

Chapter 5

Mechanical Properties

Overview

Mechanical properties refer to the response of a material to an externally applied loading force. This response is best described in terms of the strain of the material, i.e. its deformation relative to the original dimensions, vs. the applied stress, i.e. the force per unit area. At a small enough stress, a material is deformed elastically, meaning that it will resume its original shape once the stress has been removed. At a larger stress, many materials are deformed plastically, which is to say permanently. At an even larger stress, the point of mechanical failure, or fracture, will be reached. These three stages of behavior can be understood in terms of various deformation mechanisms operating at the atomic level. The mechanical behavior can also be modified to a large extent by controlling the defects present in a material.



After studying this chapter, you will be able to :

1. Define and use the most important concepts necessary for dealing with the deformation of a material under a load;
2. Distinguish the three regimes of mechanical deformation: elastic deformation, plastic deformation, and fracture;
3. Analyze quantitatively elastic deformation;
4. Describe plastic deformation in terms of the yield strength and the tensile strength of a material;
5. Differentiate between different modes of fracture;
6. Outline various methods of strengthening a material;
7. Discuss the atomic-scale mechanisms at work that give rise to the rather different mechanical behavior and properties of the various classes of materials.