Chapter 5

HETEROJUNCTION BAND OFFSETS EXPLAINED WITH CHARGE DISTRIBUTION

Heterojunction between semiconductors with different band gaps is a structure required for a large number of solid-state devices that have revolutionized the semiconductor industry in recent decades. Our lives have improved tremendously because of modern technologies employing heterojunctions in different fields of application. Even though the main interest of this book is not in device applications, it would be remiss not to mention the importance of heterojunctions in the development of advanced devices such as lasers, light-emitting diodes, solar cells, heterojunction bipolar transistors, and high electron mobility transistors that have directly impacted our daily lives. At the same time, heterojunctions are a key structure that underpins the ongoing investigations and explorations of various quantum effects for science and technology. Due to the importance of heterojunctions, the formation of band offset at heterojunction interfaces needs to be thoroughly understood. After brief descriptions of how heterojunction BOs may be experimentally measured and theoretically calculated, this chapter illustrates how these BOs may be quantitatively explained through modeling of interface charge distribution.

5.1 Band Offset Measurement

(a) Surface Photoemission Spectroscopy

Photoemission spectroscopy is a versatile technique used extensively to measure the BO of semiconductor heterojunctions.[1] Photoemitted electrons can only escape from a shallow depth beneath the surface without inelastic scattering. Since at least some parts of each semiconductor forming the interface must be visible in order for the relative band position to be determined by this technique, the surface semiconductor (over-)layer