

VI Characteristics of a Diode

Theory

Objectives

At the end of the experiment, the student should be able to

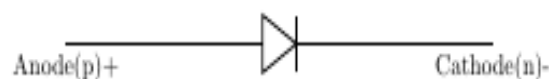
1. Explain the structure of a P-N junction diode
2. Explain the function of a P-N junction diode
3. Explain forward and reverse biased characteristics of a Silicon diode
4. Explain forward and reverse biased characteristics of a Germanium diode

Structure of P-N junction diode

The diode is a device formed from a junction of n-type and p-type semiconductor material. The lead connected to the p-type material is called the anode and the lead connected to the n-type material is the cathode. In general, the cathode of a diode is marked by a solid line on the diode.



Figurer:1

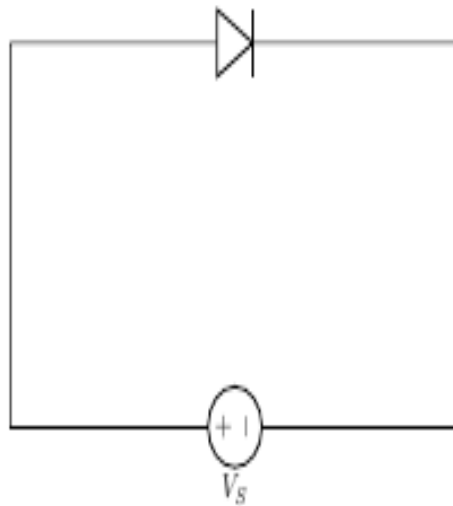


Figurer:2

Function of a P-N junction diode in Forward Bias

The positive terminal of battery is connected to the P side(anode) and the negative terminal of battery is connected to the N side(cathode) of a diode, the holes in the p-type region and

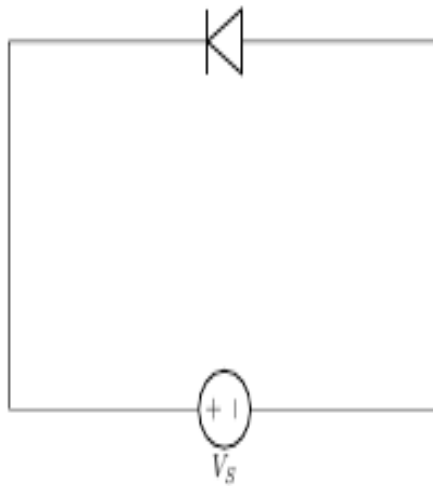
the electrons in the n-type region are pushed toward the junction and start to neutralize the depletion zone, reducing its width. The positive potential applied to the p-type material repels the holes, while the negative potential applied to the n-type material repels the electrons. The change in potential between the p side and the n side decreases or switches sign. With increasing forward-bias voltage, the depletion zone eventually becomes thin enough that the zone's electric field cannot counteract charge carrier motion across the p–n junction, which as a consequence reduces electrical resistance. The electrons that cross the p–n junction into the p-type material (or holes that cross into the n-type material) will diffuse into the nearby neutral region. The amount of minority diffusion in the near-neutral zones determines the amount of current that may flow through the diode.



Figurer:3

Function of a P-N junction diode in Reverse Bias

The positive terminal of battery is connected to the N side(cathode) and the negative terminal of battery is connected to the P side(anode) of a diode. Therefore, very little current will flow until the diode breaks down.



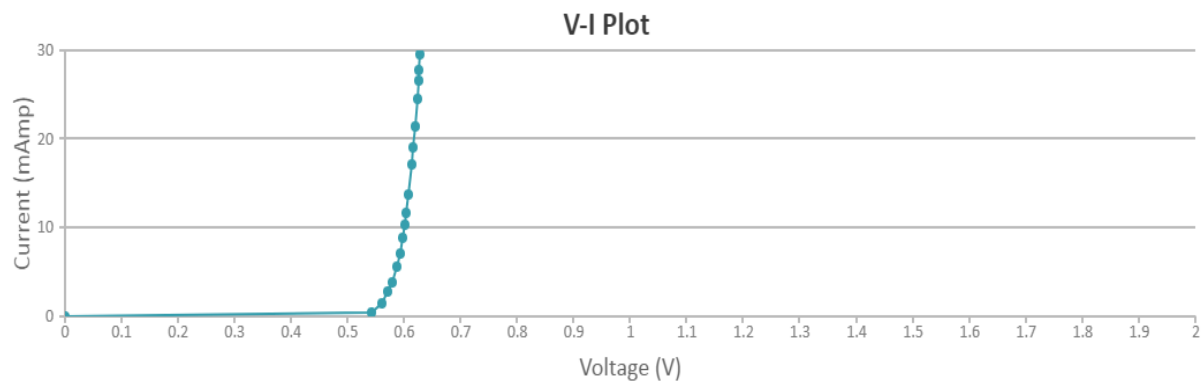
Figurer:4

The positive terminal of battery is connected to the N side(cathode) and the negative terminal of battery is connected to the P side(anode) of a diode, the 'holes' in the p-type material are pulled away from the junction, leaving behind charged ions and causing the width of the depletion region to increase. Likewise, because the n-type region is connected to the positive terminal, the electrons will also be pulled away from the junction, with similar effect. This increases the voltage barrier causing a high resistance to the flow of charge carriers, thus allowing minimal electric current to cross the p–n junction. The increase in resistance of the p–n junction results in the junction behaving as an insulator. The strength of the depletion zone electric field increases as the reverse-bias voltage increases. Once the electric field intensity increases beyond a critical level, the p–n junction depletion zone breaks down and current begins to flow, usually by either the Zener or the avalanche breakdown processes. Both of these breakdown processes are non-destructive and are reversible, as long as the amount of current flowing does not reach levels that cause the semiconductor material to overheat and cause thermal damage.

Forward and reverse biased characteristics of a Silicon diode

In forward biasing, the positive terminal of battery is connected to the P side and the negative terminal of battery is connected to the N side of the diode. Diode will conduct in forward biasing because the forward biasing will decrease the depletion region width and overcome the barrier potential. In order to conduct, the forward biasing voltage should be greater than the barrier potential. During forward biasing the diode acts like a closed switch with a

potential drop of nearly 0.6 V across it for a silicon diode. The forward and reverse bias characteristics of a silicon diode. From the graph, you may notice that the diode starts conducting when the forward bias voltage exceeds around 0.6 volts (for Si diode). This voltage is called cut-in voltage.

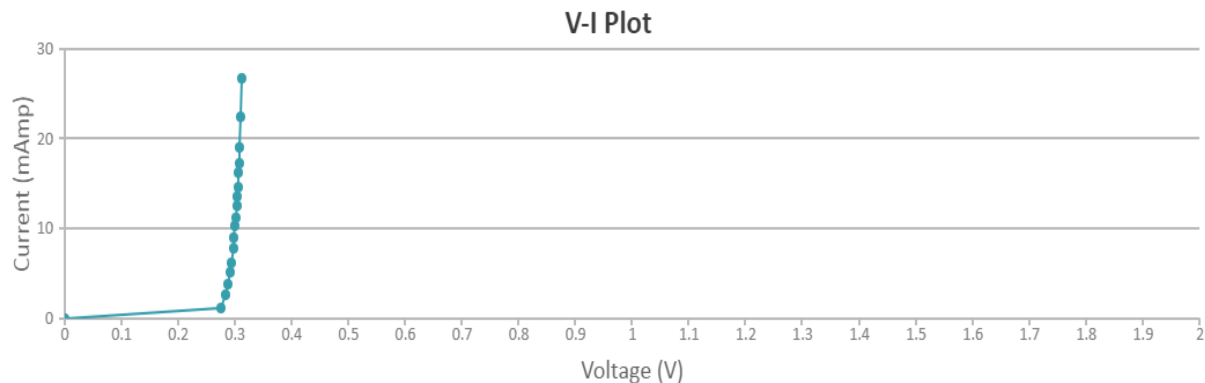


Figurer:5

In reverse biasing, the positive terminal of battery is connected to the N side and the negative terminal of battery is connected to the P side of a diode. In reverse biasing, the diode does not conduct electricity, since reverse biasing leads to an increase in the depletion region width; hence current carrier charges find it more difficult to overcome the barrier potential. The diode will act like an open switch and there is no current flow.

Forward and reverse biased characteristics of a Germanium diode

In forward biasing, the positive terminal of battery is connected to the P side and the negative terminal of battery is connected to the N side of the diode. Diode will conduct in forward biasing because the forward biasing will decrease the depletion region width and overcome the barrier potential. In order to conduct, the forward biasing voltage should be greater than the barrier potential. During forward biasing the diode acts like a closed switch with a potential drop of nearly 0.3 V across it for a germanium diode. The forward and reverse bias characteristics of a germanium diode. From the graph, you may notice that the diode starts conducting when the forward bias voltage exceeds around 0.3 volts (for Ge diode). This voltage is called cut-in voltage.



Figurer:6

In reverse biasing, the positive terminal of battery is connected to the N side and the negative terminal of battery is connected to the P side of a diode. In reverse biasing, the diode does not conduct electricity, since reverse biasing leads to an increase in the depletion region width; hence current carrier charges find it more difficult to overcome the barrier potential. The diode will act like an open switch and there is no current flow.

Procedure

5. Forward Bias-Si Diode

- a. Set DC voltage to 0.2 V .
- b. Select the diode.
- c. Set the resistor.
- d. Voltmeter is placed parallel to Silicon diode and ammeter series with resistor.
- e. The positive side of battery to the P side(anode) and the negative of battery to the N side(cathode) of the diode.
- f. Now vary the voltage upto 5V and note the Voltmeter and Ammeter reading for particular DC voltage .
- g. Take the readings and note Voltmeter reading across Silicon diode and Ammeter reading.
- h. Plot the V-I graph and observe the change.
- i. Calculate the dynamic resistance of the diode. $r_d = \Delta V / \Delta I$
- j. Therefore from the graph we see that the diode starts conducting when the forward bias voltage exceeds around 0.6 volts (for Si diode). This voltage is called cut-in voltage.

6. Reverse Bias-Si Diode

- a. Set DC voltage to 0.2 V .
- b. Select the diode.
- c. Set the resistor.
- d. Voltmeter is placed parallel to Silicon diode and ammeter series with resistor.
- e. The positive terminal of battery is connected to the N side(cathode) and the negative terminal of battery is connected to the P side(anode) of a diode.
- f. Now vary the voltage upto 30V and note the Voltmeter and Ammeter reading for DC voltage .
- g. Take the readings and note Voltmeter reading across Silicon diode and Ammeter reading.
- h. Plot the V-I graph and observe the change.

7. Forward Bias-Ge Diode

- a. Set DC voltage to 0.2 V .
- b. Use the resistor of 1K ohms and a Germanium diode.
- c. Voltmeter is placed parallel to Germanium diode and ammeter series with resistor.
- d. The positive terminal of battery is connected to the P side(anode) and the negative terminal of battery is connected to the N side(cathode) of the diode.
- e. Now vary the voltage upto 30V and note the Voltmeter and Ammeter reading for particular DC voltage .
- f. Take the readings and note Voltmeter reading across Germanium diode and Ammeter reading.
- g. Plot the V-I graph and observe the change.
- h. Therefore from the graph we see that the diode starts conducting when the forward bias voltage exceeds around 0.3 volts (for Ge diode). This voltage is called cut-in voltage.

8. Reverse Bias-Ge Diode

- a. Set DC voltage to 0.2 V .
- b. Use the resistor of 1K ohms and a Germanium diode.
- c. Voltmeter is placed parallel to Germanium diode and ammeter series with resistor.
- d. The positive terminal of battery is connected to the N side(cathode) and the negative terminal of battery is connected to the P side(anode) of a diode.
- e. Now vary the voltage upto 30V and note the Voltmeter and Ammeter reading for DC voltage .
- f. Take the readings and note Voltmeter reading across Silicon diode and Ammeter reading.
- g. Plot the V-I graph and observe the change