Drift Lesson

Lesson Topic: Drift

Objective of Lesson: To understand the concept of drift in semiconductors.

Reading Assignment: Section 3.1.1 and 3.1.2

Homework: None

What do you need to know for the exam?

1. What must be present for there to be drift current?
2. What determines the polarity of drift current?

Summary

Drift is charged particle motion in response to an applied electric field. By visualizing the process of drift we can ultimately predict the flow of carriers in response to an electric field applied to a specific semiconductor under specific conditions.

Drift

Drift is, by definition, charged particle motion in response to an applied electric field. When an electric field is applied across a semiconductor, the carriers start moving, producing a current. The positively charged holes move with the electric field, whereas the negatively charged electrons move against the electric field.

The motion of each carrier can be described as a constant drift velocity, v_d. This constant takes into consideration the collisions and setbacks each carrier has while moving from one place to another. It is a macroscopic quantity that takes into account the microscopic behavior that controls it. In the demo/animation linked below, one can see an illustration of the microscopic behavior. If you click on "semiconductor" a potential will be applied, creating an electric field. You can see how the electron does not travel in a straight line, but it makes it to the other end eventually. This is an example of drift current. If you see the demo by clicking on "free space," there isn't anything for the electron to bump into in free space, so it travels in a straight line.

Many researchers delve in great detail to the microscopic behavior of electrons and holes in a semiconductor in order to understand the macroscopic observations by building up from the basics. Such studies are critical, especially in these modern times when shrinking device dimensions make such fundamental understanding necessary to understand device performance. Such detailed studies are beyond the scope of this course, however, and we will focus on the macroscopic properties.

Figure 3.4 is an example of such macroscopic behavior. What the figure shows is that the drift velocity plotted versus the applied electric field results in a straight line for 2-3 orders of magnitude of strength of electric field. It is this fact that allows the substitution resulting in Equations 3.4. The substitution is important because we want to have equations that are in terms of quantities we can know. We cannot easily know vd, but we can know the electric field strength, and we can make tables of what the mobility is for specific semiconductors under specific conditions. The fact that the plot in Figure 3.4 becomes sub-linear for higher fields will be discussed later.

What you need to know to this point is that drift is the movement of charged carriers due to the force of an electric field and that we have the ability to reduce it down to a simple equation.

Definitions

Current density: Current is the charge per unit time crossing an arbitrarily chosen plane of observation, oriented normal to the direction of current flow. Current density, J, is the current per unit area (J=I/A).

Drift: To be carried along by or as by currents of air or water, to vary from or oscillate randomly about a fixed setting, position, or mode of operation, to move leisurely or sporadically from place to place.