Chapter 13
The Future of Materials

Overview

In this final chapter I will present a personal selection of a few case studies of fascinating materials science. They all cover subjects of current interest in research and engineering development and are likely to provide fertile ground for continued studies into the future. What I will cover is cutting-edge, and you know enough materials science now so that you will be able to appreciate this readily. More specifically, we will discuss atomic-level microscopy techniques for materials science, size effects in materials at the nanometer-scale, new carbon-based materials, advanced metals, optical fibers, and engineered materials for advanced microelectronics. In each case, we will highlight materials structure and properties, with related advanced processing methods.

After studying this chapter, you will be able to:

1. Describe the principles and limitations of some modern materials microscopy methods, e.g. atomic force microscopy and high-resolution scanning transmission electron microscopy;
2. Explain how nanoparticles differ in structure and physical properties, such as the melting point, from bulk materials;
3. Delineate the unique properties of the carbon-based materials graphene, carbon nanotubes, and nanocrystalline diamond;
4. Discuss current aspects of metals development, including Gum metal, TRIP steels, and metallic glasses;
5. Describe the materials basics of optical fibers as light guides, including photonic crystal optical fibers;
6. Outline efforts in electronics, specifically bandgap engineering with compound semiconductors, and extending microelectronics by ingenious materials developments.