Lecture 2

Tuesday, April 01, 2008
7:32 PM

Review of Last Lecture:

- Chemistry + Thermomechanical Processing --> Microstructure --> Properties --> End Use
- Reviewed atomic structure
- Reviewed the behavior of matter as it cools from ionized plasma to the solid state

  Energies of atom in molecule or solid:

  Quantum Mechanics -- quantized energy levels
  Vibrational Energy
  Angular Momentum
  Rotational Energy

How big is an atom?

	Mass (kg)	Diameter (m)	
Proton	1.67×10^{-27}	1.00×10^{-15}	
Electron	9.11×10^{-31}	1.00×10^{-18}	Actually Unknown
Proton/Electron Ratio	1833		
Hydrogen	1.00794	1.00×10^{-10}	

Diameter of baseball = 3 inches
If the proton in the Hydrogen atom was the size of a baseball:
→ Atom = 300,000 inches = 25,000 feet = 4.735 miles

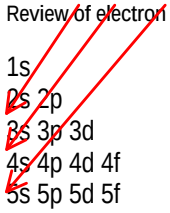
	Atomic Number	Atomic Weight (amu)	Atomic Radius (nm)	Melting Point (°C)	
Hydrogen	1	1.008	--	-259	
Carbon	6	12.011	0.071	3367	sublimes
Oxygen	8	16.00	--	-218.4	
Aluminum	13	26.98	0.143	660.4	
Iron	26	55.85	0.124	1538	
Tungsten	74	183.84	0.137	3410	
Lead	82	207.2	0.175	327	

What is an amu? -- 1/12 the weight of carbon 12.

55.85 amu/atom = 55.85 g/mol

1 mol is 6.023×10^{23}

Review of electron orbitals;



s - spherical shells -- 1 state -- each state holds 2 electrons -- 2 electrons possible
p - two spheres -- 3 states -- each holds 2 electrons -- 6 electrons possible
d - lobes - 5 states -- eac hholds 2 electrons - 10 electrons possible
f - complex - 7 states - each holds 2 electrons - 14 electrons possible

Valence electrons occupy outermost shell
Everything wants to be a noble gas with a full p orbital shell….

Bonding Forces and Energies

Interaction of two atoms with each other is described by the Leonard Jones Potential Function:

Repulsion -- + 12th power term increases as atomic or molecular distance r increases

$U(r) = 4\varepsilon_{LJ} [(\sigma_{LJ}/r)^{12} - (\sigma_{LJ}/r)^{6}]$ Minimum occurs at $-\varepsilon_{LJ}$

Attraction: negative 6th power term produces a decrease in potential energy as r decreases

- Start with two atoms (or molecules) that are "comfortable" distance from each other
- To separate them -- have to overcome the mutual attraction to each other (F_A) -- bonding energy
- To push them together -- have to overcome the mutual repulsion of electronic charges (F_R)
- Settle into a potential energy well

Leonard Jones Values are Tabulated:

Gas	Molecular Diameter (pm)	ε_{LJ}, J x10^{-21}
He	255	0.14
O_2	358	1.59
CH_4	380	1.96

Picometer = 1 x10^{-12} m