Chapter 8
Phases and Microstructure

Overview

When a material consists of two components, for example a metallic alloy, it typically melts to form a single solution at high enough temperature. However, in the solid state, the two components usually do not mix very well because the miscibility of one component in the other is limited. This leads to rather complex behavior upon solidification, and in particular to the formation of different solid phases, which are characterized by different compositions and possibly different crystal structures. Moreover, the final microstructure is a function of certain kinetic variables of the solidification process, and it can also be modified by additional heat treatment. The microstructure of such materials, and thus their mechanical properties, depend sensitively on the composition and the thermal history. These phenomena are illustrated with help of a detailed discussion of the Cu-Ni, Cu-Ag, and Fe-C material systems, among others.

After studying this chapter, you will be able to :

1. Describe qualitatively the main types of two-component materials systems;
2. Explain what a solid solution is in a two-component system;
3. Identify the major features of a two-component phase diagram, and contrast these to a one-component system;
4. From a two-component phase diagram, determine the phases present, and their amounts, in thermal equilibrium for a specified composition and temperature;
5. Determine the equilibrium microstructure of a solidified two-component material;
6. Explain how the kinetics of solidification and subsequent heat treatment affect the microstructure;
7. Associate the microstructure with mechanical properties.