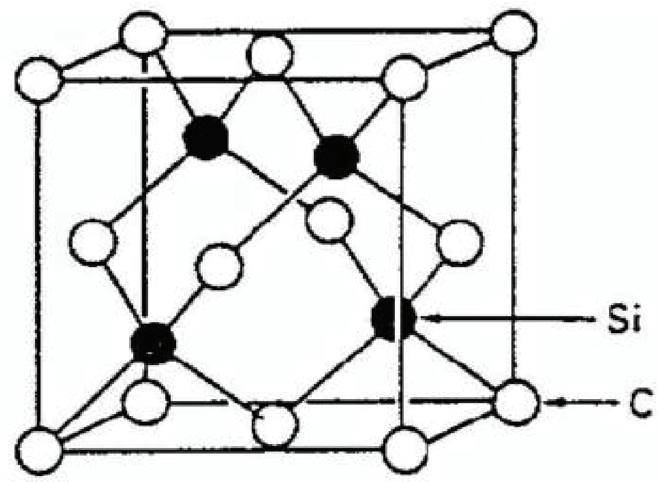
MSE250 – Pre-Exam 2 Discussion Review

10 November, 2011

Before we begin, have the following on the table:
- Homework 7
- Homework 8
- Discussion handout: "Phase Transformations in the Fe-Fe_3C System"

Ceramics



Formula units?

Ex. For AX_2, how many sets of "one A and 2 X's" are in a unit cell?
- do not count whole atoms, but only parts of atoms that lie within the unit cell

Ex. SiC (AX type, tetragonal bonding, zincblende crystal structure)

\# of Si: # of C:

\# of formula units:

Homework 8:

- "physical properties [of amorphous materials] above and below T_g": address viscosity, phase, volume change
- The critical viscosity, $\eta > 10$ Pa·s, only applies in the special/weird case when you are given for materials

Silicate, silica, silicon, silicone

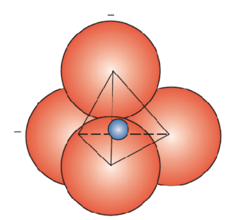


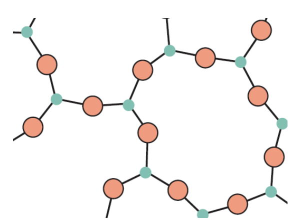
Figure 12.9 A silicon–oxygen (SiO_4^{4-}) tetrahedron.

Silicate: class of materials with building block of SiO_4^-

Silica: a simple type of silicate

Silicon: the element

Silicone: a rubbery polymer



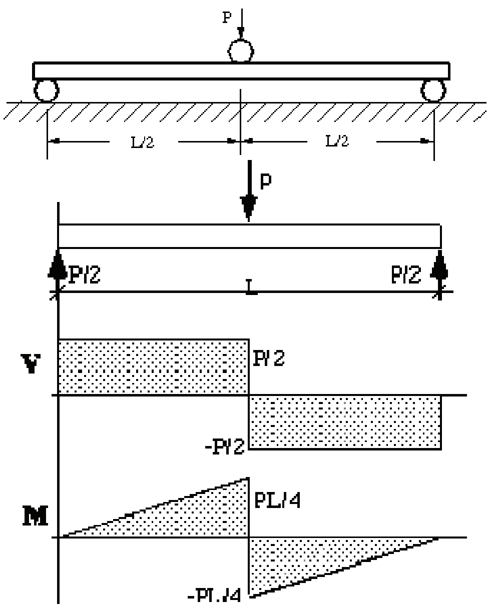
Usage of the word "glass": glass = an amorphous solid

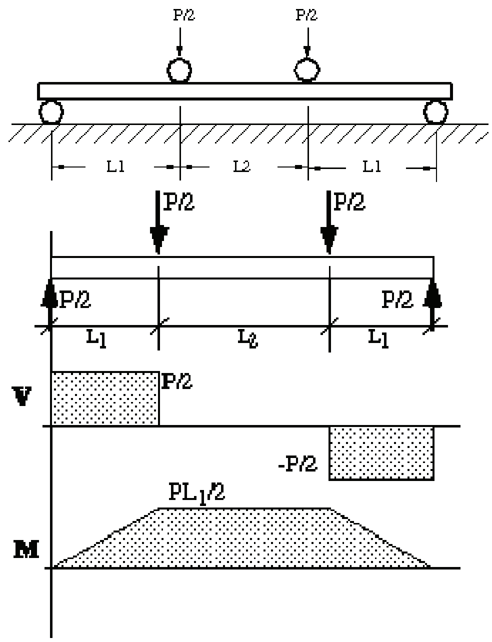
glass = silicon dioxide (silica, SiO_2)

Stress-induced phase transformation

Variation in strengths in ceramics is due to

Why 4-point bend instead of 3-point bending test?





***Why are ceramics brittle?**

Brittleness is

For ionic ceramics,

For covalent ceramics,

Why do ceramics have lower coefficient of friction than metals?

What region of a material would be most susceptible to fatigue failure? Why?

What is the principle behind fatigue strengthening processes? Why is shot peening only used in ductile materials?

<u>ad</u>sorption vs <u>ab</u>sorption [adsorb vs absorb] – ionic ceramics <u>ad</u>sorb molecules to maintain neutrality

Phases

Homework 7 common mistakes:

- TTT diagrams for non-eutectoid compositions
- practical compositions and heating temperatures for precipitation hardening
- log scale
- reading property-wt.%(composition) graphs

Phase, microstructure, or both?

- Bainite (B)
- α (ferrite)
- γ (austenite)
- Proeutectoid
- Fe_3C (cementite)
- Pearlite (P)
- Martensite (M)
- Tempered martensite
- Spheroidite

Compare precipitation hardening to steel tempering

	Synthesis steps/physics	Structure @ each step	Properties @ each step
Precipitation hardening	• • • • •	• • • • •	• • • • •
Steel tempering	• • • • •	• • • • •	• • • • •

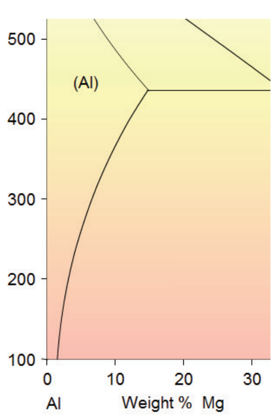
Strength of bainite vs. other steels

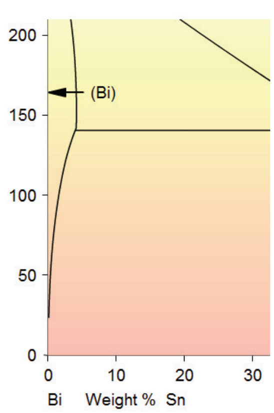
Diffusionless phase transformations:

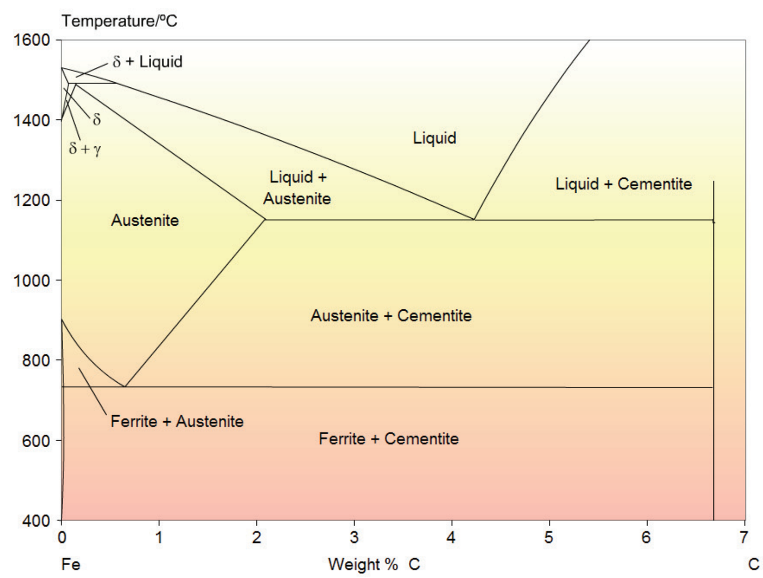
Lowest melting point of steel is C @ the .

Practical temperature/composition choices for precipitation hardening

Phase diagrams obtained from http://www.doitpoms.ac.uk/miclib/







Failure

Not much covered on this exam, just qualitative (the overview contains the questions you'll be asked)

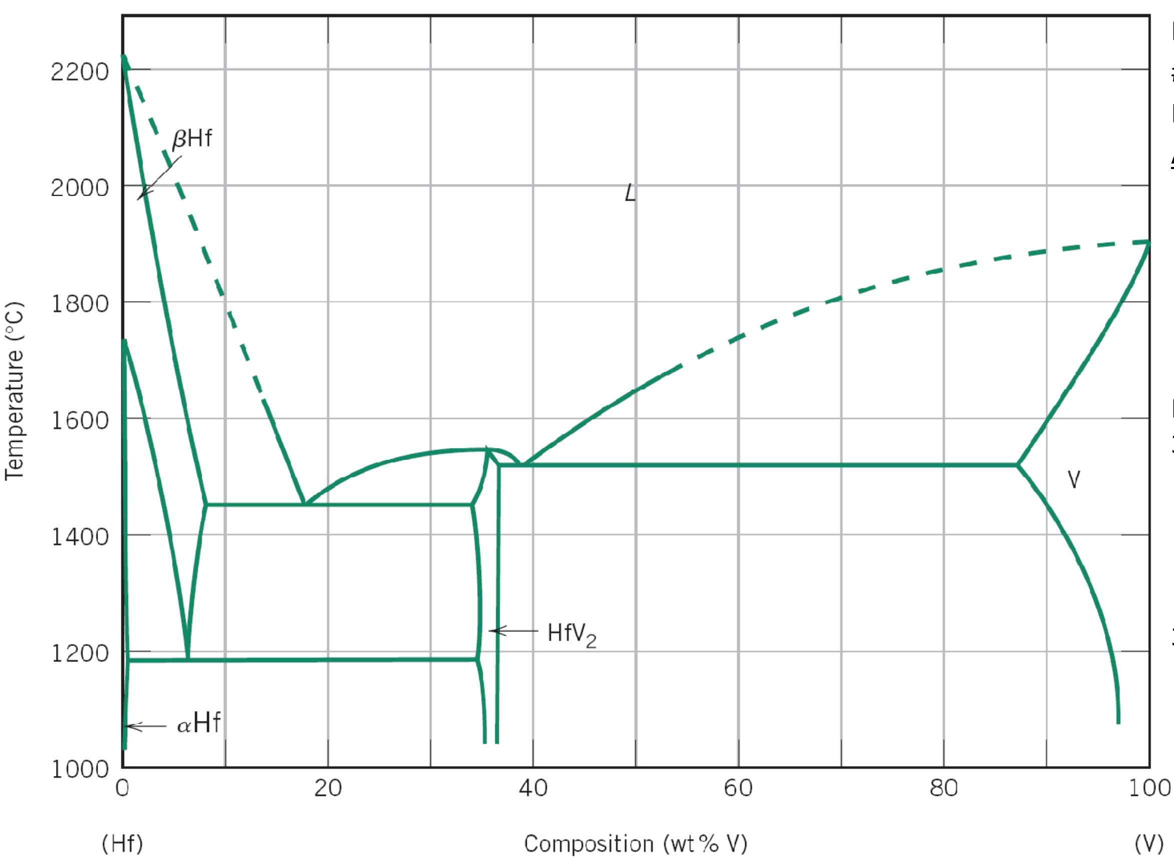
Distinction between K and K_c, K_{Ic}

Property	**Ceramic vs. Metal** vs. Polymer vs. Composite
Yield strength	
Fracture strength	
Hardness	
Wear resistance	
Stiffness (elastic modulus E)	
Toughness (K_{Ic})	
Ductility	
Modulus of resilience	
Electrical resistance	
Thermal conductivity	
Thermal expansion	
Melting point	
Coeff. of friction	
Reactivity	

Ceramics: ↑ porosity ⇒ stiffness, strength, heat conduction

For most materials: ↑ viscosity as T

For motor oil, epoxies, dissolved corn starch: ↑ viscosity as T



# of single phases =

Label all the regions

# of invariant points =

Lowest melting T=

<u>Approximate</u> @20% Hf:

- [phase amount] Largest possible amount of precipitate =
- [phase composition] What T the V phase is made up of 90% V:
- [microst. amount] of eutectic just below 1520C =

Microstructure @ 30% V, 1400C

30% Hf, 1400C