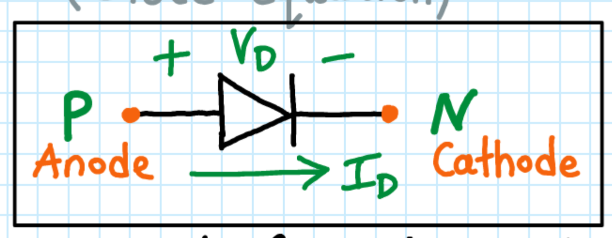
28 May 2021 20:52

Todays topic:
I-V characteristics of PN junction diode
Real Diodes

✱ Current - voltage relationship in a PN junction diode / Diode equation:

$$\boxed{I_D = I_S\left(e^{\frac{V_D}{nV_T}} - 1\right)}$$ .... Shockley's equation (Diode equation)



where, I_D is diode current in mA

V_D is applied diode voltage in volts

I_S is leakage or reverse saturation current in μA or nA

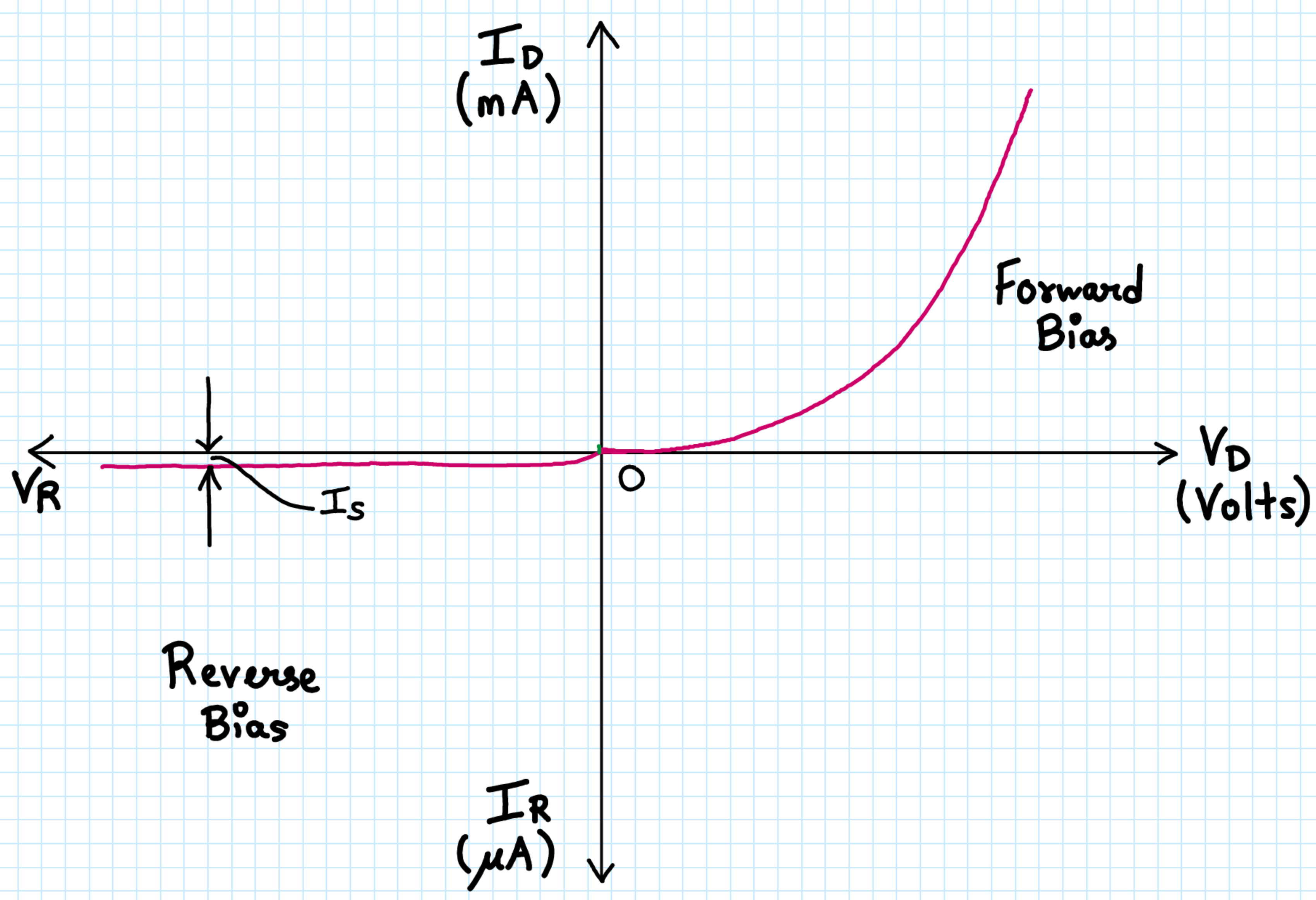
n is ideality factor

n is 1 for Ge and n is 2 for Si

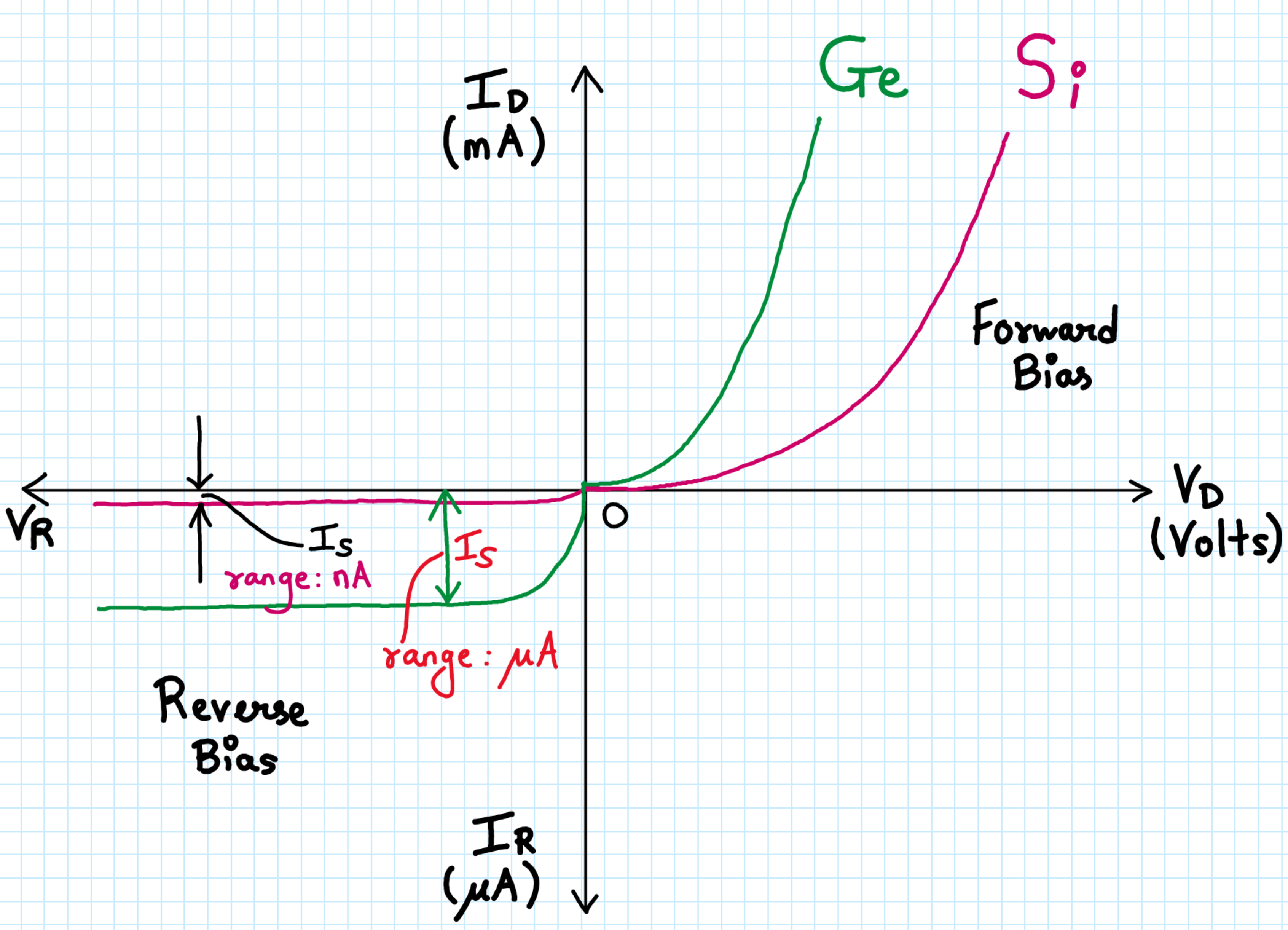
V_T is thermal voltage at $T = 300K$ (27°C)

$V_T = \frac{KT}{q} = \frac{T}{11600}$; $V_T = 26\,mV$ at $T = 300K$

V_T is also volt equivalent of temperature



I-V characteristics of diode



I-V characteristics of Si and Ge diode

✱ Observations (from I-V characteristics)

① Diode equation tells us how current I_D flows for given amount of applied voltage V_D

② In forward bias, I_D increases exponentially with applied forward voltage V_D as per diode equation

$$\boxed{I_D = I_S\left(e^{\frac{V_D}{nV_T}} - 1\right)}$$

Diode is forward biased if V_D positive (Anode is positive w.r.t cathode)

③ In reverse bias, V_D is negative (large value), thus

$$\boxed{e^{\frac{-V_D}{nV_T}} \longrightarrow 0}$$

$$\boxed{I_D = -I_S}$$ .... in reverse bias

This means that the reverse current in a diode is constant and it is equal to I_S

i.e reverse current saturates to I_S in the reverse direction

(hence the name reverse saturation current)

④ In reverse bias, I_D is independent of applied reverse bias

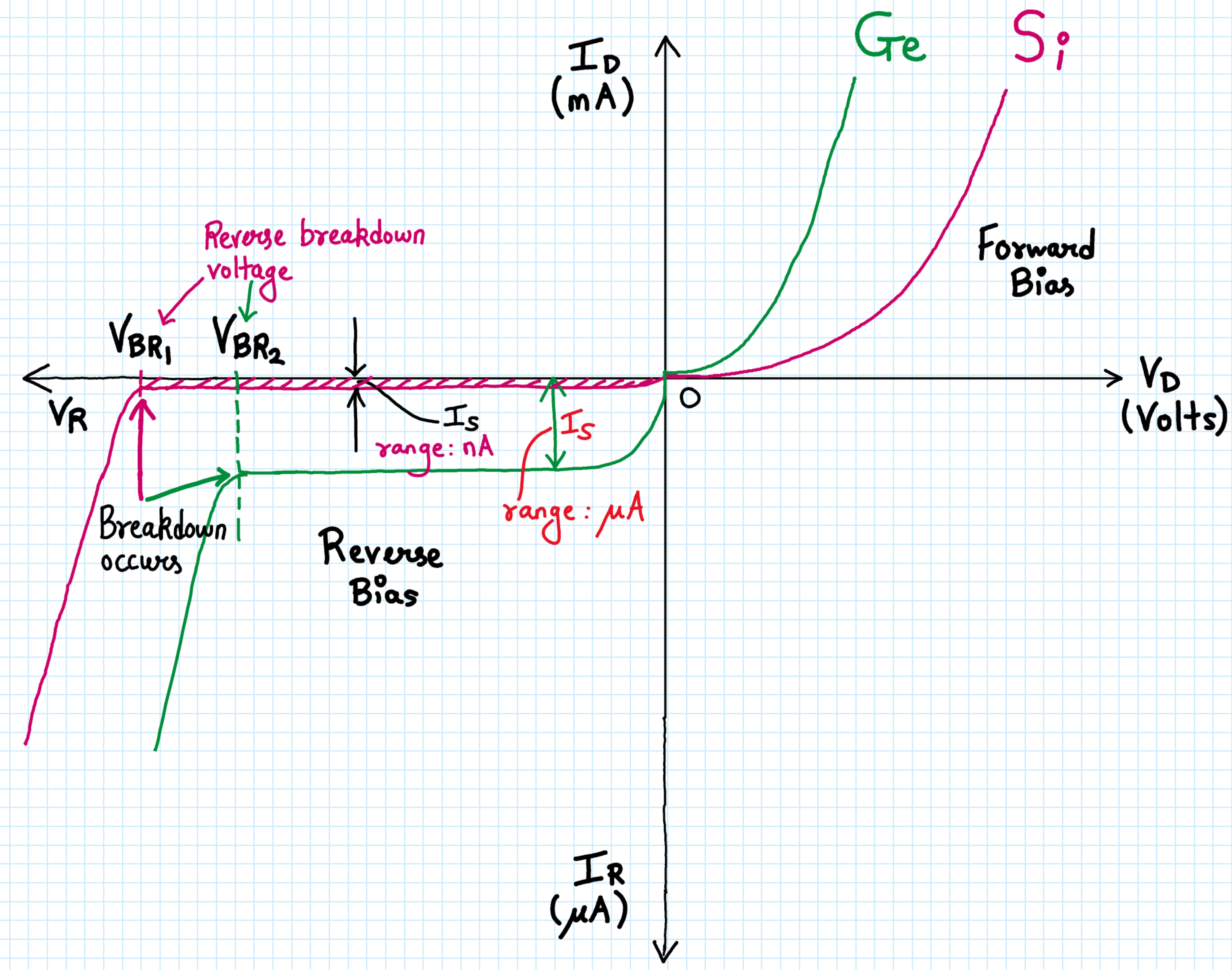
(A positive value of I_D means that current flows from p-side to n-side)

✱ Real diodes: Zener & Avalanche

① As observed in reverse bias pn junction conduct very small current (in μA or nA) & it is constant

② It is true, until a critical reverse voltage is reached & junction breakdown occurs (There are two mechanisms of breakdown)

Zener breakdown | Avalanche breakdown



③ When reverse-bias voltage V_{BR_1} (say 50V) for Si diodes, then the reverse current in the diode increases rapidly

④ When breakdown occurs, the voltage across the diode terminals remains almost more or less constant