22.14 Problem Set 4, Oral Exam, Spring 2015

March 24, 2015

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1) Dislocation Movement: *Dislocation cross slip* is a process whereby a moving screw dislocation can "jump" from one slip system to another, provided that the dislocation gets pinned (stuck) on its original slip plane, and the applied strain is high enough. This means that if a dislocation encounters a barrier on one slip plane, it may move to another slip plane to overcome this barrier.

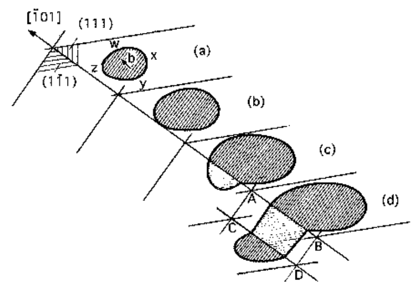

Figure 1: Diagram of dislocation cross slip

Assume that a dislocation is moving in the (111) plane in an FCC system, and that a *pure shear stress* of magnitude τ is applied on the $(111)[10\bar{1}]$ slip system. The dislocation encounters a barrier, and cross-slips onto the $(1\bar{1}1)$ system. Calculate the extra factor of shear stress required to move the dislocation from the (111) plane onto the $(1\bar{1}1)$ plane. In other words, how strong does this barrier to dislocation movement have to be?

2) Stress, Strain, and Crystallinity: Draw side-by-side stress-strain diagrams for a single-crystal and a polycrystalline FCC material, pointing out the origins of each relevant feature of the diagrams. Repeat for a single-crystal and a polycrystalline triclinic material. Explain why the curves for the two crystal systems (FCC and triclinic) appear similar or different, in both the single-crystal and polycrystalline cases.

Useful Formulas and Diagrams

Angles Between Crystals

$$cos\left(\theta\right) = \frac{h_1 h_2 + k_1 k_2 + l_1 l_2}{\sqrt{h_1^2 + k_1^2 + l_1^2}\sqrt{h_2^2 + k_2^2 + l_2^2}}$$

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