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

Problem Set #2

Due Monday, October 19, 2009

1. In class we discussed the twinning of HCP crystals, and explained why Mg twins in compression but does not do so in tension. Perform the same exercise for Zn, and convince yourself that in a polycrystal with randomly oriented grains, Zn will twin in tension but not in compression.

2. At the ideal c/a ratio achieved for close-packed HCP hard spheres, will twinning occur in compression or tension? Explain your thought process.

3. An HCP metal with ideal c/a ratio is loaded in tension on the $[\bar{2}111]$ axis. If this metal can only slip on the basal plane, which slip system operates first? Explain how you arrived at your answer.

4. For FCC crystals the twinning system is (111), $[11\bar{2}]$. In other words, K1 = (111). If K2 = $(11\bar{1})$ is the second undistorted plane, calculate the twinning shear strain.

5. For an FCC crystal loaded in tension, what is the largest possible rotation angle that the crystal can sustain during single slip?

6. Two identical pieces of an unknown pure metal are given to you in an annealed state. You deform both of them in the same way, and they become work hardened. Then, you take the first of the two samples and anneal it, for 1 hour at 1000º C. You find that the strength has dropped by a factor of two as a result of the anneal. With the second sample, you anneal at a slightly higher temperature, say, 1015º C, and you find that it takes only half as long to reduce the strength by a factor of two! Based on this data, infer what the unknown metal must (or may) be. (Hint: you will need some diffusion data for this one- I recommend the Smithell's Metals Reference Book in the library).

7. Look up the melting point of the metal you identified for problem 4. In light of the melting point, does the recovery data given make sense? Explain.

3.40J / 22.71J / 3.14 Physical Metallurgy

Fall 2009