Aufgabe 11-1: characteristics of dislocations

a) For each of edge, screws, and mixed dislocations, how is the relationship between the direction of the applied shear stress and the direction of dislocation line motion.

b) There is a dislocation lying along $[\bar{1}01]$ in a fcc crystal. Its Burgers vector is $\frac{a}{2}[0\bar{1}1]$. What type of dislocation is it? Determine its slip plane.

Aufgabe 11-2: forces between dislocations

The force experienced by a dislocation due to another at a distance x on the slip plane may be given by:

$$F = \frac{\mu b^2}{2\pi(1-\nu)x}$$

where μ is the shear modulus of the material, b is the Burgers vector. The poisson ratio $\nu \approx 0.3$ for most crystals.
Polycrystalline aluminum with average grain size of 10 μm is subjected to shear stress of 50 MPa. If a dislocation source located at the center of a grain emits dislocations which pile up at the boundary what is the stress, it would experience? ($\mu_{Al} = 70\ GPa$, and b = 0.3 nm).

Aufgabe 11-3 : low-angle grain boundary

The misorientation at the boundary is related to spacing between dislocations, D, by the following relation:

$$D = \frac{b}{2\sin\left(\frac{\theta}{2}\right)} \approx \frac{b}{\theta} \quad \text{(for very small } \theta\text{)}$$

where b is the Burgers vector.

a) Estimate the distance between dislocations in a tilt boundary of aluminum if the misorientation angle is 5^o. (Al has fcc crystal structure with a lattice parameter of a= 0.405 nm)

A more precise expression for energy of low angle grain boundary over range of 0 $< \theta < 10°$ may be given by:

$$E = \frac{\mu b}{4\pi(1-\upsilon)}\theta(A - ln\theta)$$

where A is a constant.

b) Estimate the energy of low angle boundary in aluminum crystal. (A = -1.42)

c) Estimate the dislocation spacing and energy of a low angle boundary in copper crystal with fcc structure when tilt angle = 5^{o}. ($\mu_{Cu} = 48\ GPa$, and b = 0.25 nm).