

Group Activity

2D Defects in Crystalline Solids

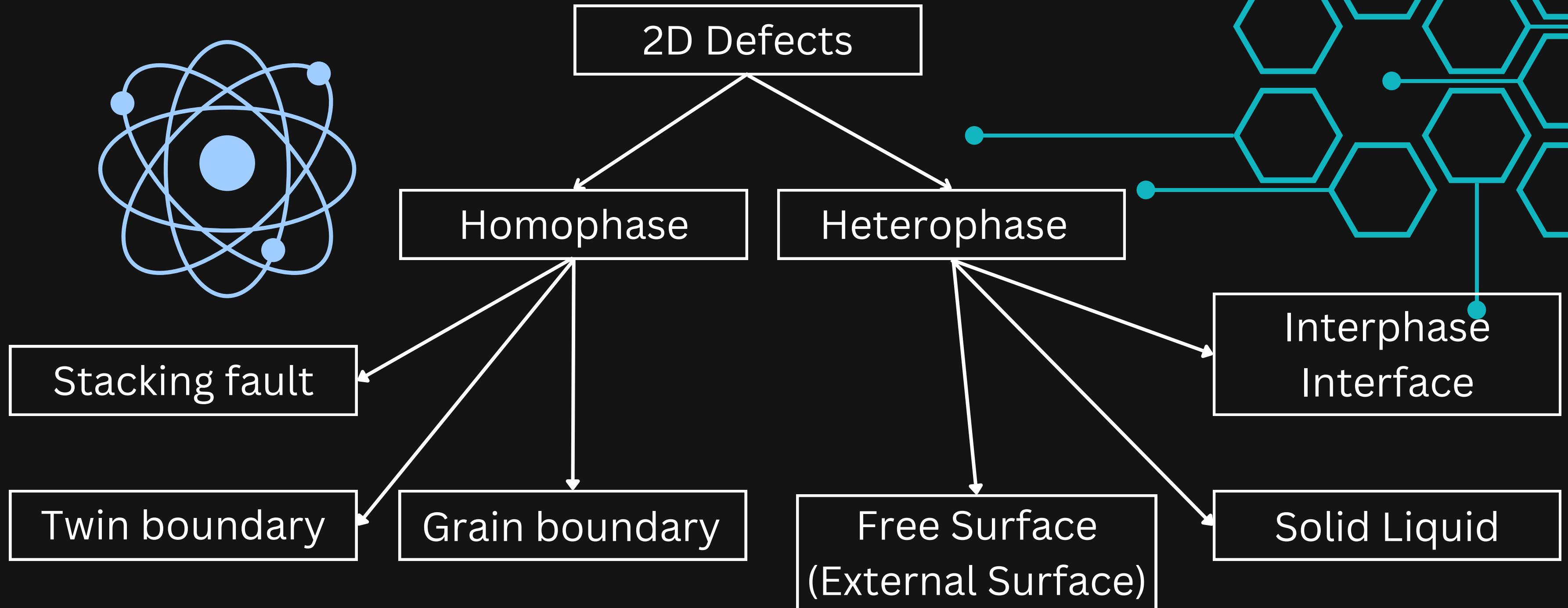


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Classification of 2D Defects





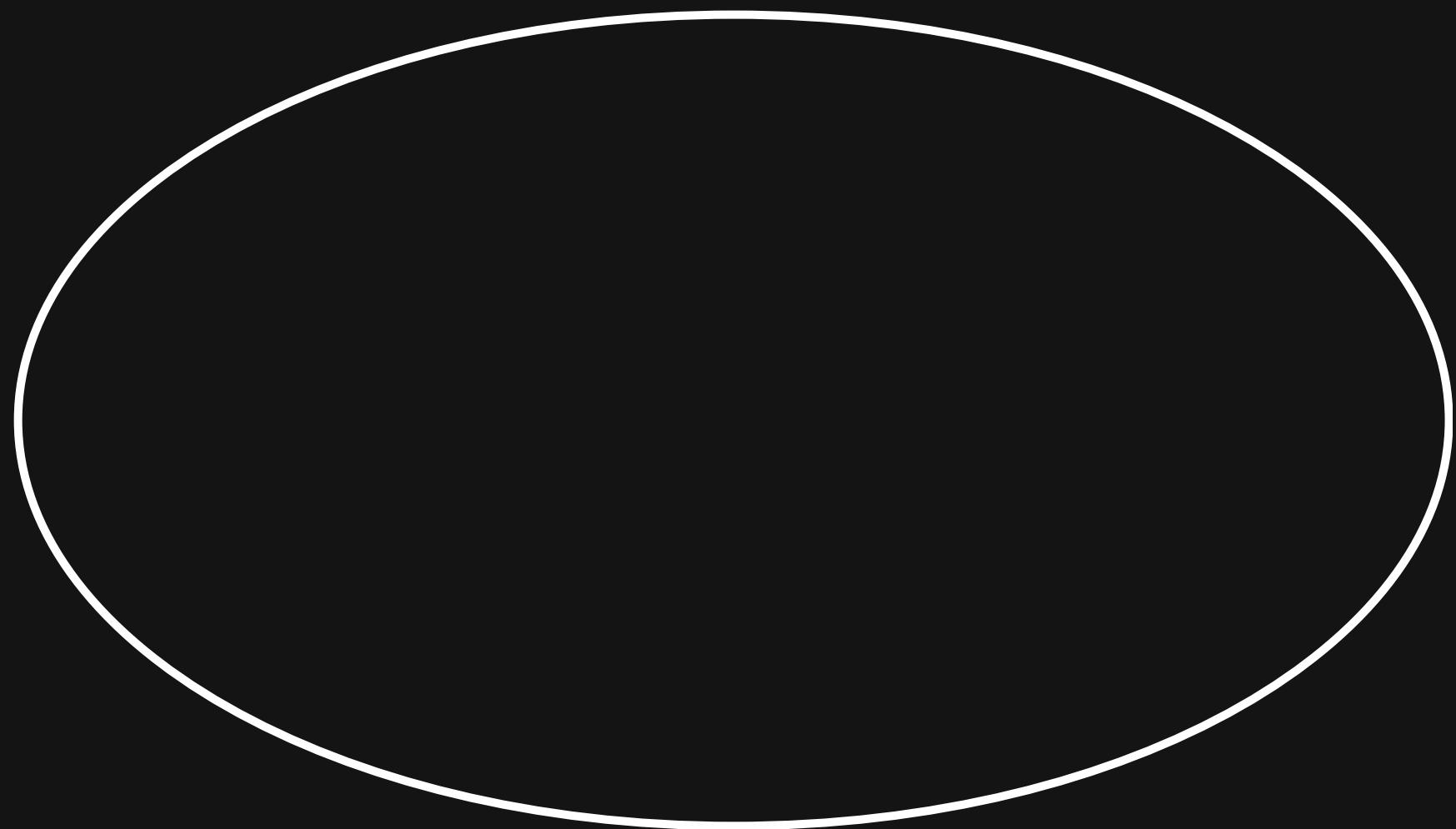
Free Surface
or
External Surface
of a crystal.

Free Surface

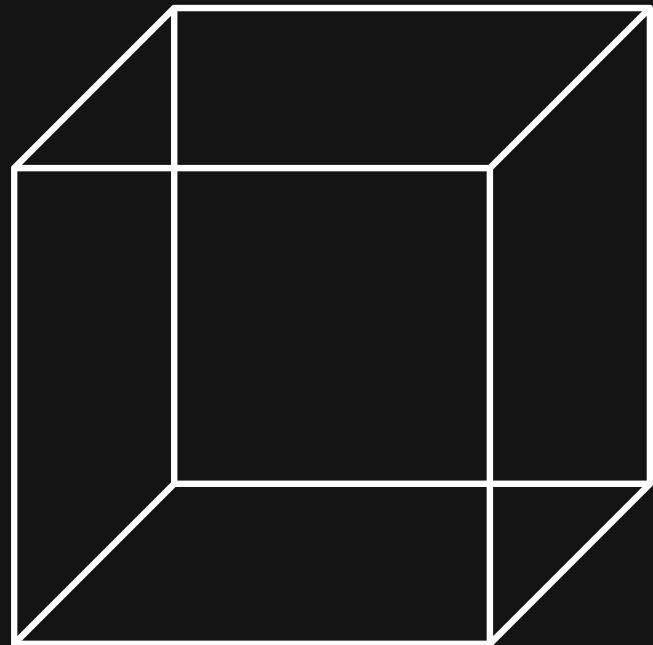
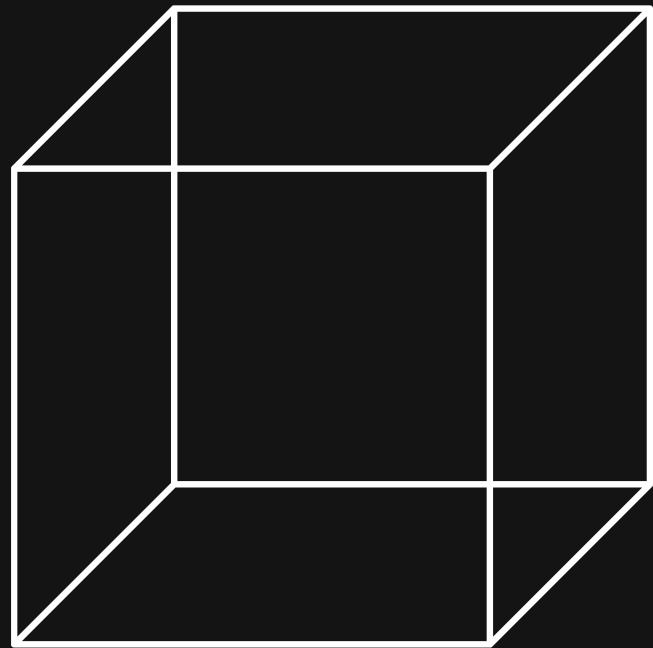
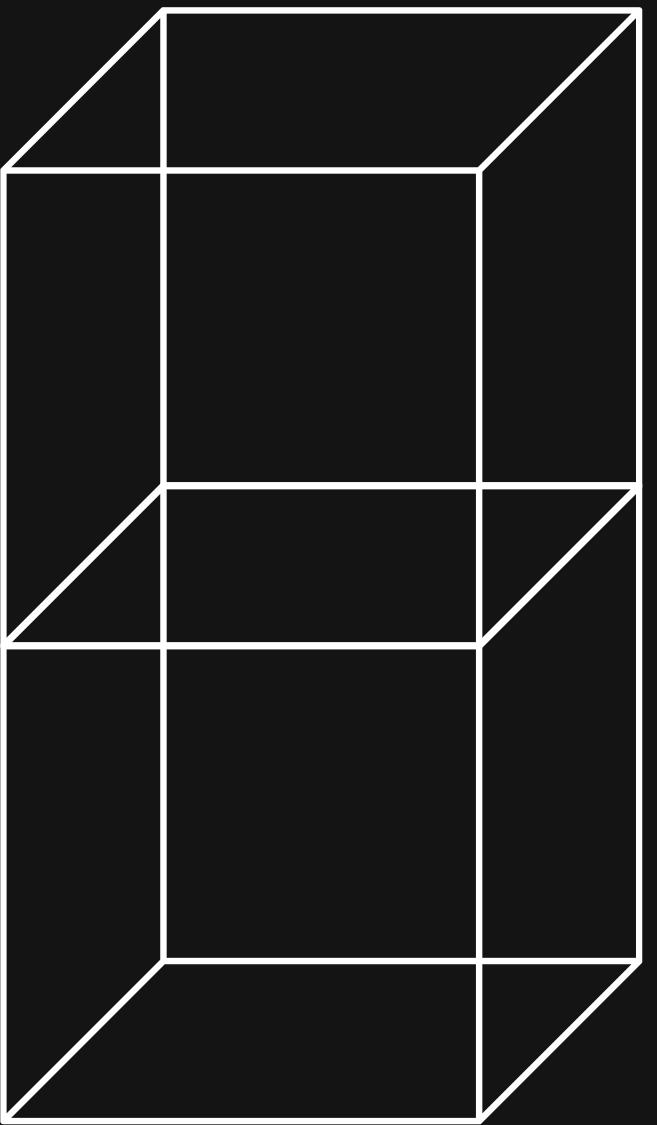
- External Surface itself is a kind of defect
- It's because external surface breaks the lattice periodicity at the position of free surface

$$\text{Surface Energy per unit area } (\gamma) = \frac{(nA \cdot nB \cdot \epsilon)}{2}$$

So how does it look like ?



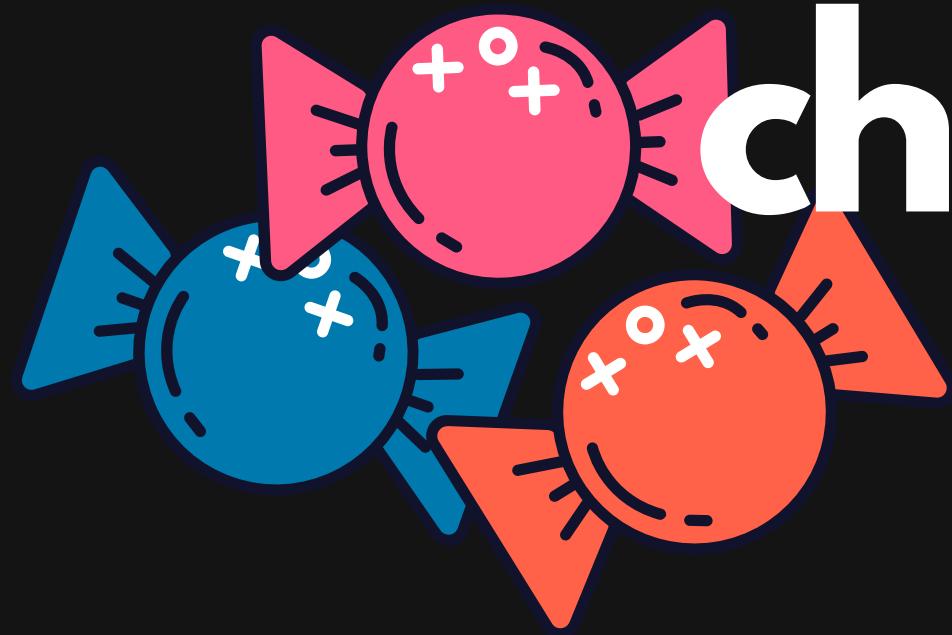
Surface Energy in terms of Bond-Breaking model



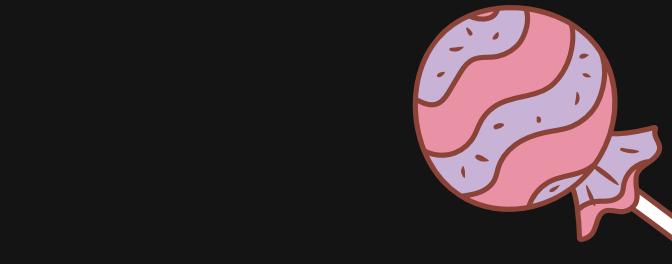
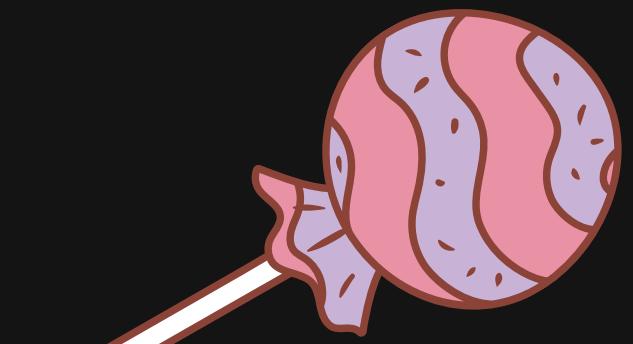
Parameters

- n_A - No. of atoms per unit area on the free surface
- n_B - No. of bonds broken per atom
- ϵ - Bond energy per bond

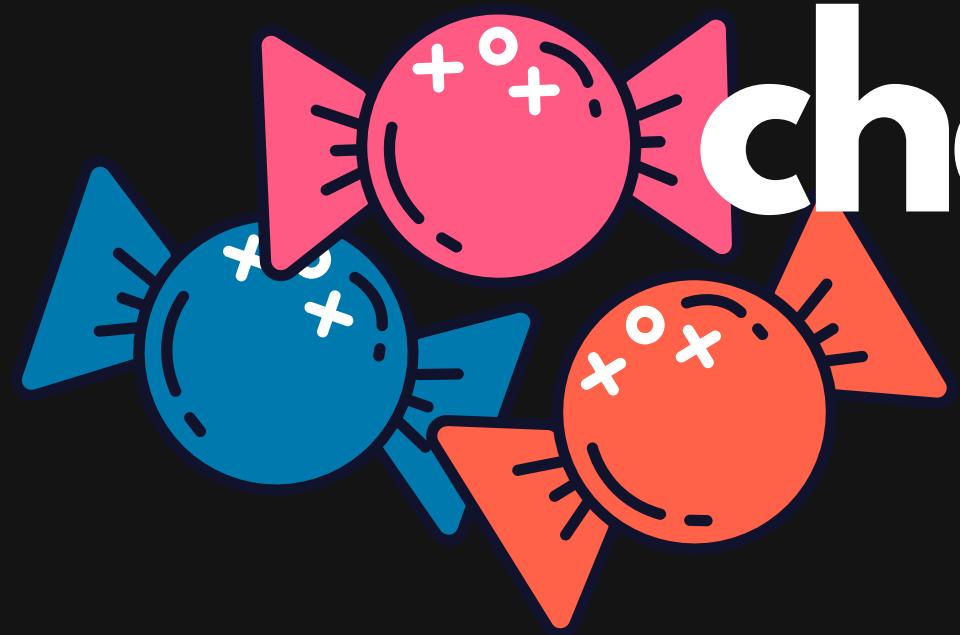
chocolate question



How can the 2D Defects be broadly classified
in terms of Phases/surfaces?

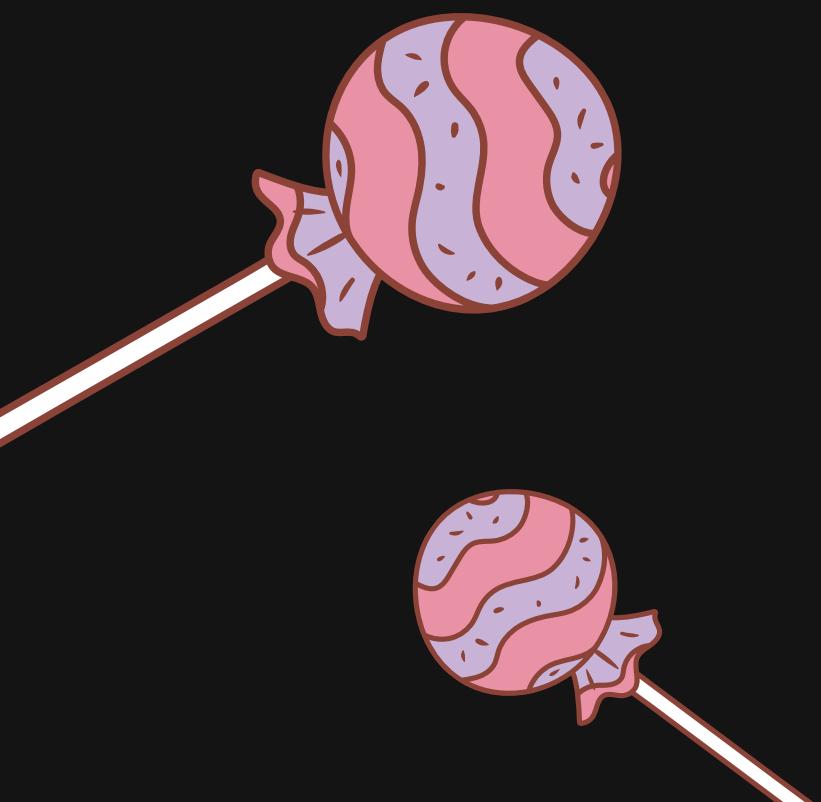


chocolate question



How can the 2D Defects be broadly classified
in terms of Phases/surfaces?

ANS: HOMOPHASE & HETEROPHASE

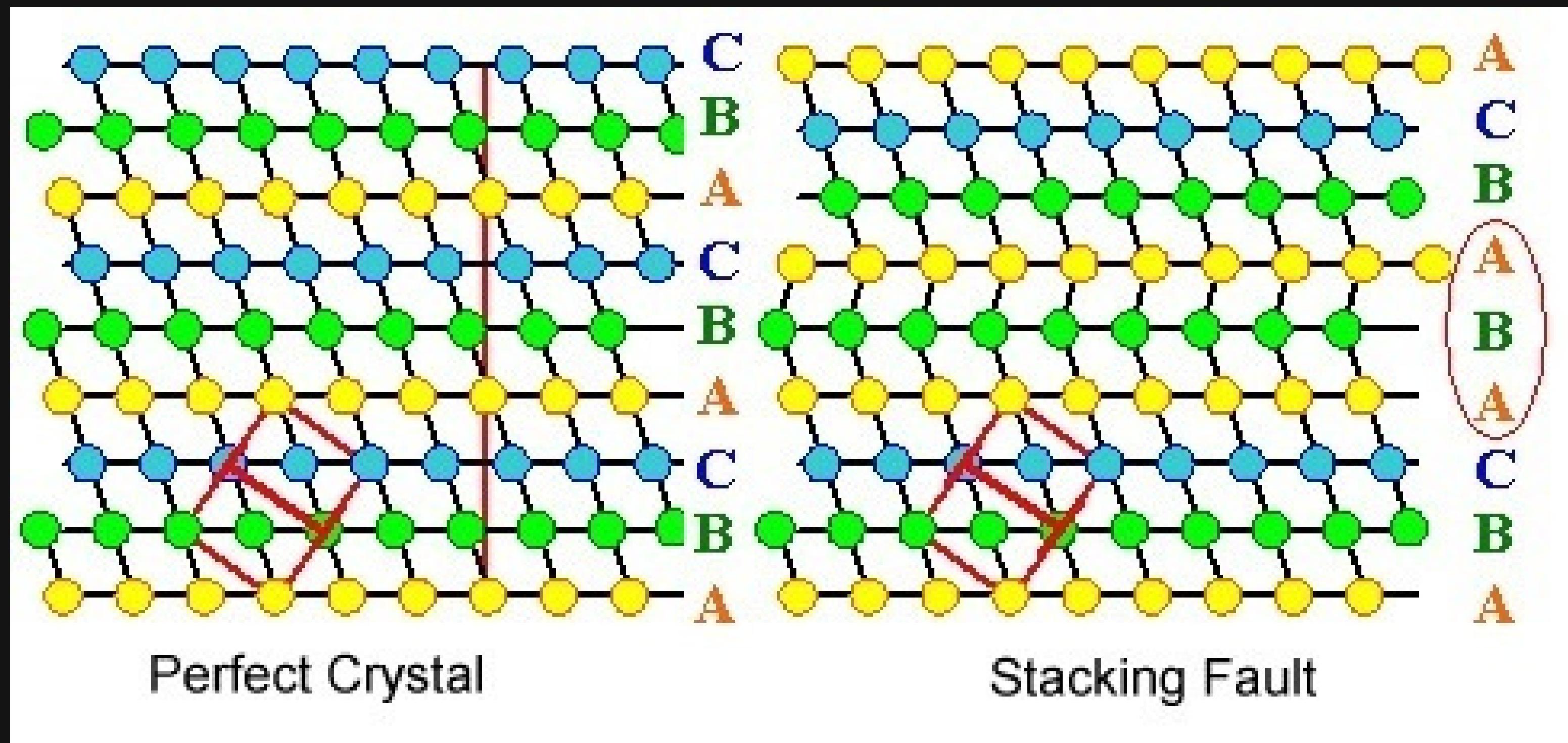


STACKING FAULT

STACKING FAULT

- Stacking faults are planar surface imperfections created by a fault in the stacking sequence of atomic planes in crystals.
- This defect results from a partial dislocation of one set of crystal planes relative to another set.
- There is no change in orientation of crystal across the fault plane

EXAMPLE



TWIN BOUNDARY

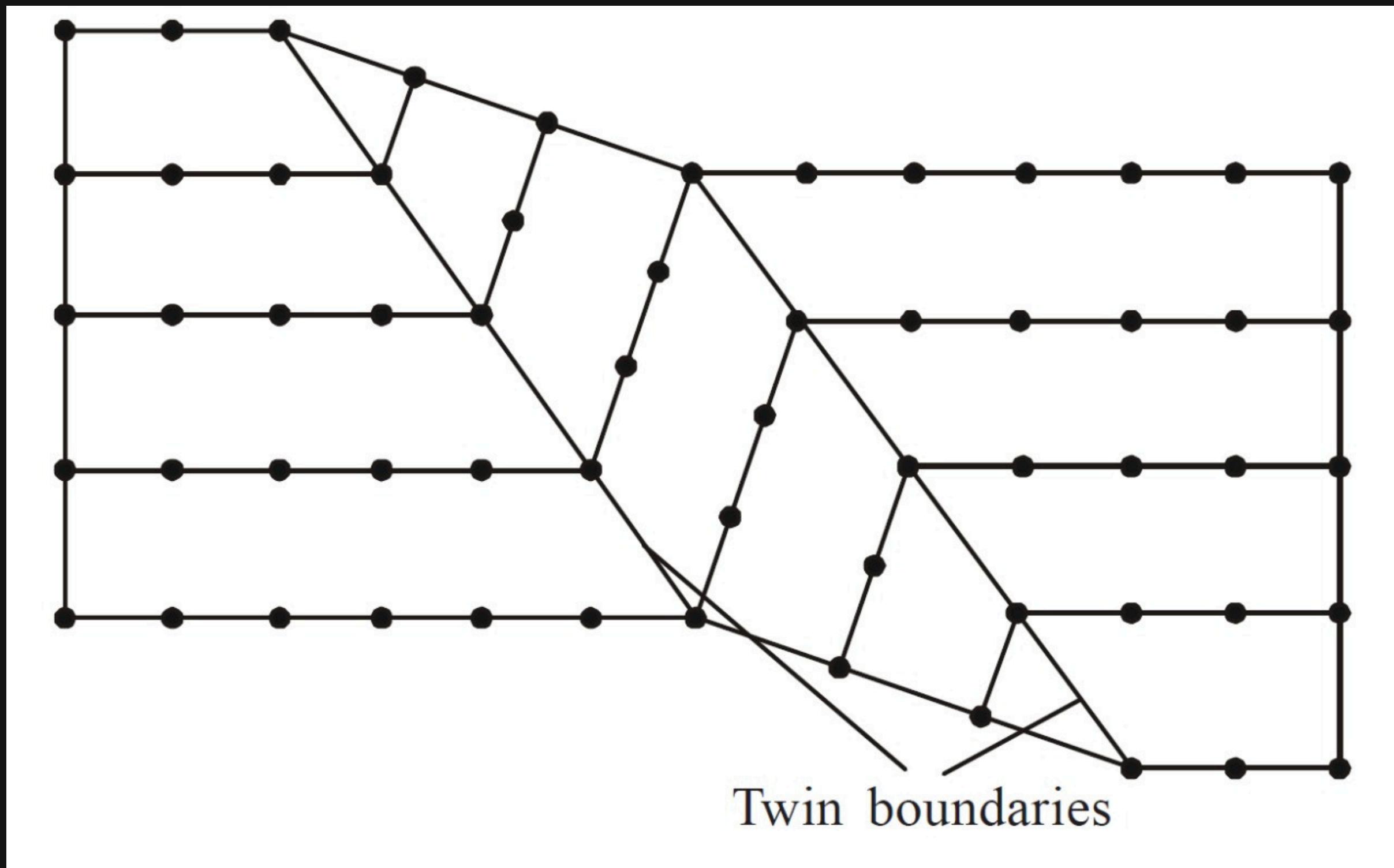
TWIN BOUNDARY

- Boundary in a crystal such that crystals on either side of it are mirror images of each other.
- Orientation is different on both sides.
- Twins which form during the process of recrystallization are called annealing twins, and those which form during plastic deformation of the material are called deformation twins
- Twin boundary usually occur in pairs.

LIKE TWIN TOWERS!

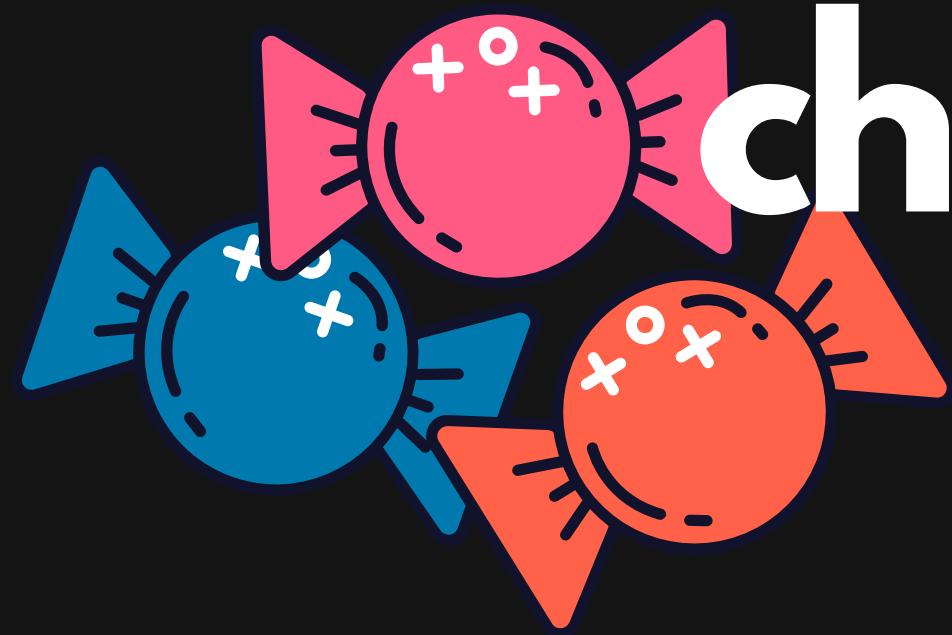


ANOTHER EXAMPLE

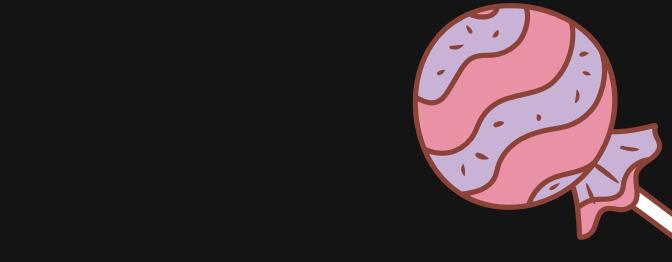
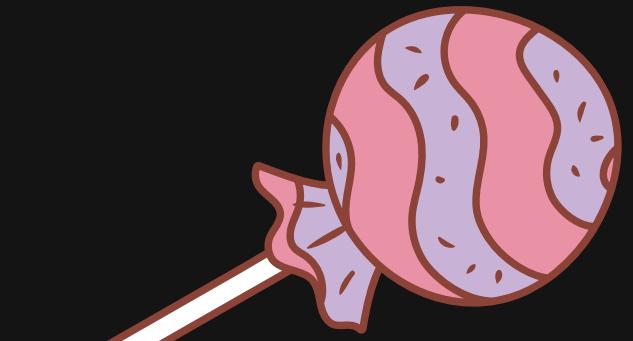


WORKSPACE

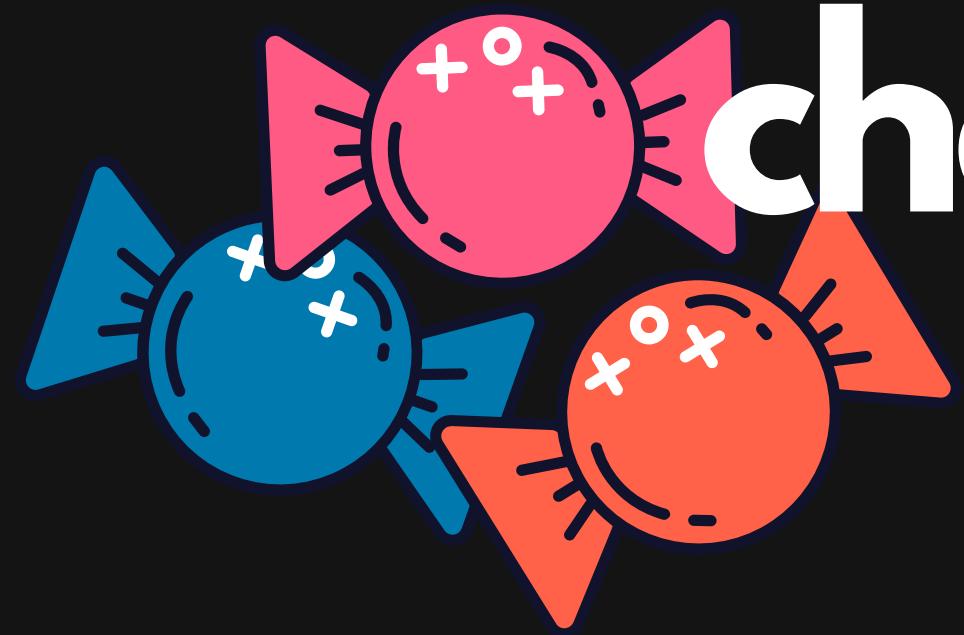
chocolate question



What do you call the twins which forms during the process of recrystallization?

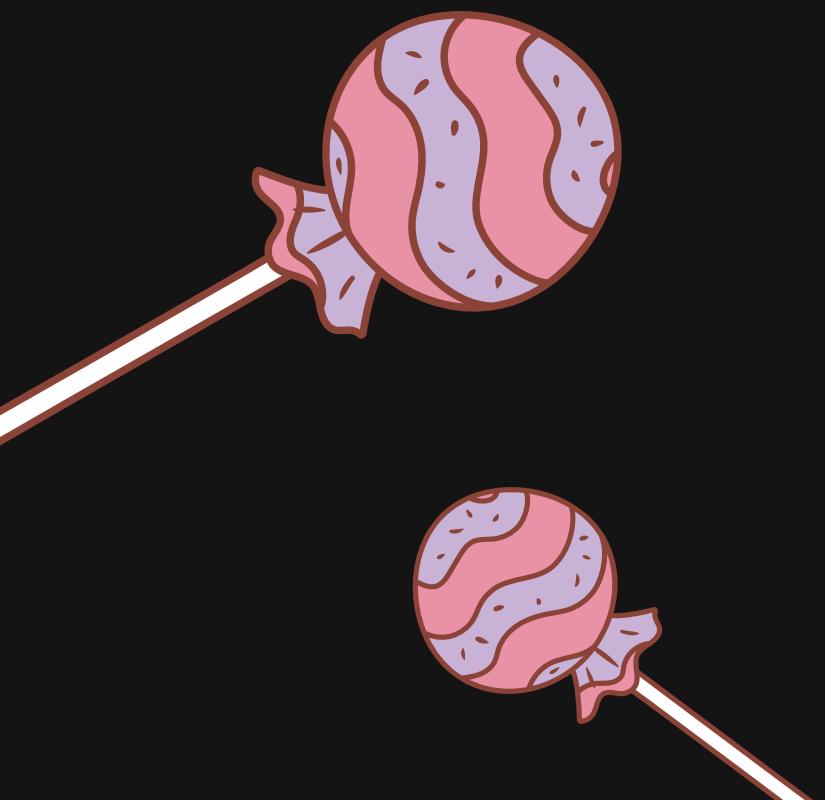


chocolate question



What do you call the twins which forms during the process of recrystallization?

ANS: ANNEALING TWINS



GRAIN BOUNDARY

Quick Question



**WHY DO MATERIAL SCIENTISTS MAKE
TERRIBLE SECRET AGENTS?**

WHY DO MATERIAL SCIENTISTS MAKE TERRIBLE SECRET AGENTS?



**Because they can't keep
their defects hidden!**

*just a terrible joke. sorry not sorry

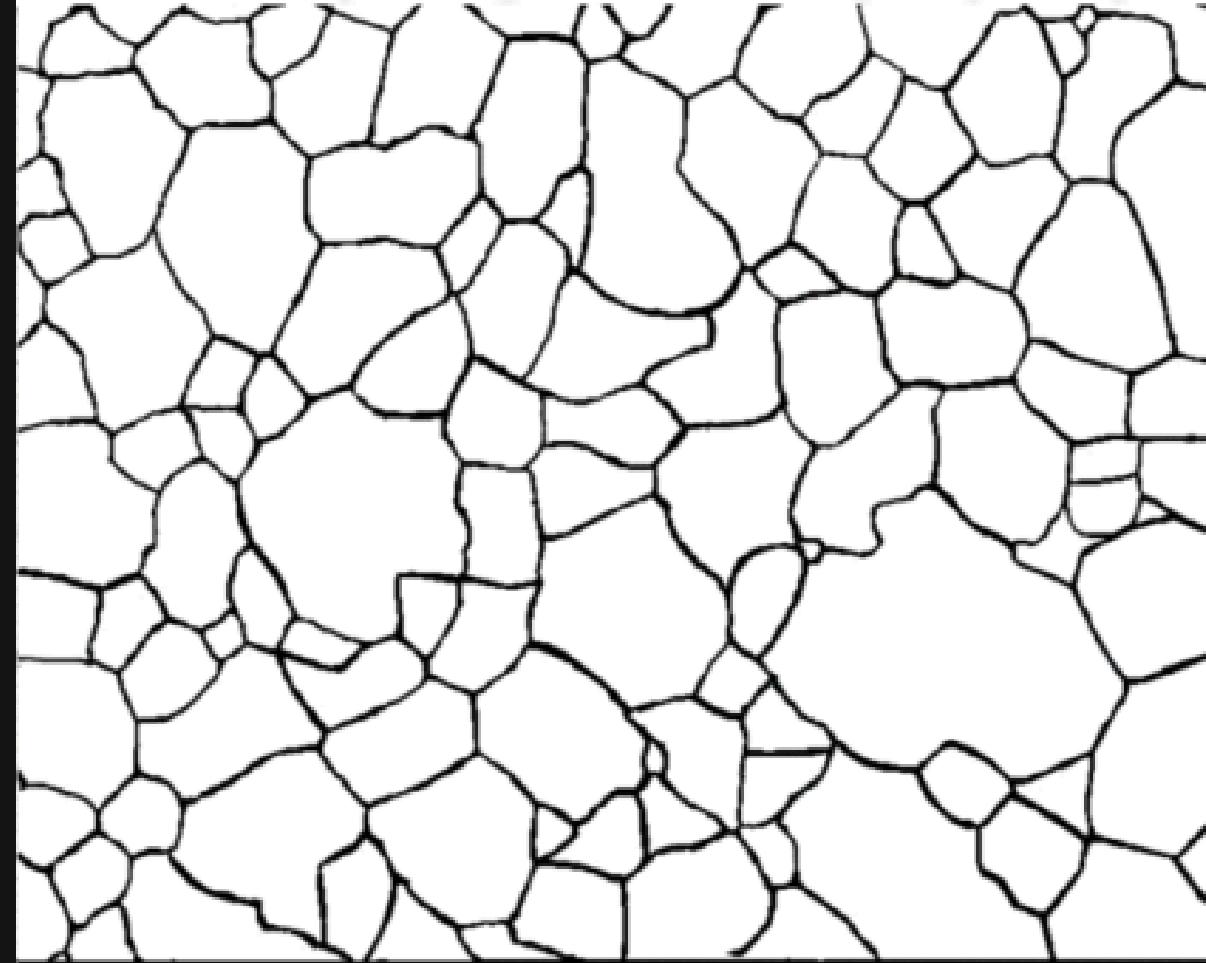
GRAIN BOUNDARY

What are they?

- Internal Boundaries inside a crystal
- Grain boundaries are interfaces or boundaries that separate two adjacent crystalline grains in a polycrystalline material.
- Each grain has its own crystal lattice orientation.
- In other words, grain on one side of the boundary is rotated to w.r.t grain on the other side



Example of Crystal systems with grain boundary

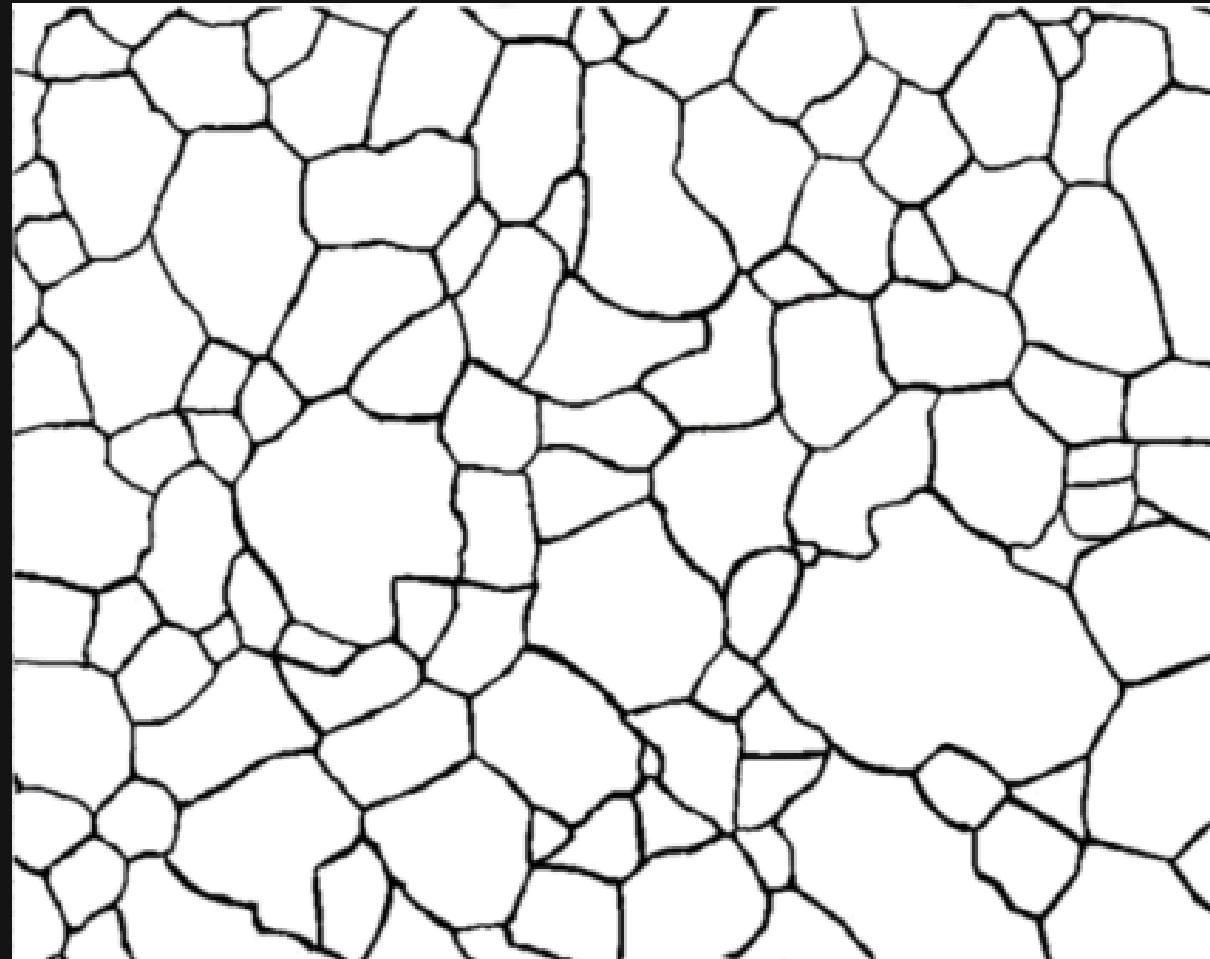


Example of Crystal systems with grain boundary

GOTCHU!



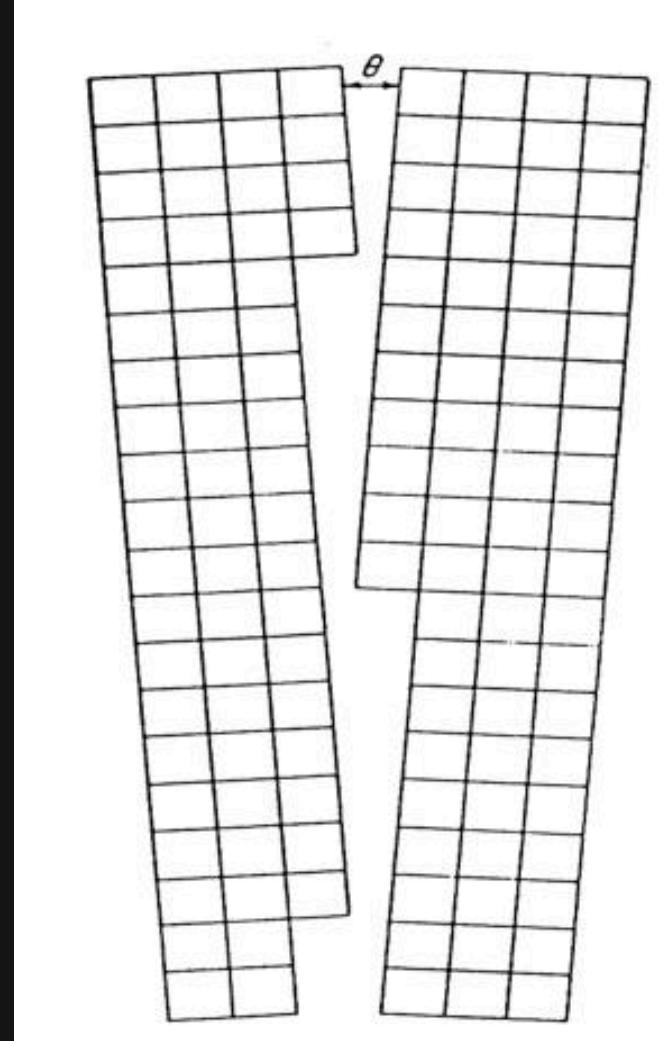
Map of the USA



Grain boundaries of crystal systems

Rotation can be: Axial or Angle

Classification of Grain Boundary based on angle of rotation



Small Angle Boundary Large Angle Boundary

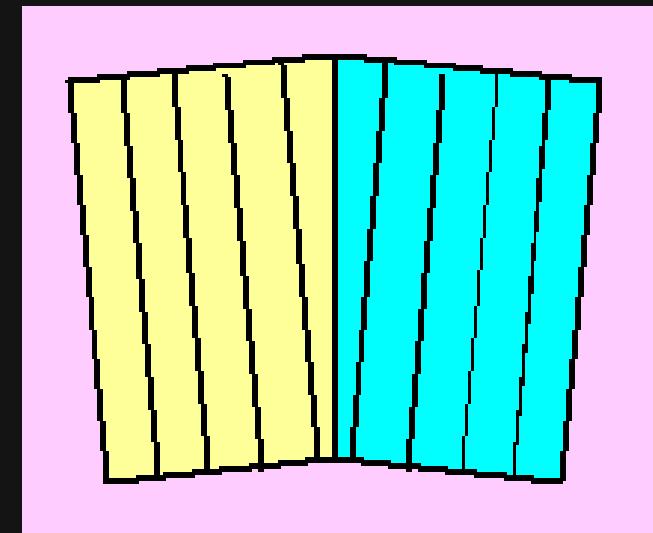
Angle of rotation

Energy

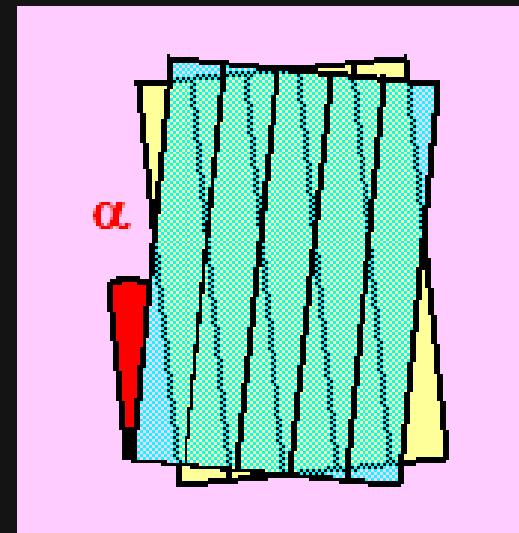
Classification of Grain Boundary based on relationship of the rotation axis w.r.t boundary plane

Relationship

Tilt Boundary

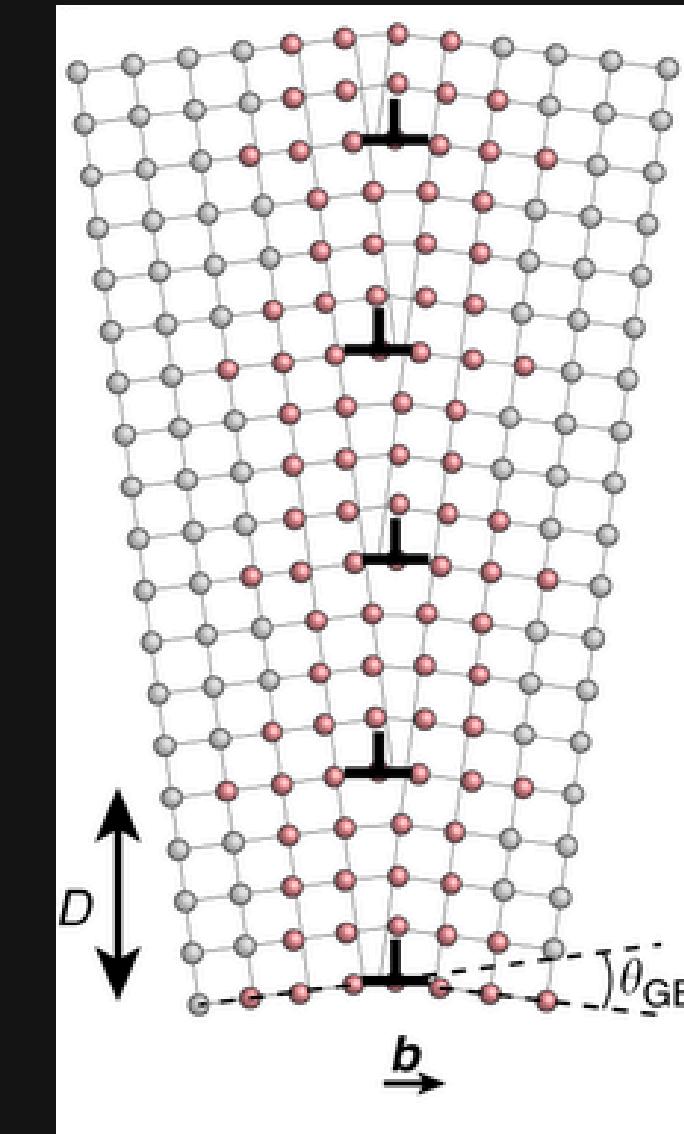
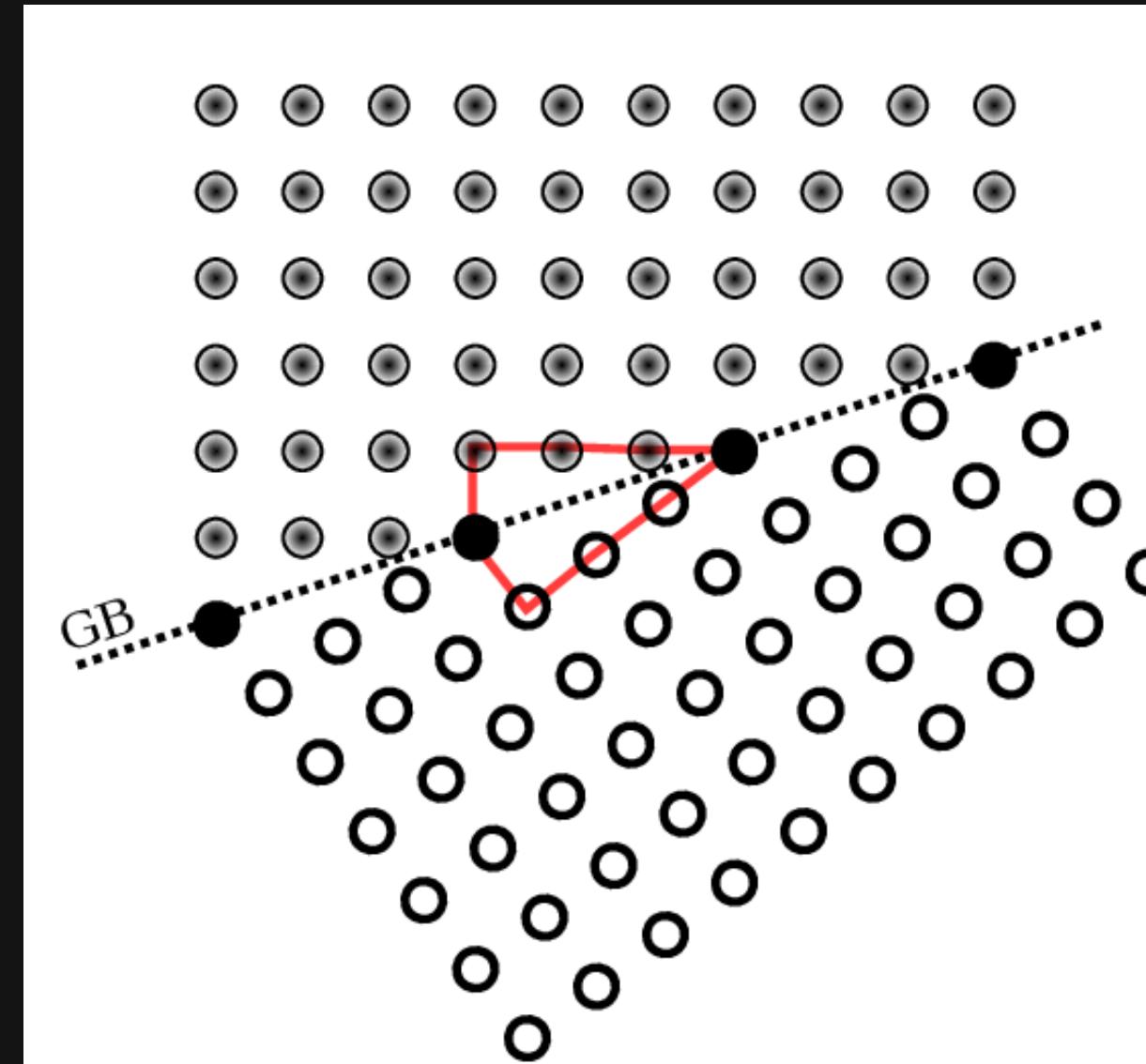


Twist Boundary



SMALL ANGLE SYMMETRIC TILT BOUNDARY

About them



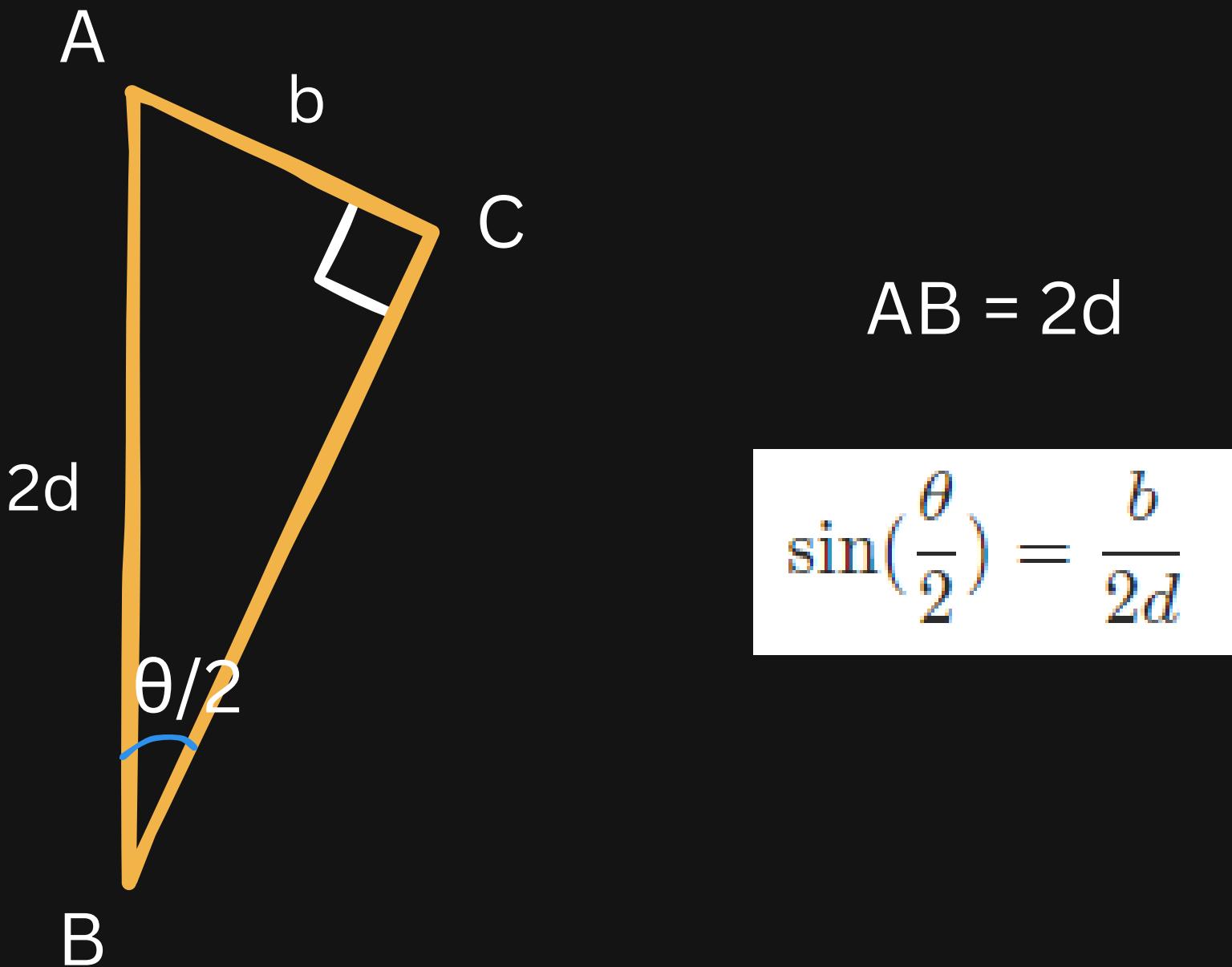
In other words, A set of parallel edge dislocation lying in boundary plane

Finding Tilt Angle

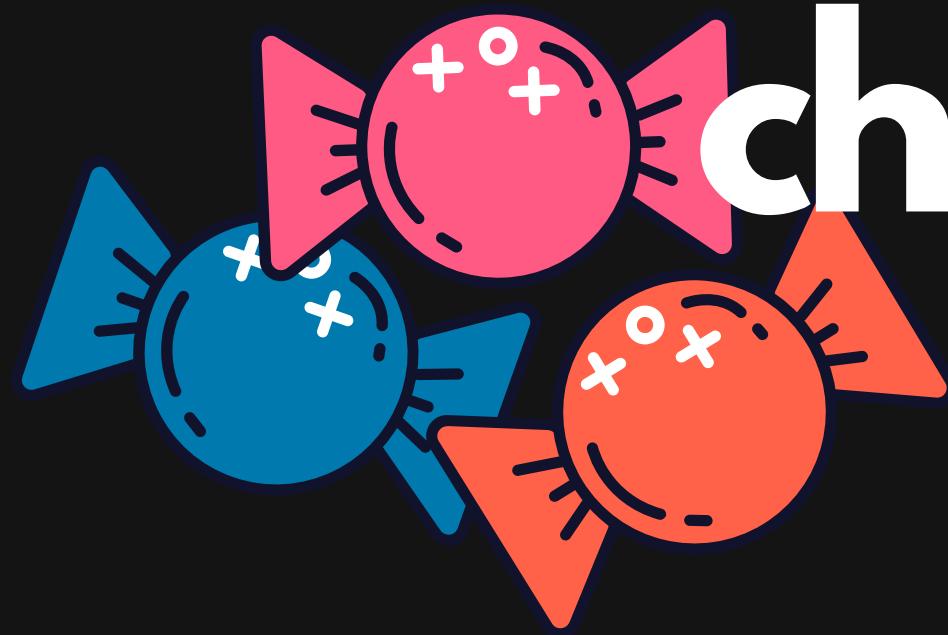
d = dislocation separation

b = burgers vector

θ = tilt angle



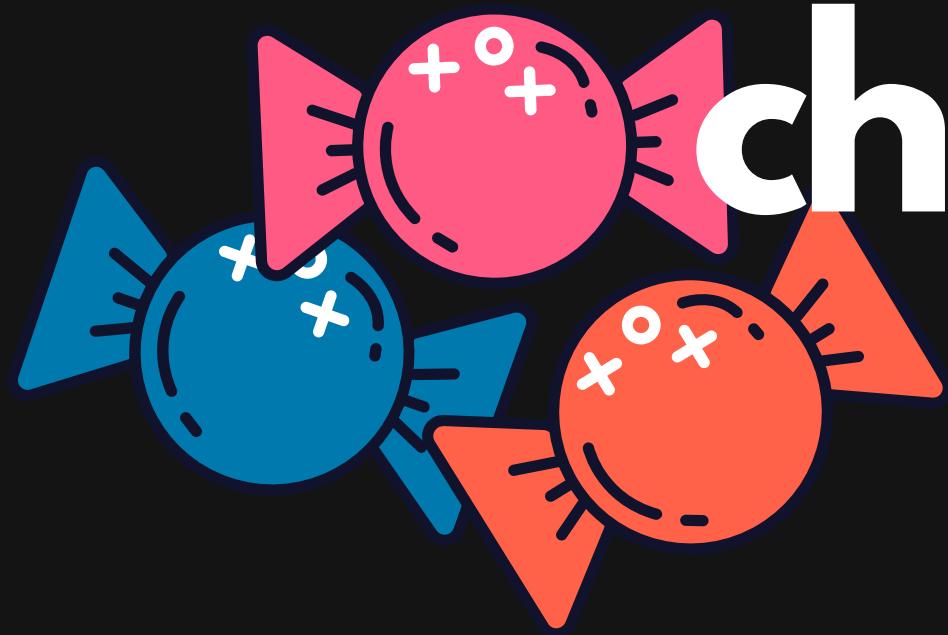
chocolate question



Which type of boundary results when rotation axis is perpendicular to boundary plane?

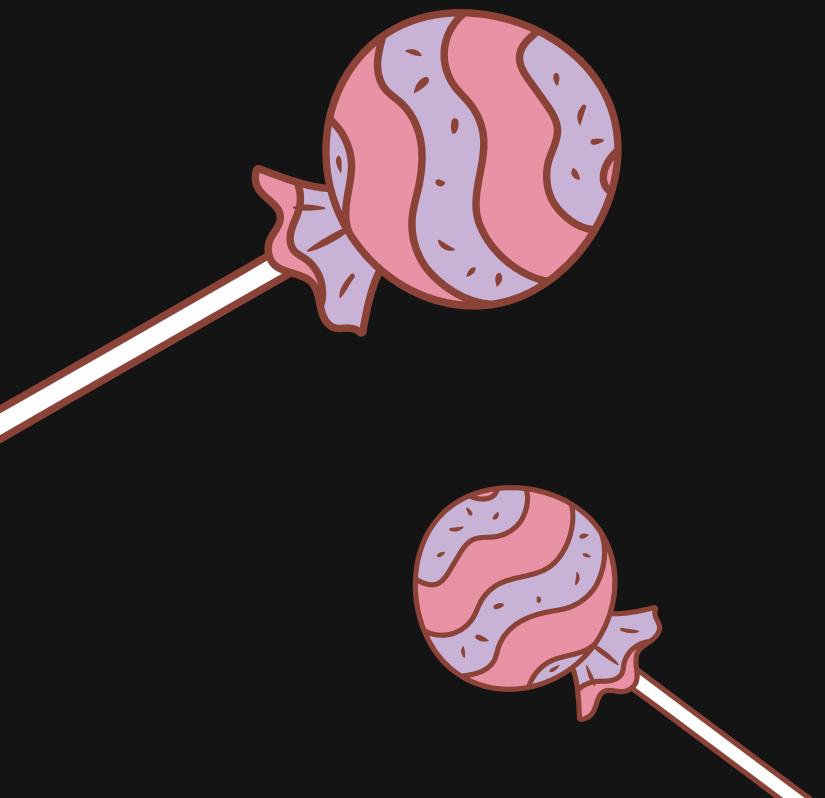


chocolate question



Which type of boundary results when rotation axis is perpendicular to boundary plane?

ANS: TWIST BOUNDARY



Bibliography:

- Materials Science and Engineering - A First Course, V. Raghavan
- Defects in Crystalline Solids, Prof. Rajesh Prasad, IIT Delhi

Find the entire playlist [here](#)

THANK YOU!