CLASSIFICATION OF MATERIALS Solid materials have been conveniently grouped into three basic categories: metals, ceramics, and polymers. This scheme is based primarily on chemical makeup and atomic structure,and most materials fall into one distinct grouping or another. In addition, there are the composites, which are engineered combinations of two or more different materials. A brief explanation of these material classifications and representative characteristics is offered next. Another category is advanced materials—those used in high-technology applications,such as semiconductors,biomaterials, smart materials, and nanoengineered materials; these are discussed in Section

1.5. Metals Materials in this group are composed of one or more metallic elements (e.g., iron, aluminum, copper, titanium, gold, and nickel), and often also nonmetallic elements (e.g.,carbon,nitrogen,and oxygen) in relatively small amounts.3Atoms in metals and their alloys are arranged in a very orderly manner (as discussed in Chapter 3), and in comparison to the ceramics and polymers, are relatively dense (Figure 1.3).With

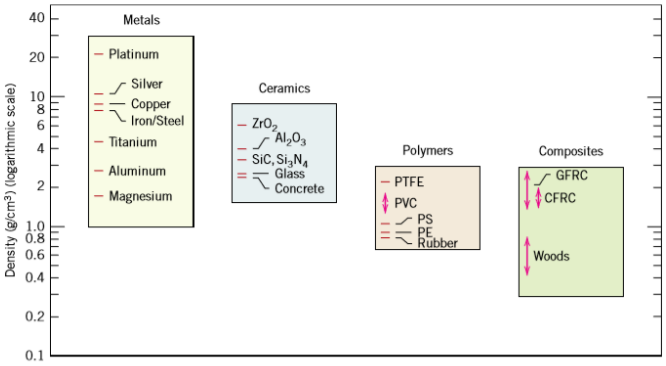

Figure 1.3 Bar chart of room-temperature density values for various metals, ceramics, polymers, and composite materials.

regard to mechanical characteristics, these materials are relatively stiff (Figure 1.4) and strong (Figure 1.5),yet are ductile (i.e.,capable of large amounts of deformation without fracture), and are resistant to fracture (Figure 1.6), which accounts for their widespread use in structural applications. Metallic materials have large numbers of nonlocalized electrons;that is,these electrons are not bound to particular atoms.Many properties of metals are directly attributable to these electrons. For example, metals are extremely good conductors of electricity (Figure 1.7) and heat,and are not transparent to visible light; a polished metal surface has a lustrous appearance. In addition, some of the metals (i.e., Fe, Co, and Ni) have desirable magnetic properties.