It should be noted here for clarification that an electron hole is not identical with a **positron**. The latter is a subatomic particle like the electron, however with a positive charge. Positrons are emitted in the β-decay or are found in cosmic radiation. When positrons and electrons react with each other they are both annihilated under emission of energy.

6.8. Conclusion

The first part of this book is intended to provide the reader with the necessary tools for a better understanding of the electronic properties of materials. We started our discussion by solving the Schrödinger equation for the free electron case, the bound electron case, and for electrons in a crystal. We learned that the distinct energy levels which are characteristic for isolated atoms widen into energy bands when the atoms are moved closer together and eventually form a solid. We also learned that the electron bands have “fine structure,” i.e., they consist of individual “branches” in an energy versus momentum (actually **k**) diagram. We further learned that some of these energy bands are filled by electrons, and that the degree of this filling depends upon whether we consider a metal, a semiconductor, or an insulator. Finally, the degree to which electron energy levels are available within a band was found to be nonuniform. We discovered that the density of states is largest near the center of an electron band. All these relatively unfamiliar concepts will become more transparent to the reader when we apply them in the chapters to come.

Problems

1. What velocity has an electron near the Fermi surface of silver? ($E_F = 5.5$ eV).
2. Are there more electrons on the bottom or in the middle of the valence band of a metal? Explain.
3. At what temperature can we expect a 10% probability that electrons in silver have an energy which is 1% above the Fermi energy? ($E_F = 5.5$ eV).
4. Calculate the Fermi energy for silver assuming 6.1×10^{22} free electrons per cubic centimeter. (Assume the effective mass equals the free electron mass.)
5. Calculate the density of states of 1 m^3 of copper at the Fermi level ($m^* = m_0$, $E_F =$ 7 eV). *Note*: Take 1 eV as energy interval. (Why?)
6. The density of states at the Fermi level (7 eV) was calculated for 1 cm^3 of a certain metal to be about 10^{21} energy states per electron volt. Someone is asked to calculate the number of electrons for this metal using the Fermi energy as the maximum kinetic energy which the electrons have. He argues that because of the Pauli principle, each