Department of Materials Science and Engineering
Massachusetts Institute of Technology
3.14 Physical Metallurgy – Fall 2003

Problem Set #2

Due Wednesday, September 17, 2003

2.1 Draw an (0001) stereographic projection for a hexagonal crystal including the following families of planes and directions:

$<0001>$ $<10\bar{1}0>$ $<11\bar{2}0>$ $<11\bar{2}2>$
$\{0001\}$ $\{10\bar{1}0\}$ $\{11\bar{2}0\}$

2.2 How do the details of the stereographic projection you've just drawn change with the c/a ratio?

2.3 Exercise 4.10

2.4 Equations 4.9 are the stress field equations of an edge dislocation, in Cartesian coordinates. Simplify the equations so that they can be expressed in terms of r and θ. On two separate graphs, plot the contours of constant stress around the edge dislocation (one graph for each of σ_{xx} and σ_{yy}). Plot the stress in units of μ, the distance in units of **b**, and use $\nu = 1/3$. Comment on the shape of the stress field and how far it extends into the crystal.

2.5 Assume that in a material with highly directional bonds, dislocation loops are confined to be composed of straight segments; loops are rectangular.

(a) Draw a dislocation loop and assign it a Burger's vector. Label the edge and screw components of the dislocation line.
(b) Explain why this dislocation loop would not form a perfect square.
(c) If this dislocation loop is allowed to come to equilibrium while maintaining constant area, calculate the aspect ratio of the equilibrium dislocation loop.
(d) In real materials, the restriction on this problem is not related to the area of the loop. What might be a more realistic formulation for this problem?

2.6 In this problem, you will calculate the equilibrium separation of partial dislocation that create a stacking fault. Assume that the components X1 and Y1 of the partials are screw and X2 and Y2 are edge (see the figure below). Consider the dislocation force as that due to repulsion between the edge components and attraction between the screw ones. As the partials separate, the energy increase by SFE*d, where SFE is the stacking fault energy and d is the fault separation distance. Thus, the "chemical" force resisting separation is SFE (dimensions of joules per square meter or force per unit length). Determine the equilibrium separation of the partials in terms of SFE and material properties.

Problem 2.6 continued: