FACTORS AFECTING SLIP IN METALS

1. CRAYSTAL STRUCTURE

Through Schmid's Law comparison of properties of different structures can be made. Properties are τ_{crss}, Number of slip systems, Cross-slip Behavior (brittle or ductile).

τ_{crss} – Critical Resolved Shear stress.

If τ_{crss} is very high ( ) then σ must be high to produce high τ_R for slip to occur.

[FCC have low τ_{crss} — 0.35 MPa to 0.7 MPa
in FCC — ~~low strong~~ (slip) ✓ weak
[BCC — (no close packed planes)
τ_{crss} — high — 70 MPa (strong for slip)

HCP — close packed planes present
so low strength $\tau_{crss} \simeq$ 0.35 MP – 0.7 MPa

Zinc; (HCP) $\frac{c}{a} = \frac{4.9470\,A^\circ}{2.6648\,A^\circ} = 1.856$ ✓

Titanium; $\frac{c}{a} = \frac{4.6831\,A^\circ}{2.9503\,A^\circ} = 1.587$ ✓ $\frac{c}{a} > 1.633$ slip is expected

Zirconium; $\frac{c}{a} = \frac{5.1477}{3.2312} = 1.593$ ✓

Number of Slip Systems

If we ~~can~~ can orient λ or ϕ 45^0 then τ_{crss} is low.

HCP is brittle because λ, ϕ become 45^0

Cross - Slip

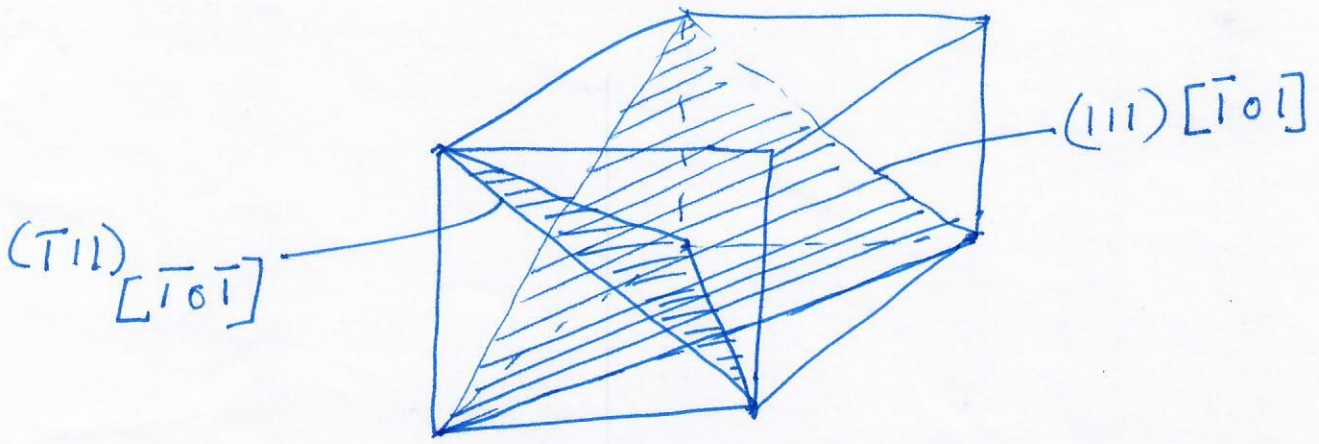
If slip jumps from one slip plane to another slip plane it is called cross-slip.

In HCP, all slip planes are parallel so no cross-slip is possible.

∴ HCP — are brittle.

If HCP is alloyed then it becomes ductile because more slip planes are available.

Factor	FCC	BCC	HCP
τ_{crss}	0.35 - 0.7 MPa	35 - 70 MPa	0.35 - 0.7 MPa
No. of slip systems	12	48	3
Cross - slip	Can occur	Can occur	Can occur
Property	Ductile	Strong	Brittle



Cross-slip of a dislocation from a (1$\bar{1}$1)[$\bar{1}$0$\bar{1}$] slip system to a (111)[$\bar{1}$01] system in an FCC crystal.

Surface Defects

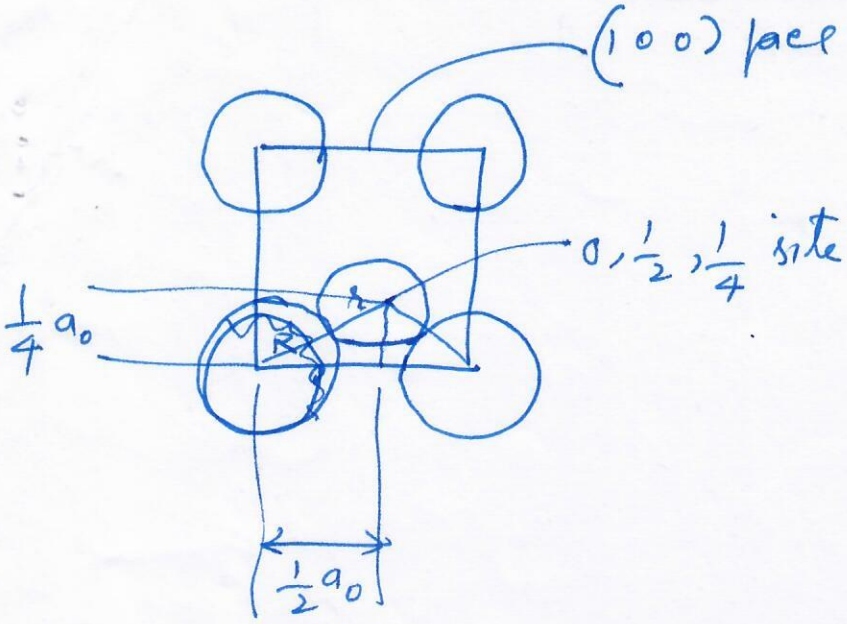
Surface Defects are the boundaries, or planes that separate a material into regions, each region having the same crystal structure but different orientations.

Material Surface

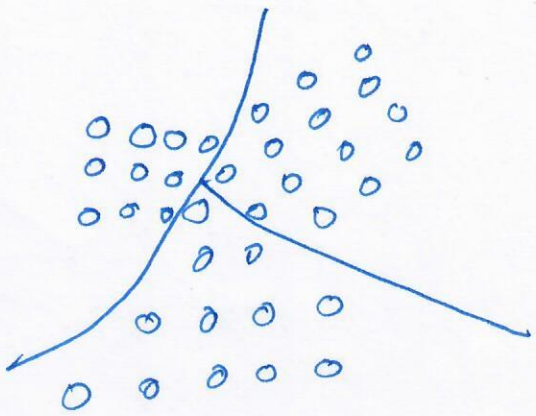
Surface at which lattice abruptly ends

Grain Boundary

A grain is a portion of the material within which the arrangement of atoms is



The location of the $0, \frac{1}{2}, \frac{1}{4}$, interstitial site in BCC metals, showing the arrangement of the normal atoms and the interstitial atom.



The atoms near the boundaries of the ~~Three regions~~ grains do not have an equilibrium spacing or arrangement.

$\sigma_y = \sigma_0 + K d^{-1/2}$] Hall-Petch Equation

$\sigma_y \rightarrow$ yield strength

d — Average dia of grain

σ_0, K are constants

d increases

σ_y — decreases.