Crystalline and Non-crystalline Materials

Materials may be **crystalline** (where the material's atoms are arranged in a periodic fashion) or they may be **amorphous** (where the material's atoms do not have a long-range order).

Single Crystals

For a crystalline solid, when the periodic and repeated arrangement of atoms is perfect or extends throughout the entirety of the specimen **without interruption**, the result is a single crystal. All unit cells interlock in the same way and have the same orientation. Single crystals found in nature, but they may also be produced artificially. They are ordinarily difficult to grow, because the environment must be carefully controlled.

If the edges of a single crystal are allowable to grow without any external constraint, the crystal will assume a regular geometric shape having flat faces, as with some of the gem stones; the shape is indicative of the crystal structure. Within the past few years, single crystals have become extremely important in many of our modern technologies, in particular electronic microcircuits, which employ single crystals of silicon and other semiconductors.

Polycrystalline Materials

Most crystalline solids are composed of a collection of many small crystals or **grains;** such materials are termed **polycrystalline.** Various stages in the solidification of a polycrystalline specimen are represented schematically in figure 1. Initially, small crystals or nuclei form at various positions. These have random crystallographic orientations, as indicated by the square grids. This stage is called **nucleation**. The small grains grow by the successive addition from the surrounding liquid of atoms to the structure of each, this stage is called **grain growth**. The edges of adjacent grains impact on one another as the solidification process approaches completion. As indicated in figure below, the crystallographic orientation varies from grain to grain. Also, there exists some atomic mismatch within the region where two grains meet; this area, called a **grain boundary.**

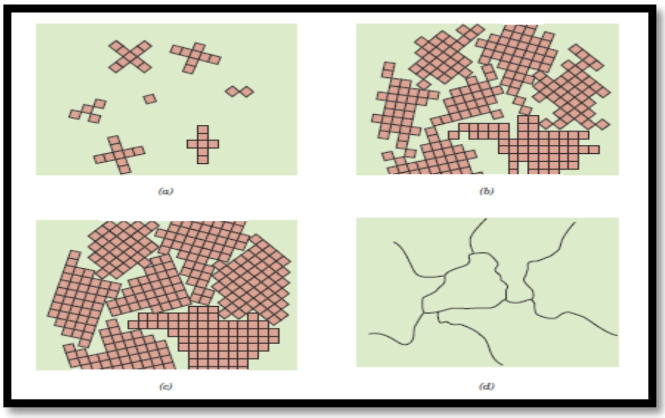

Figure 1. Schematic diagrams of the various stages in the solidification of a polycrystalline material; the square grids depict unit cells. (*a*) Small crystallite nuclei. (*b*) Growth of the crystallites; the obstruction of some grains that are adjacent to one another is also shown. (*c*) Upon completion of solidification, grains having irregular shapes have formed. (*d*) The grain structure as it would appear under the microscope; dark lines are the grain boundaries.