

3.091 Solid State Chemistry: Week 10

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Progress Update

Over the past week I have been introduced to:

- ① Defects in solids
- ② Plastic deformation

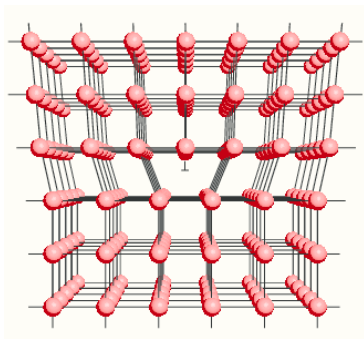
Defects in solids

In a crystalline solid, defects made up of an excess/lack of atoms may form, as well as those resulting from the nature of heat or pressure on a crystal. Common defects include:

- ① Vacancies - the transportation of an atom to the surface of a crystal due to heat breaking bonds.
- ② Substitutions - an atom in a crystalline solid is replaced with another element.
- ③ Interstitials - a small atom takes residence in the space in between the atoms of the lattice.
- ④ Grain boundary - 2 crystals that are forming intersect at a "bad" angle.
- ⑤ Frenkel defects - an atom undergoes vacancy formation and is transported to a gap in the lattice, rather than the surface.
- ⑥ Schottky defects - both an anion and cation in an ionic solid undergo vacancy formation.

Defects in solids (continued)

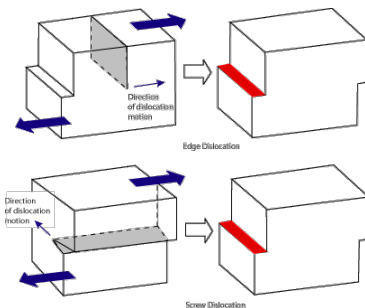
And the most interesting defect, the edge dislocation; an entire plane of atoms is missing from the crystal, causing internal compression & tension.



Edge dislocations can travel within the crystal, and ultimately can make two planes on opposite sides of the defect differ by the Burger's vector.

Plastic Deformation

Plastic deformation is the permanent change of the shape of a crystal, resulting from shearing or compressive forces; this contrasts temporary, elastic changes that “spring” back:



Example PSET Problem (Statement)

Problem: You have a single crystal of 100% pure gold. Identify which of the following defects you would expect to be present at room temperature.:

- ① Free surface
- ② Grain boundaries
- ③ Vacancies
- ④ Inclusion
- ⑤ Substitutional impurity atoms
- ⑥ Interstitial impurity atoms

Example PSET Problem (Solution)

Solution: We can immediately rule out options 4, 5 and 6; impurities don't exist in pure crystals. We can also rule out grain boundaries since it is stated that only 1 crystal is present. The remaining 2 are true; there is no shear force at play, and vacancies form at room temperature.