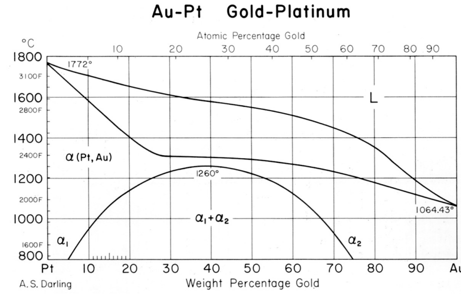
SCI 1410: materials science & solid state chemistry

EXAM FOUR.



INTRODUCTION

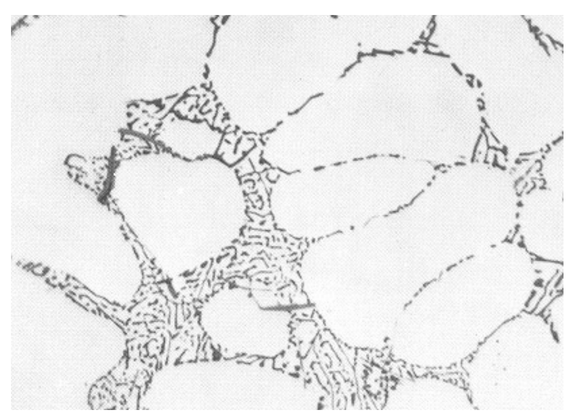
This is an open book, open notes, open web, **team-based** exam. You may work on this as much as you like, and start whenever you like. Complete the exam as a project team.

Submit one exam per project team to me via email (stolk@olin.edu) no later than **11:59 pm on Tuesday, March 10.** Please use Word format or pdf format. You may write your solutions by hand, but please scan and submit these in pdf format if you do so. Estimated time for this problem: 2 hours.

PHASE DIAGRAMS

For this question, you are going to try to predict material microstructures based on a binary phase diagram for one of the alloys you're using in your project. Let's consider the casting process, and forget about forging or rolling for now.

1. First things first: we need a phase diagram. Go forth and find a binary phase diagram for the two primary constituents of one of the alloys you're studying in this project. Your textbook has a few phase diagrams, but you'll likely need to search beyond the textbook. I find that ASM Handbooks Online (available through our library web site) has some good phase diagram information. Or, if you want ***tons*** of information on phases in binary alloy systems, check out T. B. Massalski's *Binary Alloy Phase Diagrams*, a three-volume set of books in the library stacks.
2. Consider the terminal solid solutions in your alloy system (the phases at the extreme right and left ends of the diagram). What are the solubility limits for each of these terminal solid solutions?
3. Select an alloy composition that is relevant for your project work. For example, if you're working with sterling silver, you may want to select Ag with 7.5 wt.% Cu as your alloy composition. Starting at a temperature high enough that your alloy is entirely liquid, select at least five different temperatures at which you'd like to take a closer look at your alloy. Be sure to choose temperatures that you think may help you explain the microstructural changes that occur in your actual project artifacts.
4. Let's get some information off the phase diagram for your binary alloy at the various temperatures. Assume very slow (equilibrium) cooling of your alloy.
   a. What phases exist at each temperature?
   b. What are the compositions of the phases at each temperature?
   c. What are the relative amounts of the phases at each temperature?
   d. What does the microstructure look like at each temperature?
5. Now that we have a bunch of quantitative details on your alloy at different temperatures, let's think about the appearance of the microstructure as your alloy slowly cools. Sketch the microstructure of your alloy at each of your five temperatures.
   a. On each sketch, label the phases present.
   b. On each sketch, label the ***microconstituents***. A microconstituent is defined as a portion of the microstructure that has an identifiable or characteristic appearance. For example, the product of a eutectic reaction is called "eutectic solid", a two-phase microconstituent that may be in the form of layered regions (lamellar eutectic), speckled regions, etc. For a more concrete example, take a look at the figure below. This is a micrograph of an aluminum-silicon alloy, with about 5% silicon. The large, light colored, blobby-looking regions are the aluminum solid solution that forms above the eutectic temperature, in the triangular-shaped α+L region of the phase diagram. The speckled regions are the eutectic solid, which is a two-phase structure of the α and β phases that forms during the eutectic reaction.



6. Here's a preview question for next week's mat sci readings: What mechanical properties would you expect for the various (a) phases and (b) microconstituents that appear in your binary alloy?