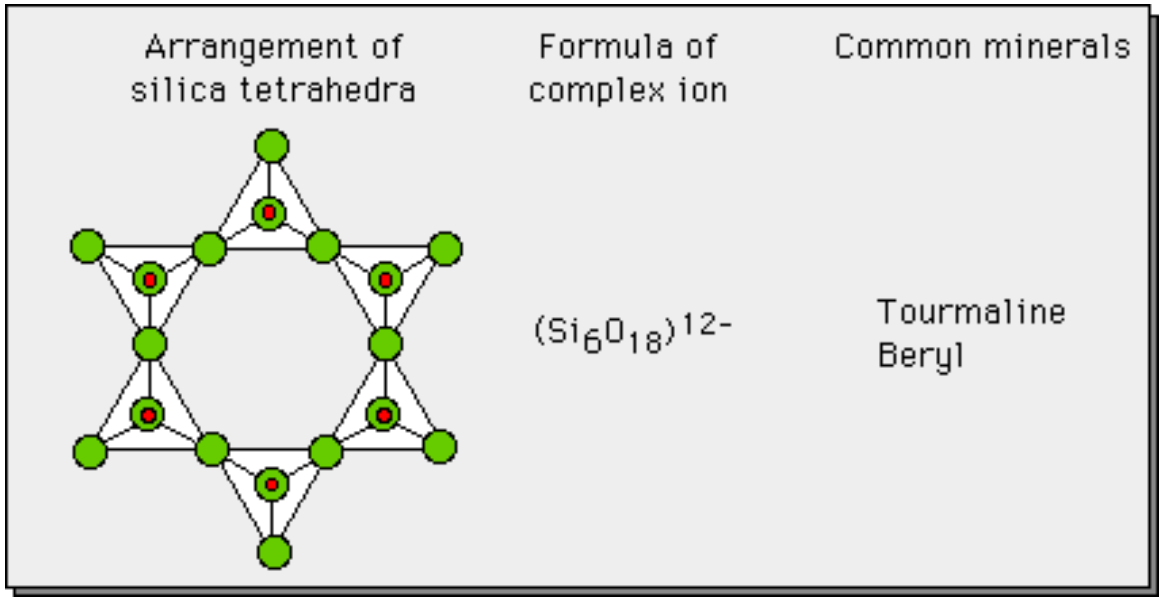
Ortossilicatos (1 tet.)
Ex.: Ca_2SiO_4

Dissilicatos $(Si_2O_7)^{6-}$

Arrangement of silica tetrahedra	Formula of complex ion	Common minerals
	$(Si_2O_7)^{6-}$	Epidote

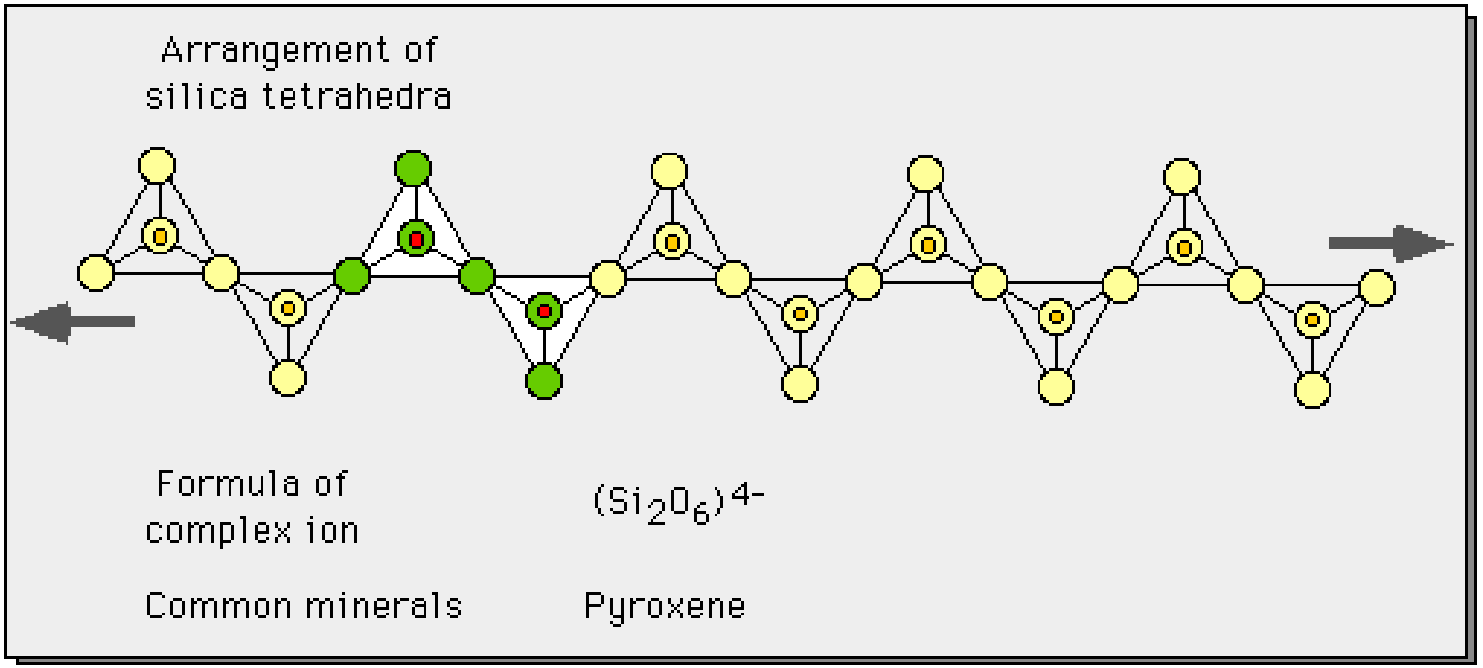
Ciclo-silicatos

- Ex.: $(Si_6O_{18})^{12-}$
- Berilo: $Be_3Al_2\ (Si_6O_{18})$

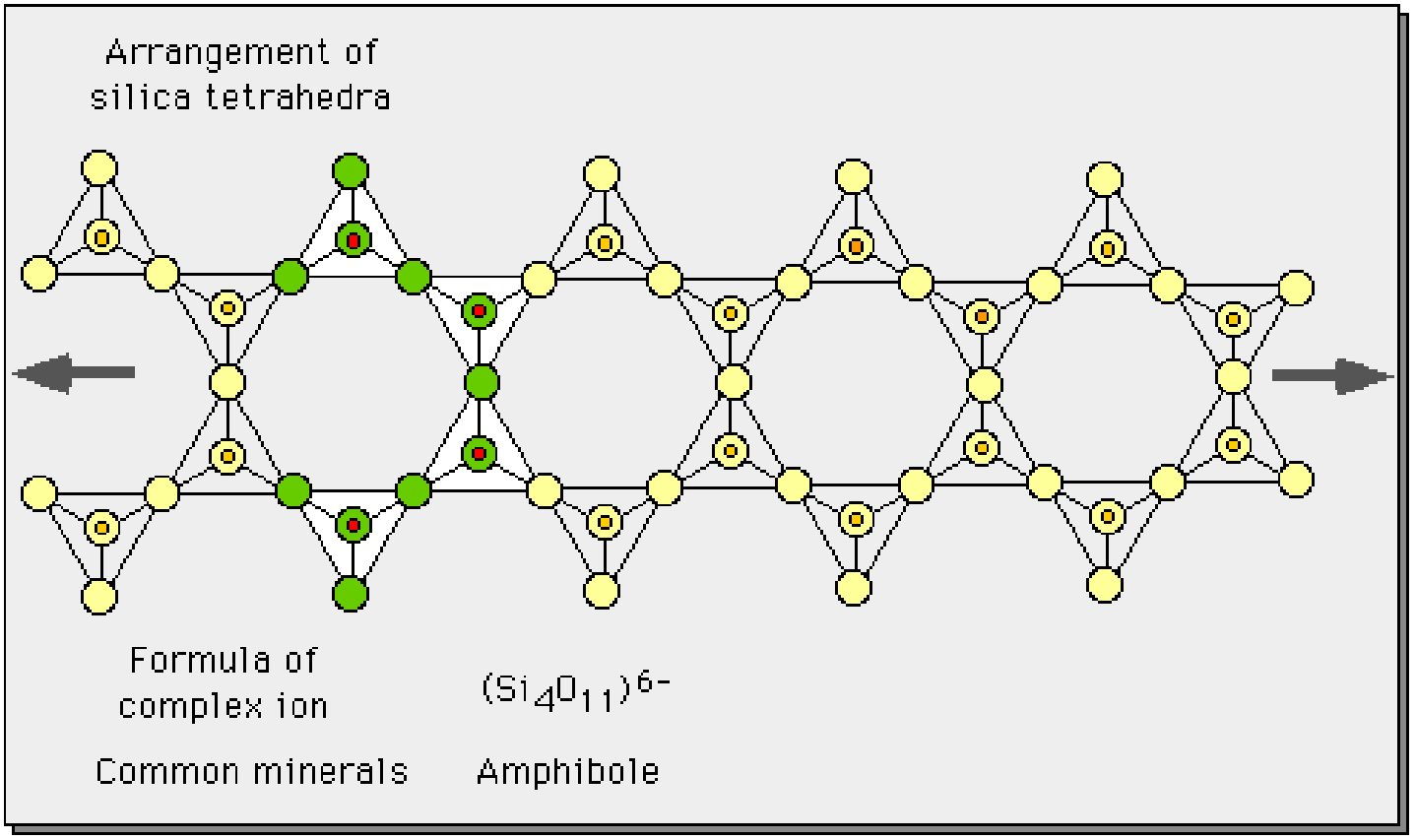


Ino-silicatos $(SiO_3)^{2-}_n$

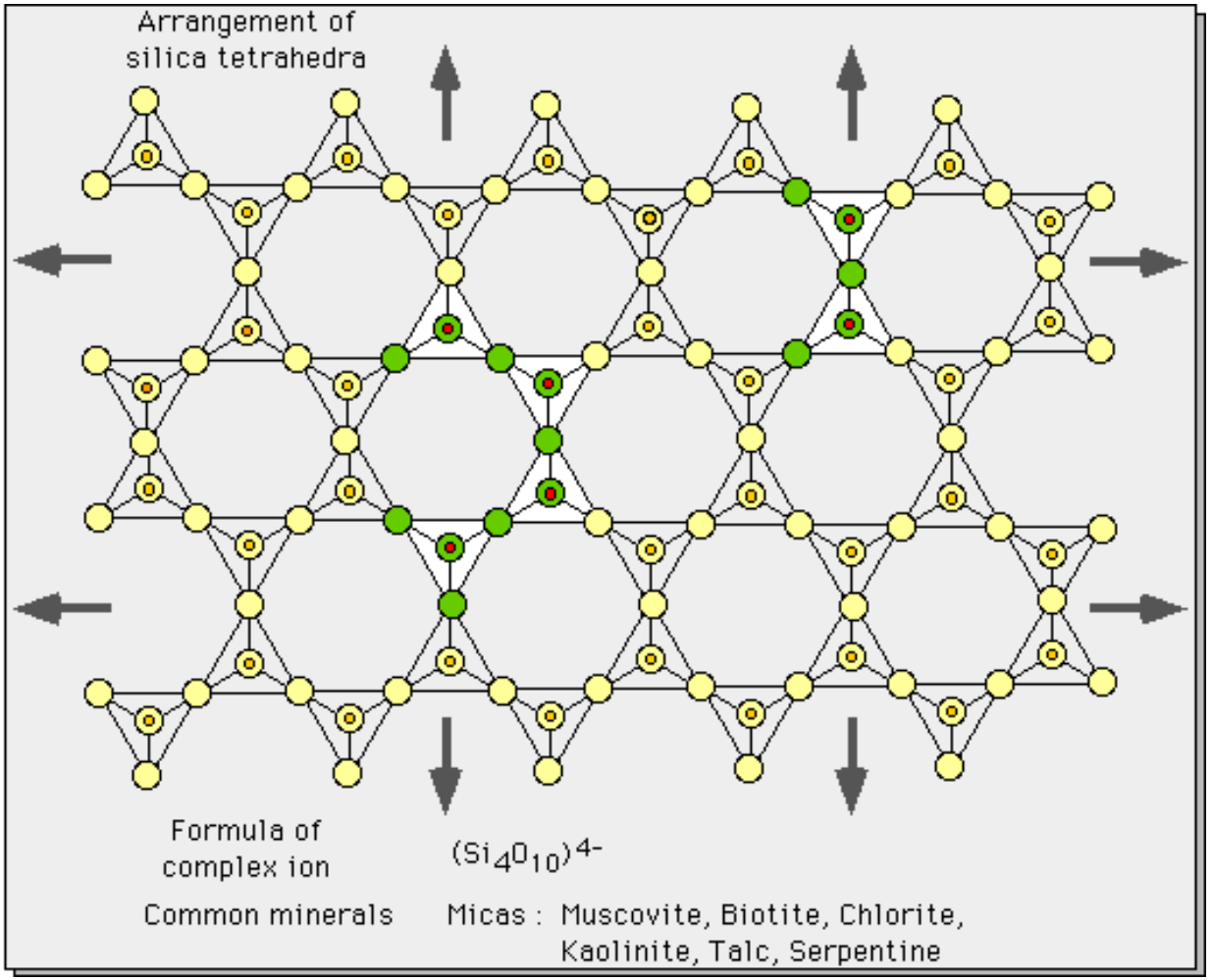
Cadeias Simples



Cadeias duplas $(Si_4O_{11})^{6-}{}_n$



Filossilicatos $(Si_2O_5)^{2-}_n$

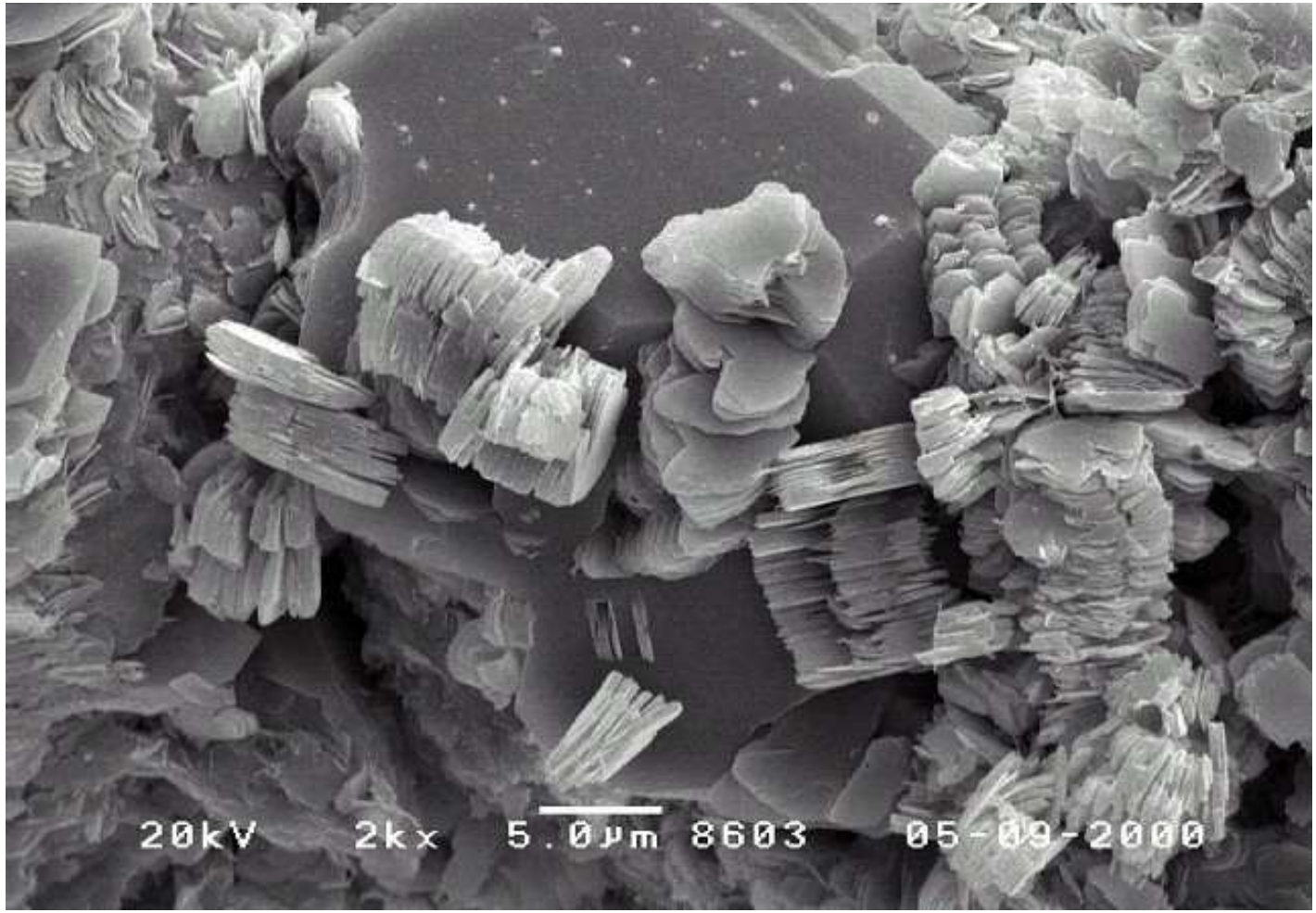


Cristais em camadas

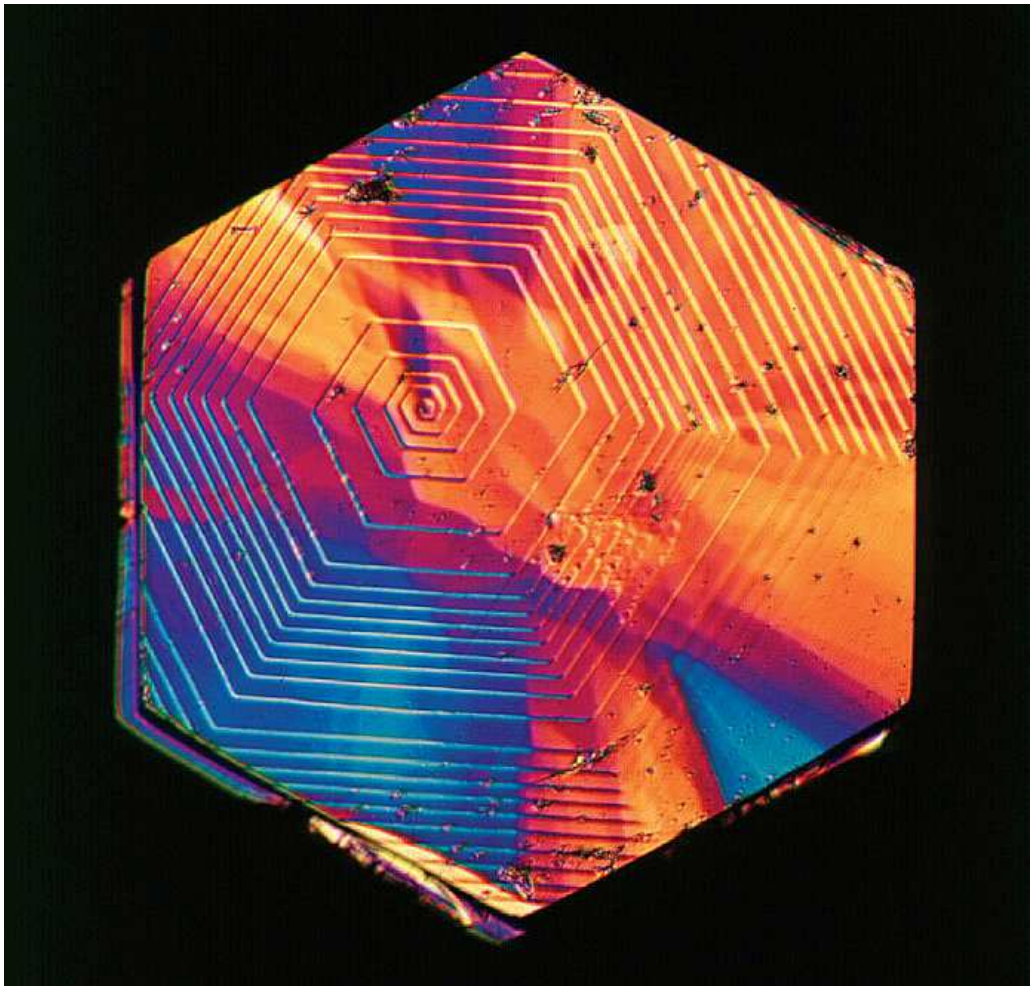
- Caulinita (filossilicato) $Al_2(OH)_4Si_2O_5$
- Montimorilonita (filossilicato)
- Talco (filossilicato) $Mg_3(OH)_2Si_4O_{10}$
- Grafita
- MoS_2

  - obs.: os nomes são links p/ as estruturas

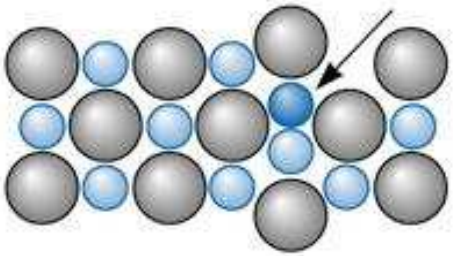
Cristais de Caulinita



Monocristal de Grafita



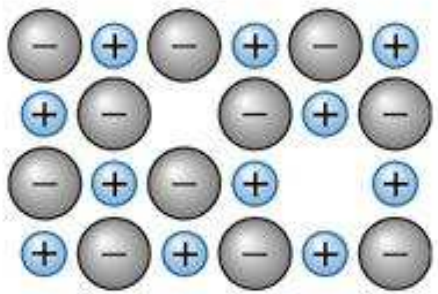
Defeitos em cristais cerâmicos



(e)

Figure 4.1 Point defects: (e) Frenkel defect.
All of these defects disrupt the perfect arrangement of the surrounding atoms.

Defeitos em cristais cerâmicos



(f)

Figure 4.1 Point defects: (a) vacancy, (b) interstitial atom, (c) small substitutional atom, (d) large substitutional atom, (e) Frenkel defect, (f) Schottky defect. All of these defects disrupt the perfect arrangement of the surrounding atoms.

Cristais não estequiométricos

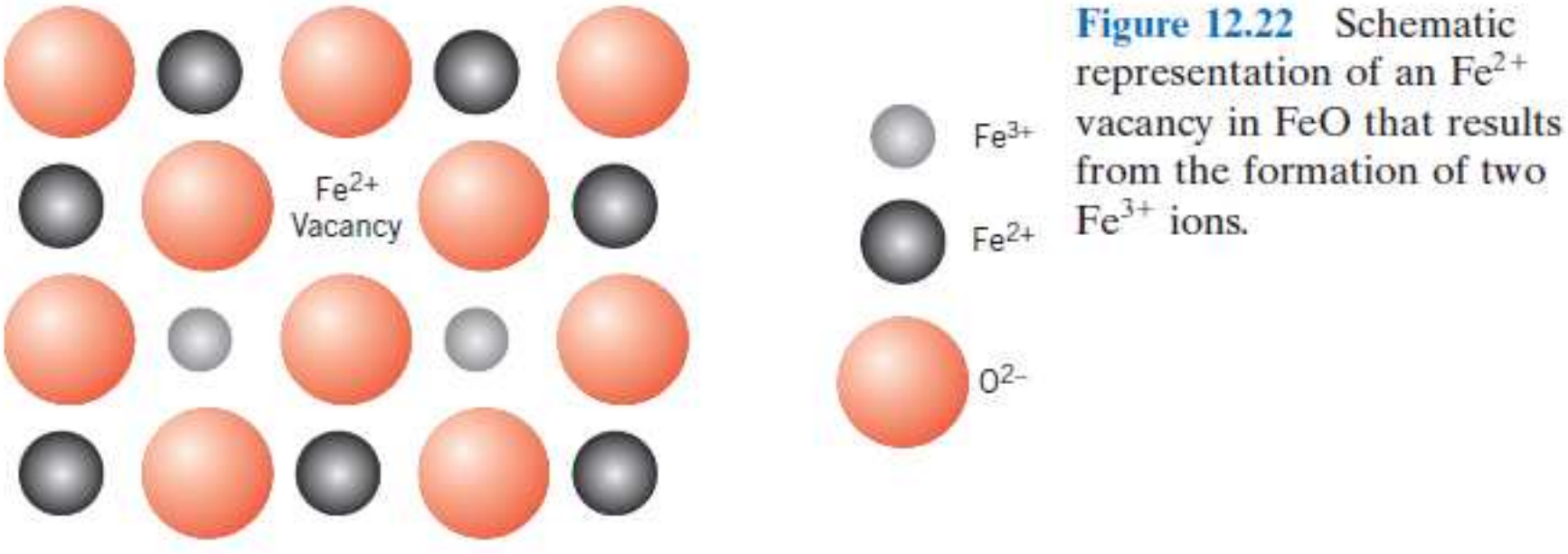


Figure 12.22 Schematic representation of an Fe^{2+} vacancy in FeO that results from the formation of two Fe^{3+} ions.

Sol. Sol. Em Cerâmicas e a formação de vacâncias

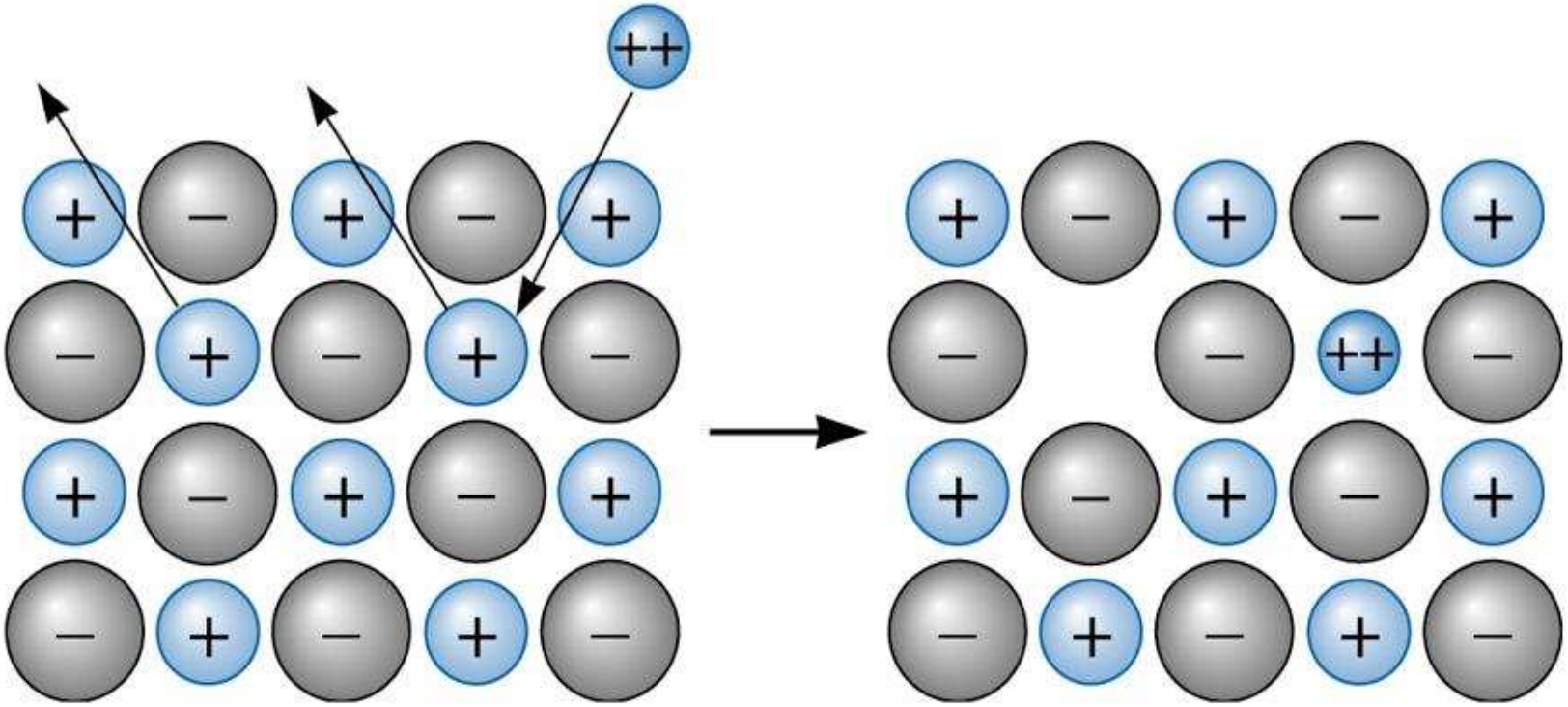
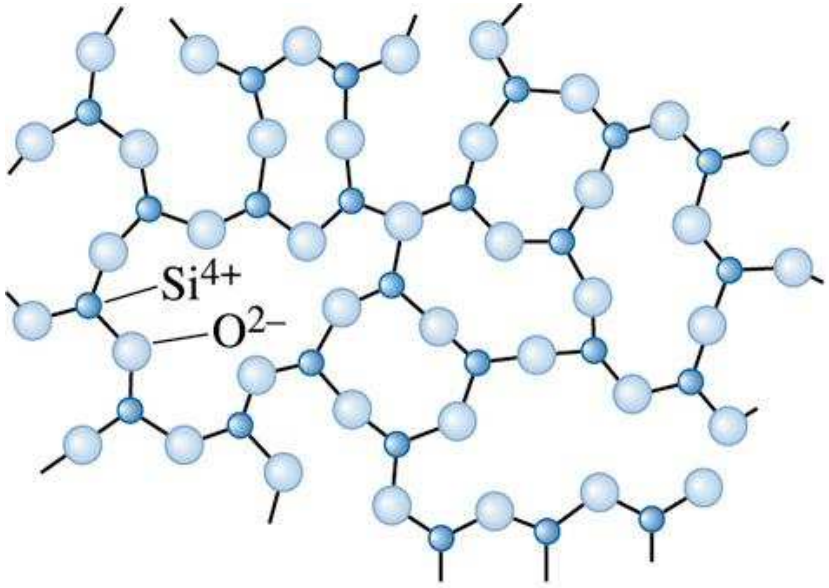
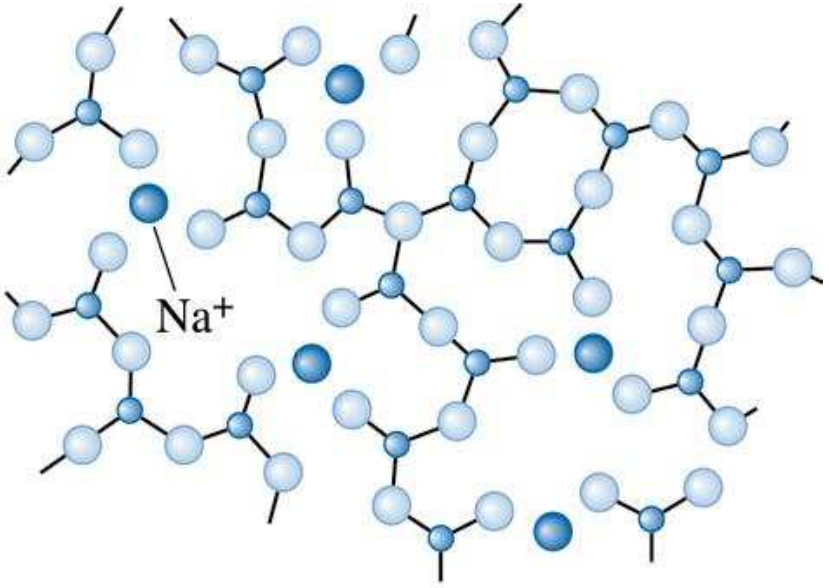


Figure 4.3 When a divalent cation replaces a monovalent cation, a second monovalent cation must also be removed, creating a vacancy.

Estruturas amofas
Vidros de Silicatos



SiO_2 glass



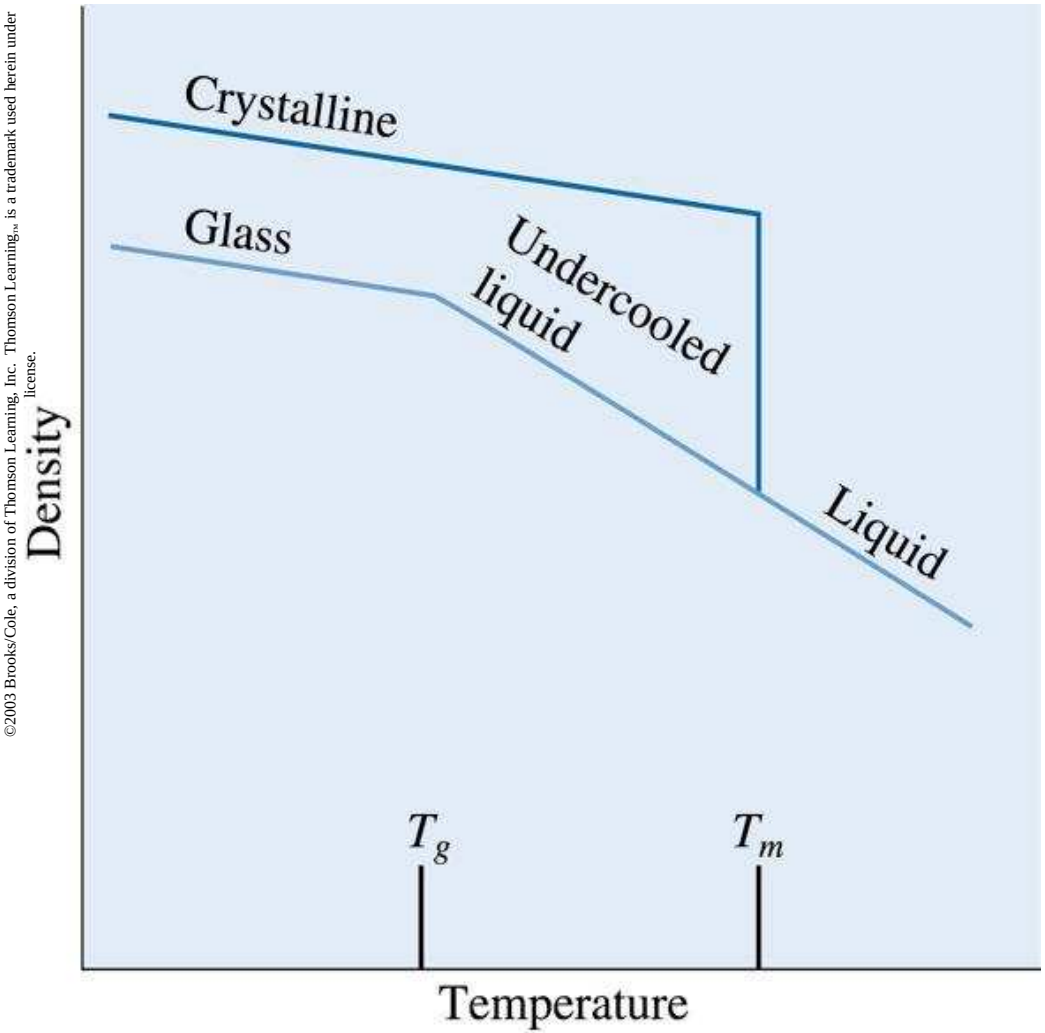
Na_2O modified glass

Formadores e Modificadores

TABLE 14-5 ■ ***Division of the oxides into glass formers, intermediates, and modifiers***

Glass Formers	Intermediates	Modifiers
B_2O_3	TiO_2	Y_2O_3
SiO_2	ZnO	MgO
GeO_2	PbO_2	CaO
P_2O_5	Al_2O_3	PbO
V_2O_3	BeO	Na_2O

Transição Vítrea



Expansão térmica