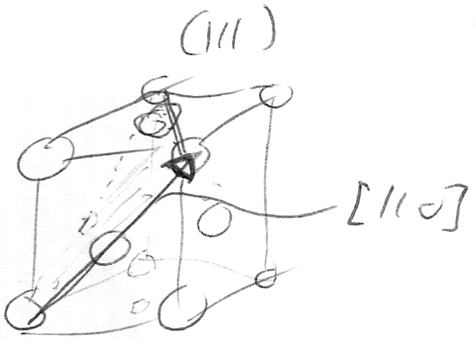
1) a)



b) This is the slip system for FCC.

c) We can calculate the yield stress for motion of an entire plane of atoms

$$\tau \sim \frac{G}{2\pi} \sim 3-30\ GPa$$

& this is 100 to 1000 times the observed yield stress

d)

Compression

The interstitial atom will tend to locate at the dislocation to relieve the tension. This makes motion of the dislocation more difficult

This leads to a larger yield stress & a harder material; e.g. steel vs. iron when the impurity is carbon in steel.

e) Point defects

Vacancy

Interstitial Atom (Carbon in Steel)

Substitutional Atom (Zn in Cu)
(Small or Large)

Frenkel Defect

Schottky defect

Screw Dislocation

Edge Dislocation

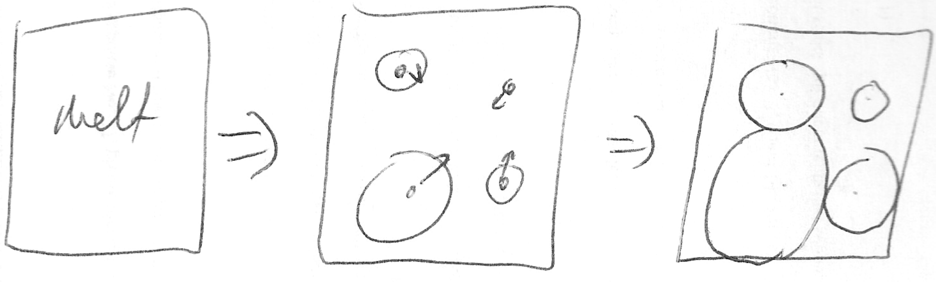
Mixed Dislocation

Twining Surface defect

Grain Boundary

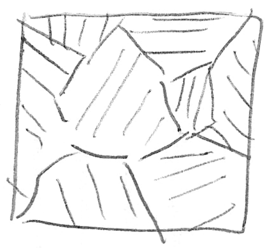
Small angle or Large angle

2) a) Grains are single crystals in a polycrystalline sample. They form due to nucleation of different crystals during crystallization.



Nucleation

impinging crystals/grains



Grain sketch (Lines show different crystallographic orientation)

b) Hall-Petch Relationship

$$\sigma_{yield} = \underbrace{\sigma_i}_{\text{No grains}} + \frac{K}{D^{1/2}}$$

$D = \langle$grain diameter$\rangle$

c) (i) each dot represent one grain in the x-ray beam. ~20 grains in a 20 μm beam so the grains are on the order of 3 μm in diameter.

(ii) Large Grains give rise to streaks due to residual stress in grains

(iii) Large Grains showing Orientation of the crystals.

d) Motion of disclinations stop at the grain boundary.

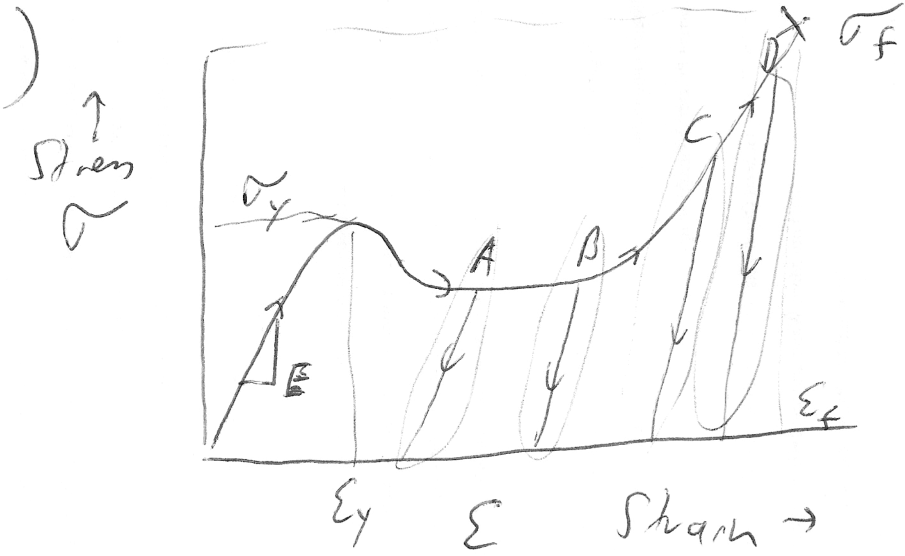
e) A plane separates 2 twins. In FCC we have stacks of A B C A B C in the [111] direction. A twin would occur if there were a stacking fault. A B C A B A B C A B C

Twin Plane

5

Other crystal systems can display twins.

3) a)



b) Modulus increases with strain harden
(E slope of σ vs ε)
Yield Stress increases

c) $\tau = \tau_0 + G \alpha b \rho_\perp^{1/2}$

No Dislocation

dislocation density
(wiki Work Hardening)

d)e) see wiki page on strain hardening