

**Department of Materials Science and Engineering  
Massachusetts Institute of Technology  
3.14 Physical Metallurgy – Fall 2009**

**Problem Set #4**

**Due Wednesday, November 25, 2009**

1. On the last PSet we analyzed the effect of various solutes on the solid solution strengthening of aluminum. One aspect of that analysis was to inspect the phase diagram: higher solubilities were helpful for optimizing solid solution strengthening. Now, if we are planning to strengthen the alloy by precipitation strengthening, what aspects of the phase diagram are “desirable”?
2. Following on from Problem 1 above, revisit the Al phase diagrams for all binary systems, as you did for the last PSet. Based on your answer to Problem 1, make a short list of likely choices (pick 3 or 4) that you think would be especially efficacious for precipitation strengthening of aluminum. (Restrict your discussion to things that the phase diagram tells you- don't worry about surface energy, modulus, etc.).
3. Following on from Problem 2 above, for each of the three or four prime candidates you selected, specify a particular composition that you would propose to use.
4. An alloy of composition Mg-20Al (atomic %) is melted, cast, and slowly cooled to 400° C. It is then quenched to room temperature, and reheated to 200° C, and allowed to reach an equilibrium fraction of  $\alpha$  and intermetallic  $\gamma$  phase. It is finally quenched again.

What does the structure look like after all this history? Draw a picture of it and label it carefully. It might help to draw several different pictures at different points in the history in order to work through the details.

5. For the alloy described above in Problem 4, list all of the microstructural sources of strengthening as compared to pure magnesium.

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