


ENLACES QUIMICOS

INTRODUCCIÓN A LA INGENIERIA DE
MATERIALES - **2015717 – 1**
PROGRAMA DE INGENIERÍA QUÍMICA
UNIVERSIDAD NACIONAL DE COLOMBIA

PROFESOR: JAIME AGUILAR ARIAS

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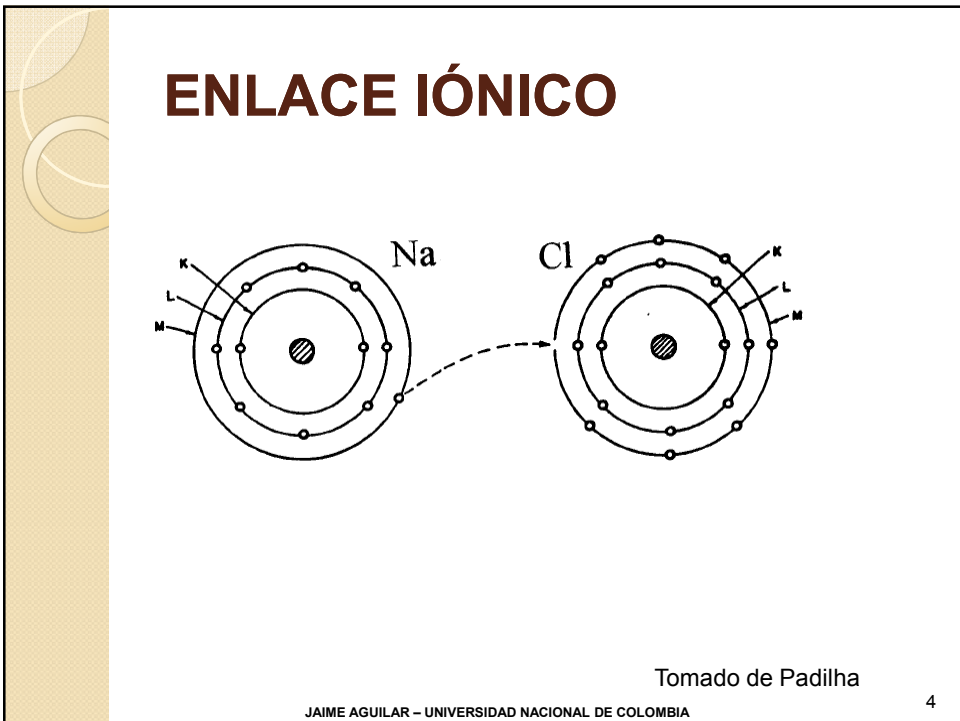
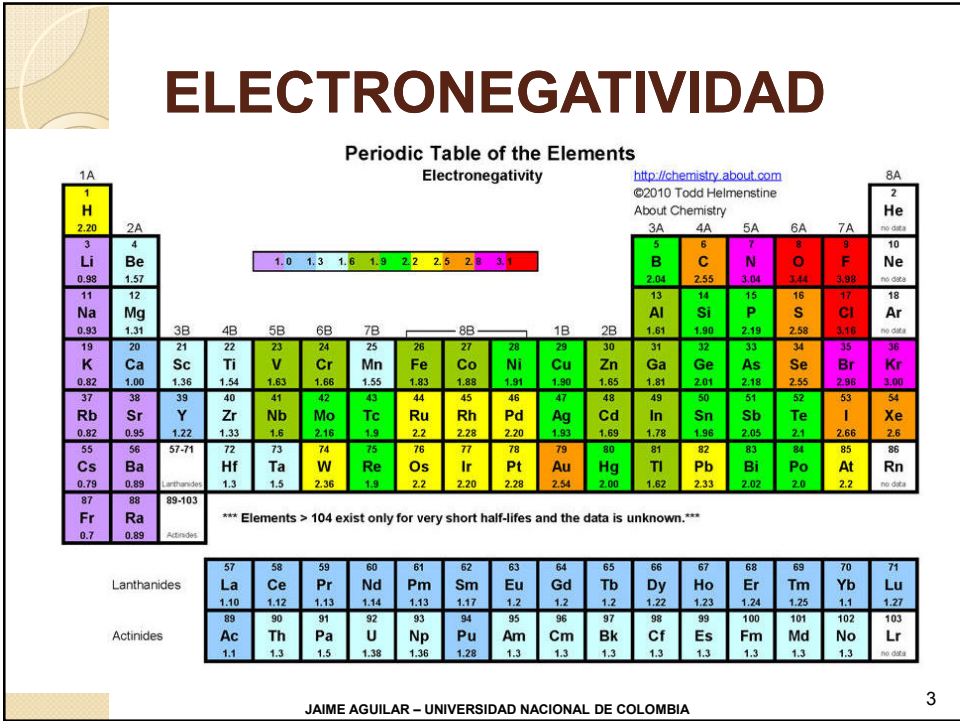


TIPOS DE ENLACES

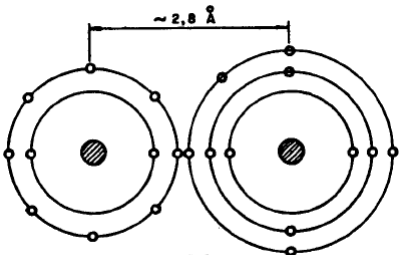
- ENLACES PRIMARIOS
 - IÓNICOS
 - COVALENTES
 - METÁLICOS
- ENLACES SECUNDARIOS
 - PUENTES DE HIDRÓGENO
 - FUERZAS DE DISPERSIÓN

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ENLACE IÓNICO



~ 2,8 Å

NaCl

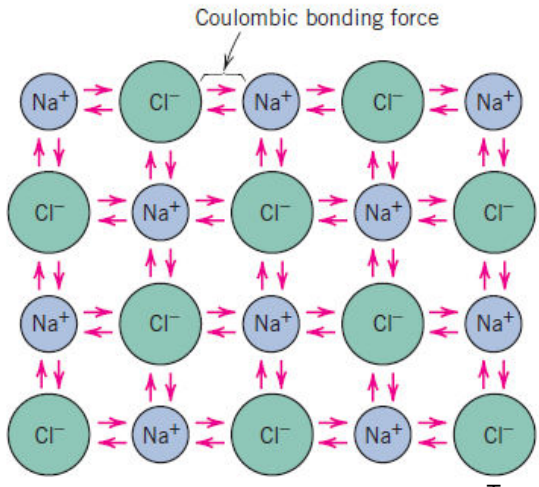
Tomado de Padilha

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Detailed description: The diagram shows two sodium chloride ions. Each ion consists of a central nucleus (represented by a shaded circle) and three concentric electron shells. The outermost shells of the two ions are in contact. A horizontal line with arrows at both ends spans the distance between the centers of the two nuclei, labeled as approximately 2.8 Å. The chemical formula 'NaCl' is centered below the diagram.

ESTRUCTURA ENLACES IÓNICOS



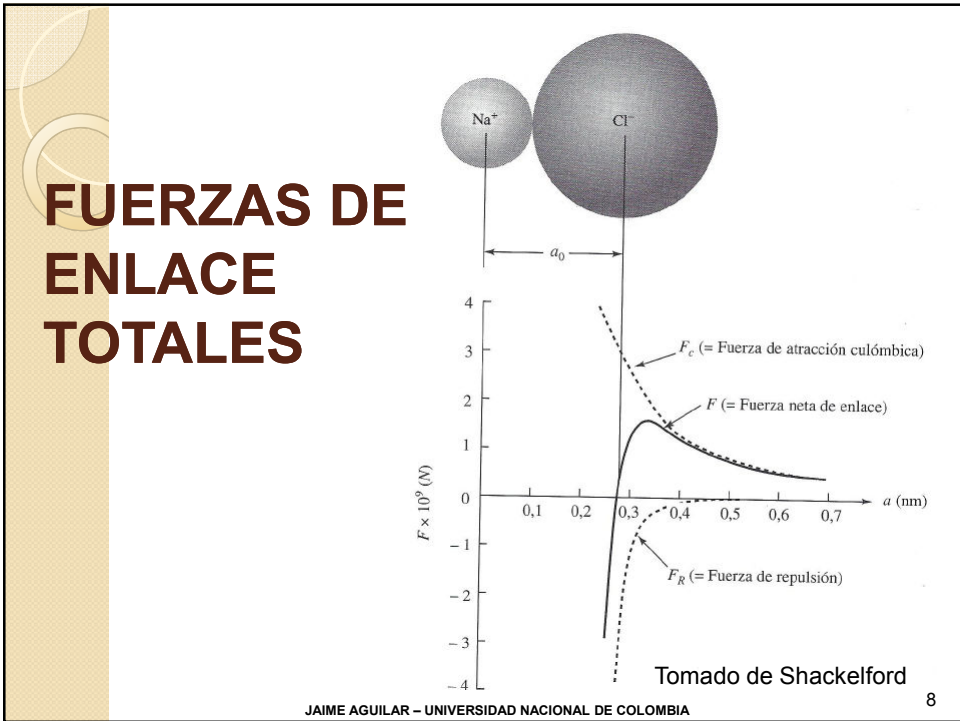
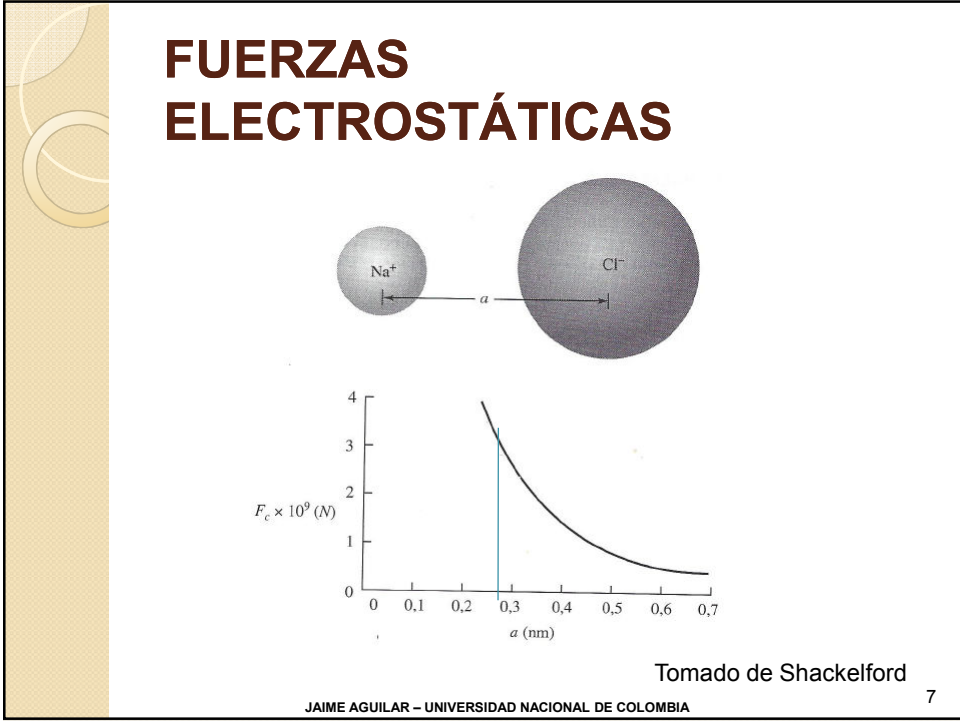
Coulombic bonding force

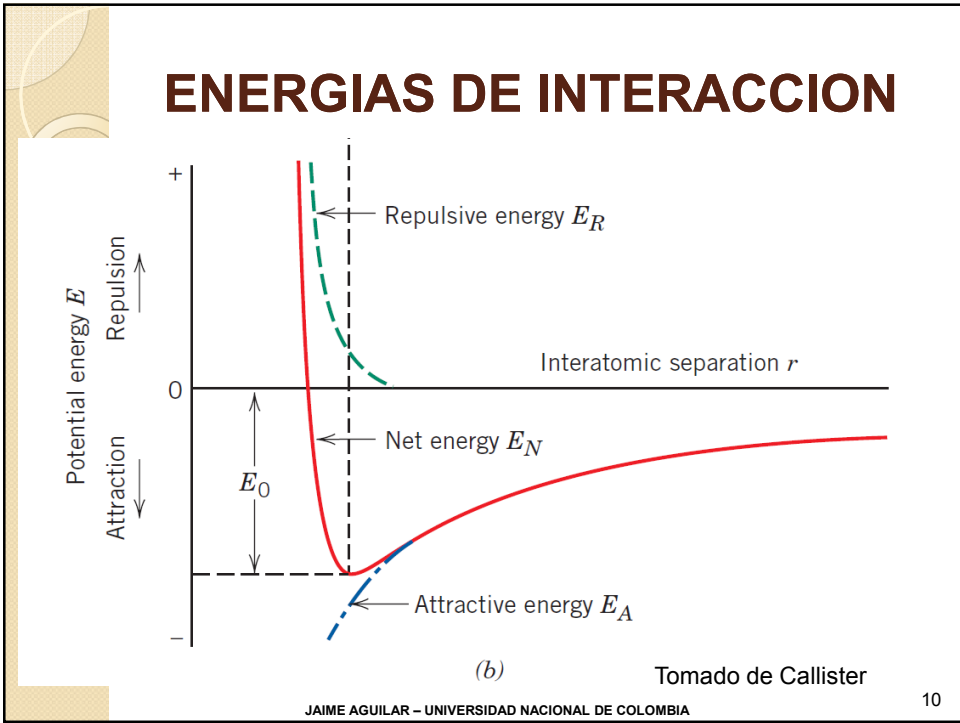
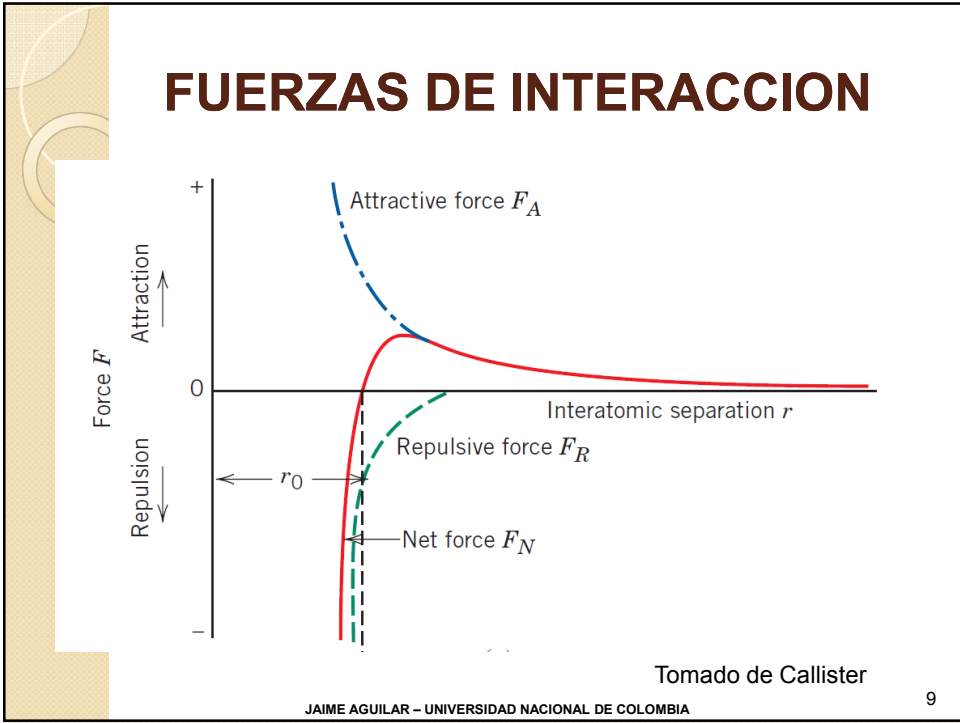
Tomado de Callister

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Detailed description: The diagram illustrates a crystal lattice of sodium chloride. It is a 4x4 grid of ions. Sodium ions (Na+) are represented by blue circles, and chloride ions (Cl-) are represented by green circles. The ions are arranged in an alternating pattern: Na+ in the top-left, Cl- in the top-right, Na+ in the bottom-left, and Cl- in the bottom-right of each pair. Double-headed pink arrows connect adjacent ions in all four directions (horizontal, vertical, and diagonal), representing the Coulombic bonding forces between them. An arrow points from the text 'Coulombic bonding force' to one of these double-headed arrows.





CALCULAR FUERZAS

CALCULAR LA FUERZA DE ATRACCIÓN ENTRE UN ION DE SODIO Y UNO DE CLORO QUE SE ENCUENTRAN A UNA DISTANCIA DE 2.8 Å.

$$F_c = - \frac{k_c (Z_1 q)(Z_2 q)}{r^2}$$

$q = 1.6 \times 10^{-19} \text{ C}$ $k_c = 9 \times 10^9 \frac{\text{V} \cdot \text{m}}{\text{C}}$
 $1 \text{ Å} = 1 \times 10^{-10} \text{ m}$ $1 \text{ nm} = 1 \times 10^{-9} \text{ m}$

$F_c = 2.94 \times 10^{-9} \text{ N}$ $F_r = -2.94 \times 10^{-9} \text{ N}$
 $F_c = 2.94 \times 10^{15} \text{ N/mol}$

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ENLACE IONICO

Forming ionic bond

$r = 0.186 \text{ nm}$ (Na) $r = 0.099 \text{ nm}$ (Cl)
 5.14 eV Ionization energy -3.62 eV Electron affinity
 $r = 0.095 \text{ nm}$ (Na^+) $r = 0.181 \text{ nm}$ (Cl^-)
 .236 nm (bond length)

Energy balance
 5.14 eV Ionization energy
 -3.62 eV Electron affinity
 -6.10 eV Coulomb attraction

 -4.58 eV

But the dissociation energy of NaCl is measured to be -4.26 eV. The difference is +0.32 eV attributed to Pauli repulsion.

Electric potential energy
 $\frac{-k_e q^2}{r} = \frac{-1.44 \text{ eV} \cdot \text{nm}}{0.236 \text{ nm}} = -6.1 \text{ eV}$

Tomado de <http://hyperphysics.phy-astr.gsu.edu/hbase/molecule/boneng.html>

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CARÁCTER IÓNICO

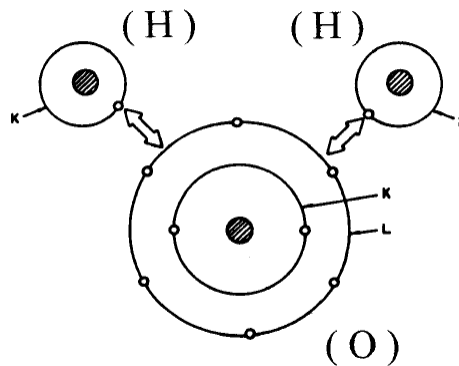
$$\% \text{ ionic character} = \{1 - \exp[-(0.25)(X_A - X_B)^2]\} \times 100$$

Donde X_A es la electronegatividad del más electronegativo, y X_B , la del menos

Ejemplo:

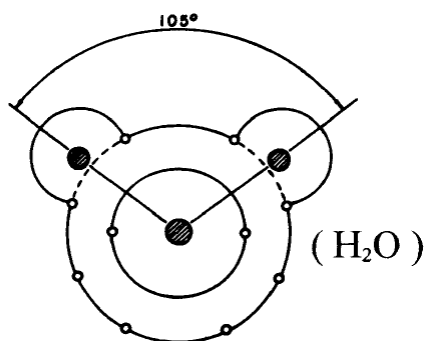
Calcular el carácter iónico de los enlaces para el NaCl.

ENLACE COVALENTE



Tomado de Padilha

ENLACE COVALENTE



Tomado de Padilha

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TABLA 2.2 ENERGÍAS Y LONGITUDES DE ENLACE PARA ENLACES COVALENTES REPRESENTATIVOS

Enlace	Energía de enlace °	
	kJ/mol	
	Longitud del enlace (nm)	
C–C	370 ^b	0,154
C=C	680	0,13
C≡C	890	0,12
C–H	435	0,11
C–N	305	0,15
C–O	360	0,14
C=O	535	0,12
C–F	450	0,14
C–Cl	340	0,18
O–H	500	0,10
O–O	220	0,15
O–Si	375	0,16
N–H	430	0,10
N–O	250	0,12
F–F	160	0,14
H–H	435	0,074

* Valores aproximados, los valores reales dependen de los enlaces adyacentes.

Tomado de Shackelford

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ESTRUCTURAS ENLACES COVALENTES

The diagram illustrates the process of cross-linking in a polymer network. On the left, a tangled network of polymer chains is shown with small dots representing water molecules. Labels 'polymer' and 'water' point to the respective components. An arrow labeled 'physical or chemical cross-linking' points to the right. On the right, the polymer chains are now interconnected by horizontal and vertical lines, forming a more rigid grid. Labels 'cross-link' and 'cross-linked polymer network' point to these connections.

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ENLACE METÁLICO

The diagram shows two sodium (Na) atoms. Each atom has a central nucleus and three concentric electron shells labeled K, L, and M. The outermost shell (M) contains one electron, which is shown being transferred from one atom to another, as indicated by dashed arrows. This illustrates the formation of a metallic bond through the delocalization of valence electrons.

Tomado de Padilha

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ENLACE METÁLICO

~3,9 Å

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ENLACE METÁLICO

Ion cores

Sea of valence electrons

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TABLA 2.3 CALORES DE SUBLIMACIÓN (A 25 °C) DE ALGUNOS METALES Y SUS ÓXIDOS

Metal	Calor de sublimación	Óxido metálico	Calor de sublimación
	kJ/mol		kJ/mol
Al	326		
Cu	338		
Fe	416	FeO	509
Mg	148	MgO	605
Ti	473	TiO- α	597
		TiO ₂ (rutilo)	639

FUENTE: Datos de *JANAF Thermochemical Tables*, 2nd ed., National Standard Reference Data Series, Natl. Bur. Std. (U.S.), 37 (1971), y Suplemento en *J. Phys. Chem. Ref. Data* 4 (1), 1-175 (1975).

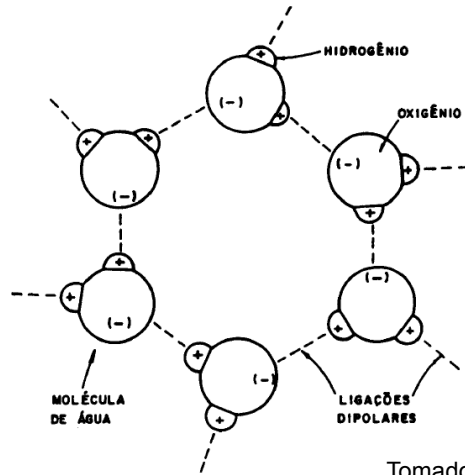
Tomado de Shackelford

Table 2.3 Bonding Energies and Melting Temperatures for Various Substances

Bonding Type	Substance	Bonding Energy		Melting Temperature (°C)
		kJ/mol	eV/Atom, Ion, Molecule	
Ionic	NaCl	640	3.3	801
	MgO	1000	5.2	2800
Covalent	Si	450	4.7	1410
	C (diamond)	713	7.4	>3550
Metallic	Hg	68	0.7	-39
	Al	324	3.4	660
	Fe	406	4.2	1538
	W	849	8.8	3410
van der Waals	Ar	7.7	0.08	-189
	Cl ₂	31	0.32	-101
Hydrogen	NH ₃	35	0.36	-78
	H ₂ O	51	0.52	0

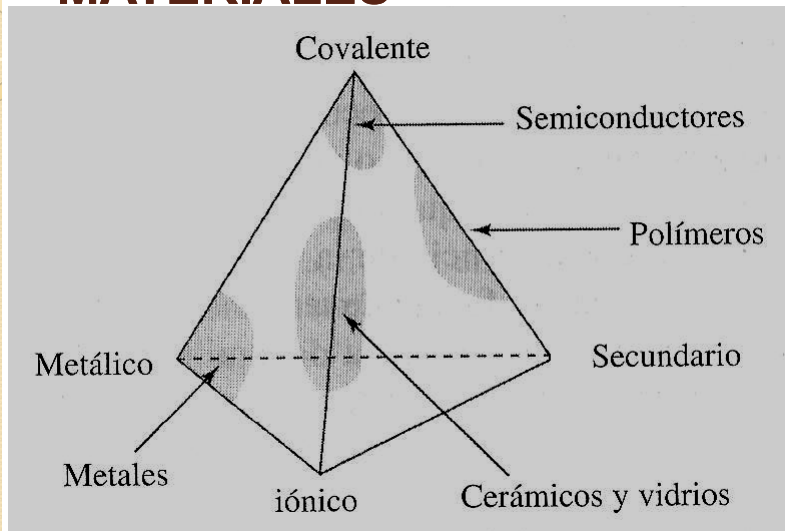
Tomado de Callister

ENLACES SECUNDARIOS PUENTES DE HIDRÓGENO



Tomado de Padilha

ENLACES EN LOS MATERIALES



Tomado de Shackelford