SCHOTTKY BARRIER, MONOLITHIC DIODES AND SCHOTTKY TRANSISTOR

Schottky Barrier Diode:

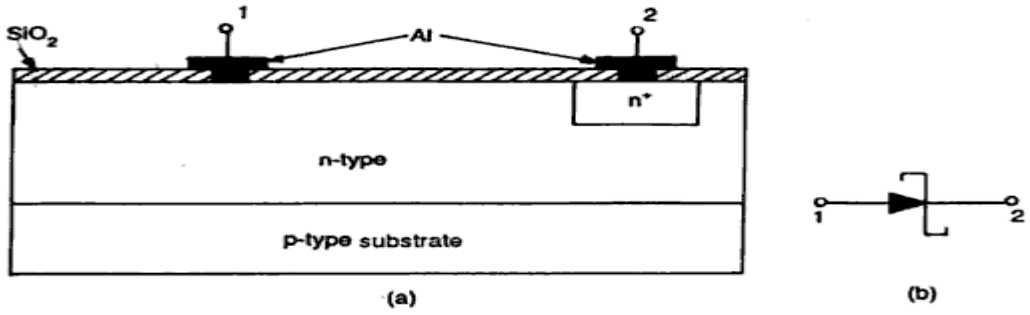


Fig. 1.21 (a) A Schottky diode, (b) Symbol for metal semiconductor diode

The metal contacts are required to be ohmic and no PN junctions to be formed between the metal and silicon layers. The N^+ diffusion region serves the purpose of generating ohmic contacts. On the other hand, if aluminium is deposited directly on the N-type silicon, then a metal semiconductor diode can be said to be formed. Such a metal semiconductor diode junction exhibits the same type of V-I Characteristics as that of an ordinary PN junction.

The cross sectional view and symbol of a Schottky barrier diode as shown in figure. Contact 1 shown in figure is a Schottky barrier and the contact 2 is an ohmic contact. The contact potential between the semiconductor and the metal generated a barrier for the flow of conducting electrons from semiconductor to metal. When the junction is forward biased this barrier is lowered and the electron flow is allowed from semiconductor to metal, where the electrons are in large quantities.

The minority carriers carry the conduction current in the Schottky diode whereas in the PN junction diode, minority carriers carry the conduction current and it incurs an appreciable time delay from ON state to OFF state. This is due to the fact that the minority carriers stored in the junction have to be totally removed. This characteristic puts the Schottky barrier diode at an advantage since it exhibits negligible time to flow the electron from N-type silicon into aluminum almost right at the contact surface, where they mix with the free electrons. The other advantage of this diode is that it has less forward voltage (approximately 0.4V). Thus it can be used for clamping and detection in high frequency applications and microwave integrated circuits.

Schottky transistor:

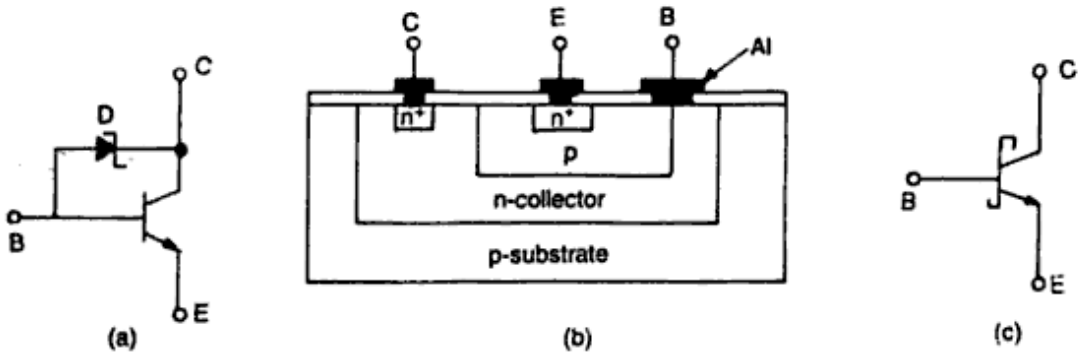


Fig. 1.19 (a) A transistor with a Schottky-barrier diode clamped between base and collector to prevent saturation, (b) Cross-section of a Schottky-barrier transistor, (c) Symbolic representation

The cross-sectional view of a transistor employing a Schottky barrier diode clamped between its base and collector regions is shown in figure. The equivalent circuit and the symbolic representation of the Schottky transistor are shown in figure. The Schottky diode is formed by allowing aluminium metallization for the base lead which makes contact with the N-type collector region also as shown in figure.

When the base current is increased to saturate the transistor, the voltage at the collector C reduces and this makes the diode Ds conduct. The base to collector voltage reduces to 0.4V, which is less the cut-in-voltage of a silicon base-collector junction. Therefore, the transistor does not get saturated.

Monolithic diodes:

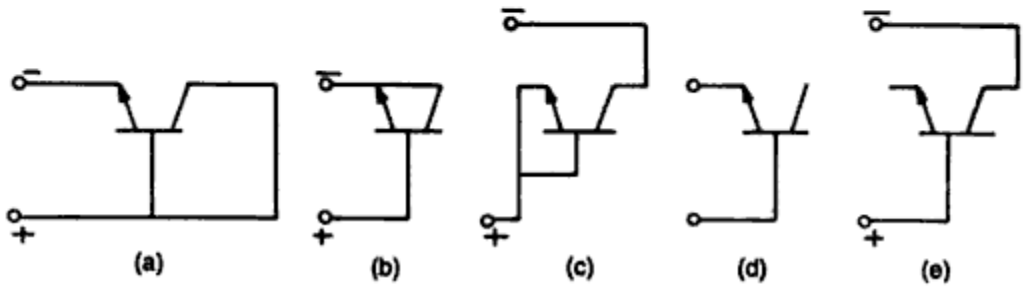
The diode used in integrated circuits are made using transistor structures in one of the five possible connections. The three most popular structures are shown in figure. The diode is obtained from a transistor structure using one of the following structures.

1. The emitter-base diode, with collector short circuited to the base.

2. The emitter-base diode with the collector open and
3. The collector –base diode, with the emitter open-circuited.

The choice of the diode structure depends on the performance and application desired. Collector-base diodes have higher collector-base arrays breaking rating, and they are suitable for common-cathode diode arrays diffused within a single isolation island. The emitter-base diffusion is very popular for the fabrication of diodes, provided the reverse-voltage requirement of the circuit does not exceed the lower base-emitter breakdown voltage.

Characteristic	*(a)* $V_{CB} = 0$	*(b)* $V_{CE} = 0$	*(c)* $V_{EB} = 0$	*(d)* $I_C = 0$	*(e)* $I_E = 0$
Breakdown voltage in volts	7	7	55	7	55
Storage time, n sec	9	100	53	56	85
Forward voltage in volts	.85	.92	.94	.96	.95



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