Lecture 9

Tuesday, April 15, 2008
8:29 PM

http://courses.washington.edu/mse170/index.shtml

Course Notes:

1. First Exam is scheduled for next Monday (4/21) -- Cover all material up through Diffusion (end of today)
2. For the exam:
   - I will provide a periodic table
   - You will be allowed to bring a single 4 x 6 Note Card on which you will be allowed to:
     - Write Equations and Constants -- any that you feel might be relevant
     - Only equations and Constants -- we will walk around and check
     - If you have anything else -- you will fail
     - You can write on the front and back of the card
3. Second Homework is due today -- remember it must be submitted on engineering paper for full credit
4. The game ended yesterday

Review:

- Last time we started off talking about dislocations and how they are critical to understanding crystalline slip
  - We talked about screw dislocations
  - We talked about edge dislocations
  - We talked about their geometries and their burger's vectors
  - We talked about how they move
- We then talked about planar defects
  - We talked about surfaces
  - We talked about grain boundaries
    - > We talked about how grain boundaries are the three dimensional interfaces between crystals
    - > We talked about how they are areas of lattice distortion and misfit
    - > And how therefore they are collection points that impurity atoms segregate to
  - We briefly talked about twin boundaries and stacking faults
- We then switched gears entirely and we started talking about diffusion
- We talked about diffusion -- mass transport by atomic motion
- We talked about interdiffusion -- mixing of two different components
- We talked about self diffusion -- which is really just a description of atomic motion within a solid
- We talked about how the driving force for diffusion is concentration gradients
  - How things diffuse from high concentrations to low concentrations
- We talked about the vacancy diffusion mechanism
- We talked about the interstitial diffusion mechanism
- We mentioned a practical application for diffusion control -- case hardening or carburizing gears

Information was extracted from: Porter and Easterling, **Phase Transformations in Metals and Alloys, 2nd Edition,** *CRC Press*, 2004.

Surface energy at the solid liquid interface (AKA: interfacial free energy)

Crystal	T_m (°C)	γ_{sv} (mJ/m²)	γ_b (mJ/m²)	T (°C)	γ_b/γ_{sv}
Sn	232	680	164	223	0.24
Al	660	1080	324	450	0.30
Ag	961	1120	375	950	0.33
Au	1063	1390	378	1000	0.27
Cu	1084	1720	625	925	0.36
γ-Fe	NR	NR	756	1350	0.40
δ-Fe	1536	2080	468	1450	0.23
Pt	1769	2280	660	1300	0.29
W	3407	2650	1080	2000	0.41

Rule of thumb that high angle grain boundary energies γ_b:

$\gamma_b \approx 1/3\ \gamma_{sv}$

Grain boundary surface energies are temperature dependent they decrease with temperature

Random High Angle Grain Boundary:

$\theta > 10\text{-}15^\circ$

Crystal	Coherant Twin Boudary Energy (mJ/m^2)	Incoherant Twin Boundary Energy (mJ/m^2)	Grain Boundary Energy (mJ/m^2)
Cu	21	498	623
Ag	8	126	377
Fe-Cr-Ni (Stainless Steel Type 304)	19	209	835

Rest of Lecture is on PowerPoint presentation that goes with Lecture 9