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

Problem Set #3

Due Monday, November 9, 2009

You would like to solid-solution strengthen aluminum. You have the entire periodic table at your disposal! Let's calculate which elements are viable as interstitial strengtheners.

1. Although the whole periodic table may be available to you, there may not be thermodynamic data for all choices. Start by collecting together all the phase diagrams for binary Al-X alloys. (Hint: If you use VERA, you can find the "ASM Handbooks" online; these have all the phase diagrams.) Make a list of all the candidate elements that have binary phase diagrams with aluminum.

2. Based ONLY on the phase diagrams, which elements are your best hope for solid solution strengthening? For this problem, DO NOT consider the stress field or modulus effects; only consider the phase diagram! (Hint: what does a phase diagram tell us about the solid solution phase of FCC Al?)

3. For all of the candidate elements in Problem 1, evaluate the modulus effect; which elements have the strongest interactions with dislocations on this basis? (Yes, you may have to look up moduli)

4. For all of the candidate elements in Problem 1, evaluate the stress field effect; which elements have the strongest interactions with dislocations on this basis? (Yes, you may have to look up metallic radii)

5. Finally, based on the above three questions, select your favorite choice for strengthening aluminum by solid solution strengthening. Explain briefly why it is a good choice relative to all others in the periodic table.

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