5.1 INTRODUCTION

In addition to the PN junction diode, other types of diodes are also manufactured for specific applications. These special diodes are two terminal devices with their doping levels carefully selected to give the desired characteristics.

5.2 ZENER DIODE

When the reverse voltage reaches breakdown voltage in normal PN junction diode, the current through the junction and the power dissipated at the junction will be high. Such an operation is destructive and the diode gets damaged. Whereas diodes can be designed with adequate power dissipation capabilities to operate in the breakdown region. One such a diode is known as Zener diode. Zener diode is heavily doped than the ordinary diode.

From the *V–I* characteristics of the Zener diode, shown in Fig. 5.1, it is found that the operation of Zener diode is same as that of ordinary PN diode under forward-biased condition. Whereas under reverse-baised condition, breakdown of the junction occurs. The breakdown voltage depends upon the amount of doping. If the diode is heavily doped, depletion layer will be thin and, consequently, breakdown occurs at lower reverse voltage and further, the breakdown voltage is sharp. Whereas a lightly doped diode has a higher breakdown voltage. Thus breakdown voltage can be selected with the amount of doping.

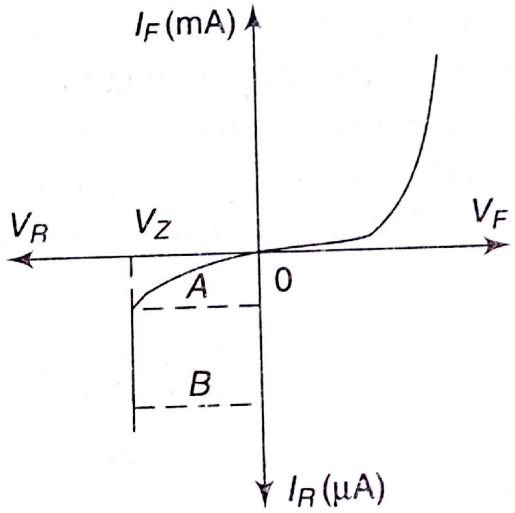

Fig. 5.1 *V–I* characteristics of a zener diode

The sharp increasing current under breakdown conditions are due to the following two mechanisms.

(1) Avalanche breakdown
(2) Zener breakdown.

5.2.1 Avalanche Breakdown

As the applied reverse bias increases, the field across the junction increases

correspondingly. Thermally generated carriers while traversing the junction acquire a large amount of kinetic energy from this field. As a result the velocity of these carriers increases. These electrons disrupt covalent bond by colliding with immobile ions and create new electron-hole pairs. These new carriers again acquire sufficient energy from the field and collide with other immobile ions thereby generating further electron–hole pairs. This process is cumulative in nature and results in generation of avalanche of charge carriers within a short time. This mechanism of carrier generation is known as Avalanche multiplication. This process results in flow of large amount of current at the same value of reverse bias.

5.2.2 Zener Breakdown

When the P and N regions are heavily doped, direct rupture of covalent bonds takes place because of the strong electric fields, at the junction of PN diode. The new electron–hole pairs so created increase the reverse current in a reverse biased PN diode. The increase in current takes place at a constant value of reverse bias typically below 6 V for heavily doped diodes. As a result of heavy doping of P and N regions, the depletion region width becomes very small and for an applied voltage of 6 V or less, the field across the depletion region becomes very high, of the order of 10^7 V/m, making conditions suitable for Zener breakdown. For lightly doped diodes, Zener breakdown voltage becomes high and breakdown is then predominantly by Avalanche multiplication. Though Zener breakdown occurs for lower breakdown voltage and Avalanche breakdown occurs for higher breakdown voltage, such diodes are normally called Zener diodes.