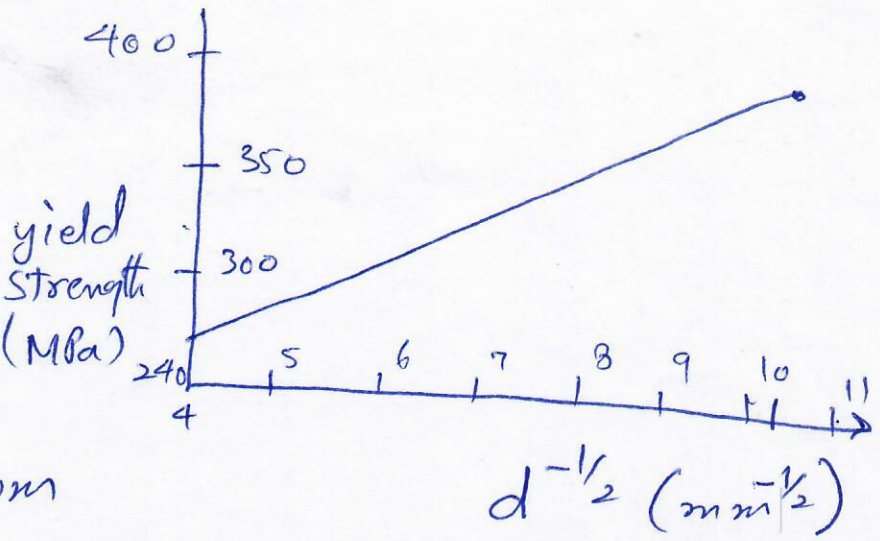
4. 5. 2012

The effects of grain size on the yield strength of steel at room temperature.



Specifications of Grain Size

SI — Standard International System

ASTM — American Society for Testing and Materials

Grain Size is determined from

ASTM
- $N = 2^{n-1}$
- $N \longrightarrow$ Number of grains per square inch at 100 times magnification.
- $n \longrightarrow$ grain size no.

S.I.
- $N = 2^{n+3}$
- $N \longrightarrow$ Number of grains per square millimetre
- $n \longrightarrow$ grain size number

Standard Grain size Number	Average grains per square millimeter	Average grains per square inch at 100x
1	16	1
5	256	16
7	1024	64
8	2048	128

* A large grain size number indicates many grains, or a fine grain size and correlates with high strengths.

EXAMPLE

Suppose we count 16 grains per square inch at magnification x100 in a photomicrograph. Determine the ASTM grain size number.

Sol.

$$N = 16 = 2^{n-1}$$

$$\log 16 = (n-1)\log 2$$

$$1.204 = (n-1)(0.301)$$

$$\boxed{n = 5}$$

EXAMPLE IX

If we count 16 grains per square inch at magnification ×250, we must have at magnification ×100. what is ASTM grain size number?

Sol For 16 grains per square inch at magnification ×250, we must have at magnification ×100

$$N = \left(\frac{250}{100}\right)^2 (16) = 100 = 2^{n-1}$$

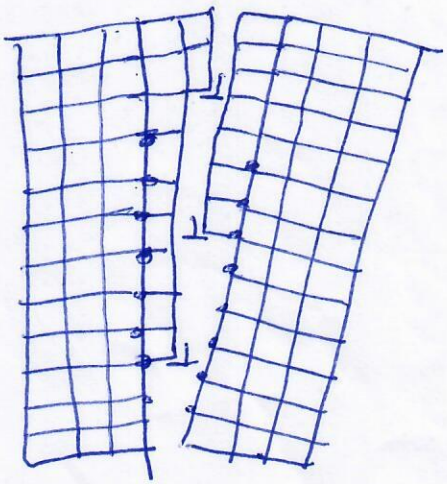
$$\log 100 = (n-1)\log 2$$

$$2 = (n-1)(0.301)$$

$$n = 7.64$$

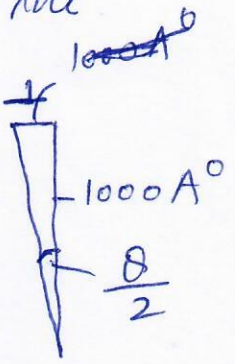
The Small Angle Grain Boundaries

The small angle grain boundary is produced by an array of dislocations, causing an



EXAMPLE

Determine the angle θ across a small angle grain boundary in copper when the dislocations in the boundary are 1000 A^0 apart.



Sol.

The grains are tilted one Burgers vector in each direction every 1000 A^0. The Burgers vector in FCC copper is [110], so the length of the Burgers vector is the repeat distance in the [110] direction, or d_{110}.

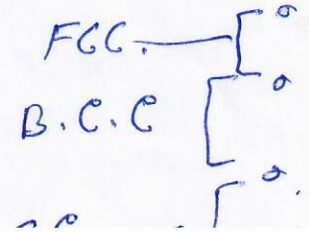
$$d_{110} = \frac{a_0}{\sqrt{h^2+k^2+l^2}} = \frac{3.615}{\sqrt{2}} = 2.557 A^0$$

$$\sin\frac{\theta}{2} = \frac{2.557}{1000} = 0.00255 \quad , \theta = 0.293^0$$

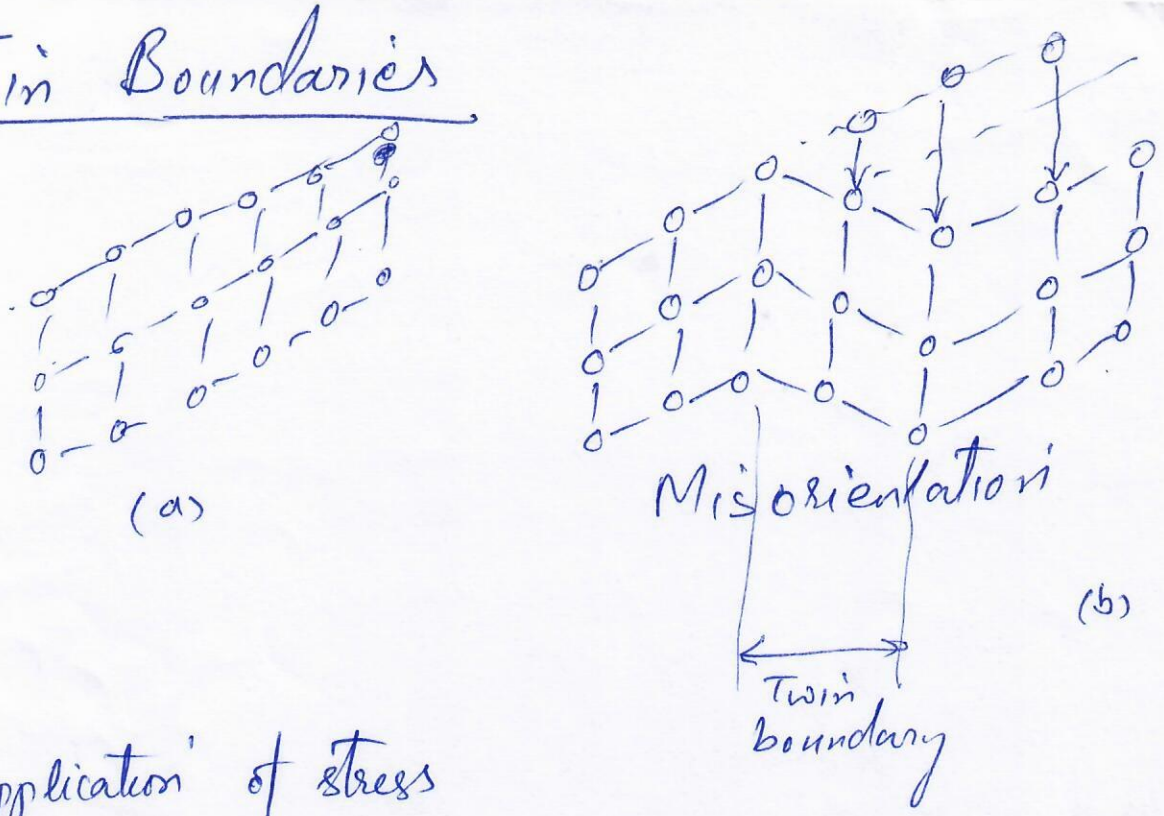
Stacking Faults

If in the structure stacks are not same structure, then fault is called stacking fault.

Stacking faults interfere with the slip process.



Twin Boundaries



Application of stress to the perfect crystal (a) may cause a displacement to the atoms (b), causing the formation of a twin. Note that the crystal has deformed as a result of twinning.

A twin boundary is a plane across which there is a special mirror image misorientation of the lattice structure. Twins can be produced when a shear force, acting along the twin boundary, causes the atoms to shift our positions.

Energies of Surface imperfections in selected metals

Surface Imperfections mJ/m^2	Al	Cu	Pt
Stacking fault energy	200	75	95
Energy		45	195