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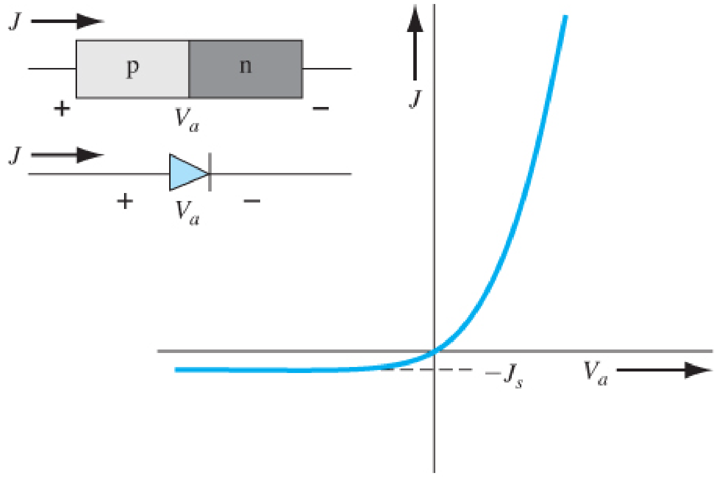

Figure 8.8 | Ideal *I*–*V* characteristic of a pn junction diode.

- $J = \left[\frac{eD_p p_{n0}}{L_p} + \frac{eD_n n_{p0}}{L_n}\right]\left(e^{eV_a/k_BT} - 1\right) = J_s\left(e^{eV_a/k_BT} - 1\right) = J_s\left(e^{V_a/V_t} - 1\right)$
- At 300 K, $V_t = k_BT/e = 0.025852$ V.
- Scale is exaggerated for sake of illustration.

Example- Let's revisit our germanium pn junction at 300 K where $N_a = 6 \times 10^{15}$ cm^{-3} (p region) and $N_d = 3 \times 10^{15}$ cm^{-3} (n region). Use MathCad to calculate the current densities versus applied forward bias voltage V_a.

Use values from prior example to get-

$Dp = 41.363$ cm^2/s $pn0 = 1.92 \times 10^{17}$ m^{-3} $Lp = 9.095405 \times 10^{-6}$ m

Hole contribution to J_s $\frac{qe \cdot Dp \cdot 10^{-4} \cdot pn0}{Lp} = 13.9895$ A/m^2

$Dn = 87.897$ cm^2/s $np0 = 9.6 \times 10^{16}$ m^{-3} $Ln = 2.651744 \times 10^{-5}$ m

Electron contribution to J_s $\frac{qe \cdot Dn \cdot 10^{-4} \cdot np0}{Ln} = 5.0983$ A/m^2

(8.26) $Js := \frac{qe \cdot Dp \cdot 10^{-4} \cdot pn0}{Lp} + \frac{qe \cdot Dn \cdot 10^{-4} \cdot np0}{Ln}$ $Js = 19.0878$ A/m^2

Now, plot current densities versus V_a

$n := 0..45 \qquad Va_n := -0.15 + 1 \cdot \frac{n}{100} \qquad Jn_n := \frac{qe \cdot Dn \cdot 10^{-4} \cdot np0}{Ln} \cdot \left(e^{\frac{Va_n}{Vt}} - 1 \right)$

$Jp_n := \frac{qe \cdot Dp \cdot 10^{-4} \cdot pn0}{Lp} \cdot \left(e^{\frac{Va_n}{Vt}} - 1 \right) \qquad J_n := Js \cdot \left(e^{\frac{Va_n}{Vt}} - 1 \right)$