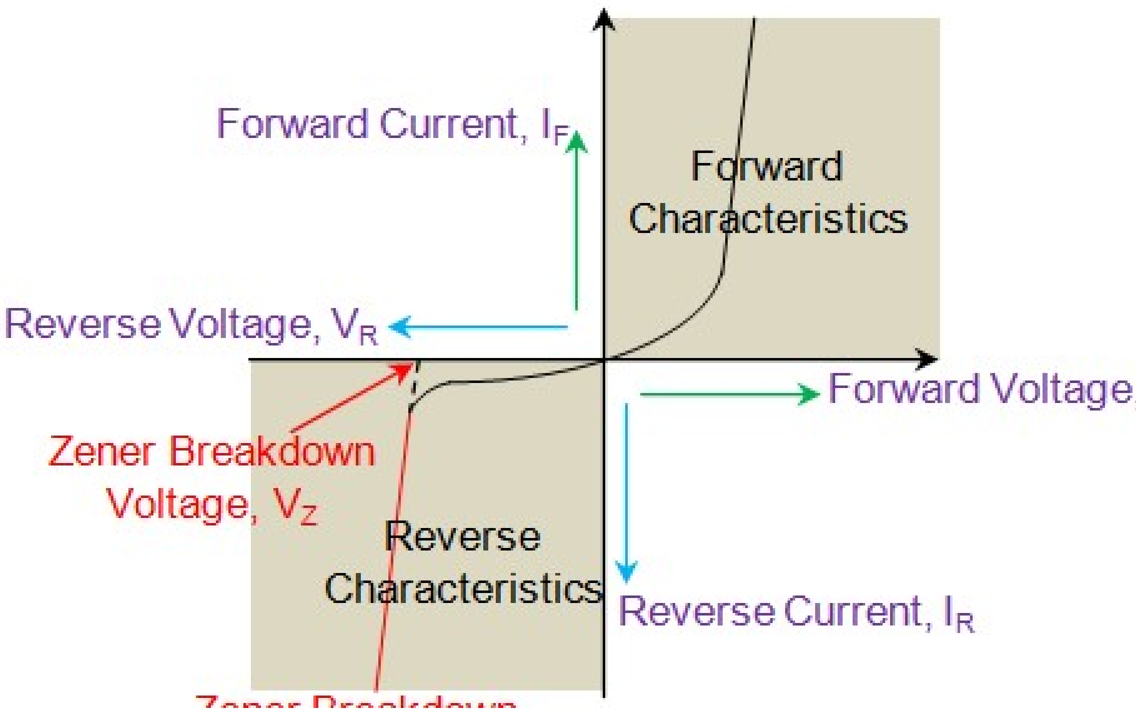
Zener Breakdown and Zener Characteristic

The width of the depletion region is quite narrow in heavily doped semiconductor diode. Let us consider a heavily doped semiconductor diode in reverse bias condition. Here the width of the narrow depletion region (due to high doping) leads to a high electric field developed across the junction since the electric field equals to the potential gradient. For example, a reverse voltage of 3V across a 100 A° thick (extremely narrow) depletion region results electric field of

$$\frac{3}{100 \times 10^{-10}} = 3 \times 10^{8} \ \ Volt/meter$$

Due to this highly intensified electric field, a number of the covalent bonds in the p-n junction break-off releasing their valence electrons. In this way, valence electrons get excited and migrated to the conduction band leading to an abrupt increase in the current flow through the diode. This phenomenon is referred to as **Zener Breakdown**, and the corresponding voltage is called **Zener Breakdown Voltage** and usually denoted by V_Z, shown in red color in Figure 1. The phenomenon was first observed and explained by Dr. Clarence Zener in 1934 and is thus named after him.



Further, it is to be noted that the Zener break down is a controllable phenomenon as the number of charge carriers generated can be effectively controlled by controlling the electric field applied. Typically Zener breakdown causes the diode junction to break down below 5V and will not damage the device unless there is no provision made to release the heat generated. Moreover, the Zener breakdown voltage has a negative temperature coefficient meaning which the Zener breakdown voltage reduces with the increase in the junction temperature. However, it is to be noted that the voltage at which the **Zener breakdown** occurs is adjustable during the diode manufacturing. Lastly, it should be kept in mind that the applications of widely used Zener diode are based upon the Zener effect or Zener break down voltage.