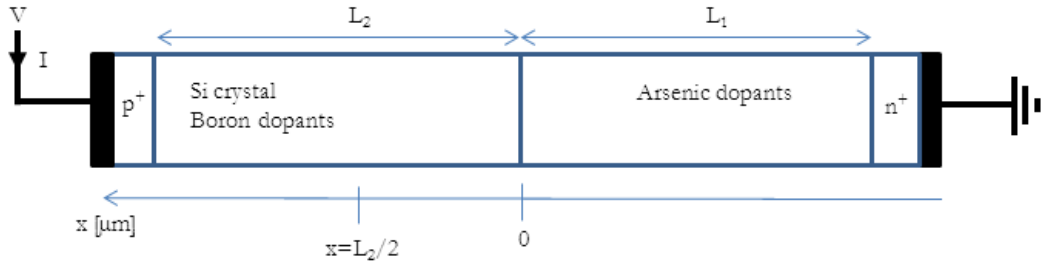
Fråga 12.1

- Vilket randvillkor gäller vid $x=L_2$ om diffusionskonstanten är 18 cm^2/s

A) $p'(x=L_2)=0$
B) $p'(x=\infty)=0$
C) $n'(x=L_2)=0$
D) $n'(x=\infty)=0$

2. Calculate the electron concentration at $x=L_2/2$ on the p-side of the pn junction below when $V=24kT/q$.. The boron concentration is 10^{17} cm^{-3} and the arsenic concentration is 10^{20} cm^{-3}. The carrier lifetime is 100 μs between $x=0$ and $x=L_2=10$ μm.



Fråga 12.2

- Vad är sant för en struktur med n-p-n dopning. När går en stor ström från första n- till andra n-området?

A) Om det första n-området ansluts till positiv potential och det andra till negativ.

B) Om det första n-området ansluts till negativ potential och det andra till positiv.

C) Om p-området ansluts till positiv potential och det andra n-området till negativ.

D) Om p-området ansluts till positiv potential och det andra n-området till postiv.

Figure 8.1 (a) Schematic NPN BJT and normal voltage polarities; (b) electron injection from emitter into base produces and determines I_C ; and (c) I_C is basically determined by V_{BE} and is insensitive to V_{CB}.

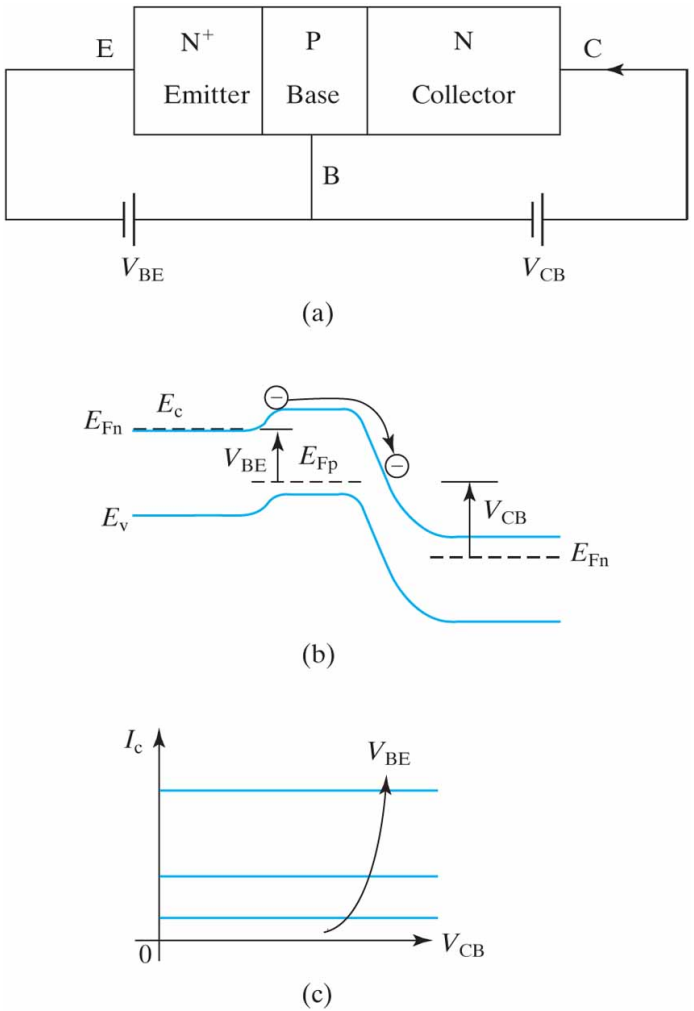


Figure 8.2 (a) Common-emitter convention; (b) I_C vs. V_{CE}; (c) I_B may be used as the parameter instead of V_{BE}; and (d) circuit symbol of an NPN BJT and an inverter circuit.

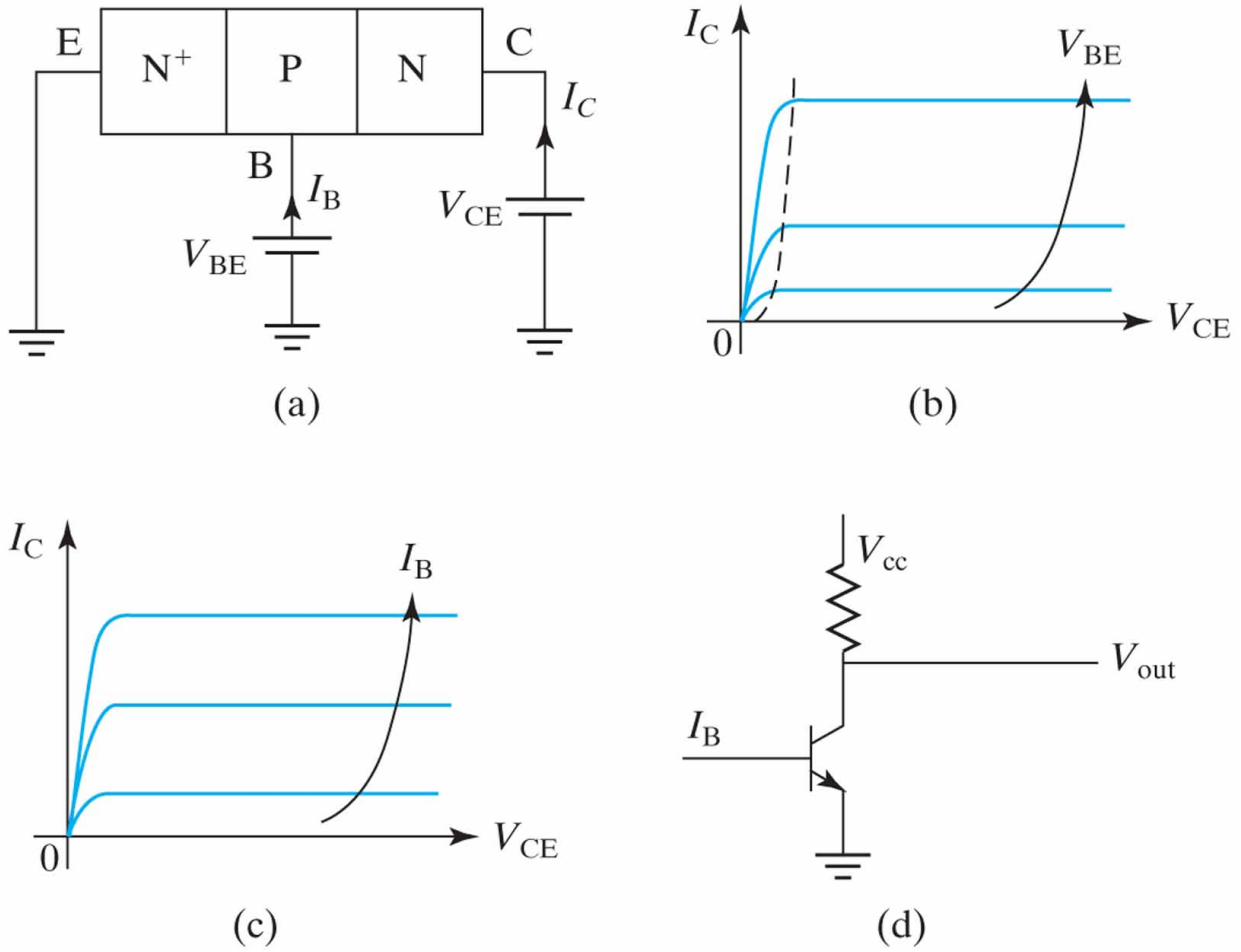


Figure 8.3 $x = 0$ is the edge of the BE junction depletion layer. W_B is the width of the base neutral region.

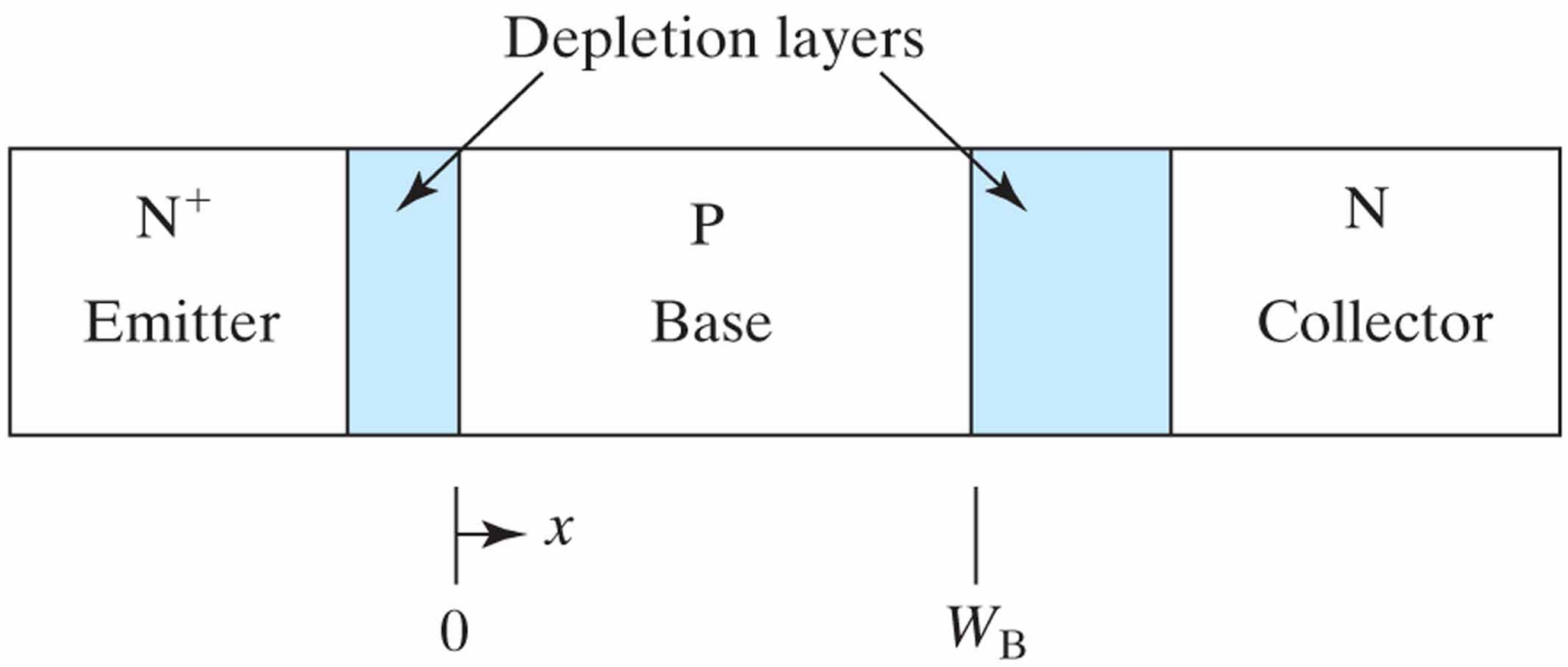


Figure 8.4 When $W_B << L_B$, the excess minority carrier concentration in the base is approximately a linear function of x.

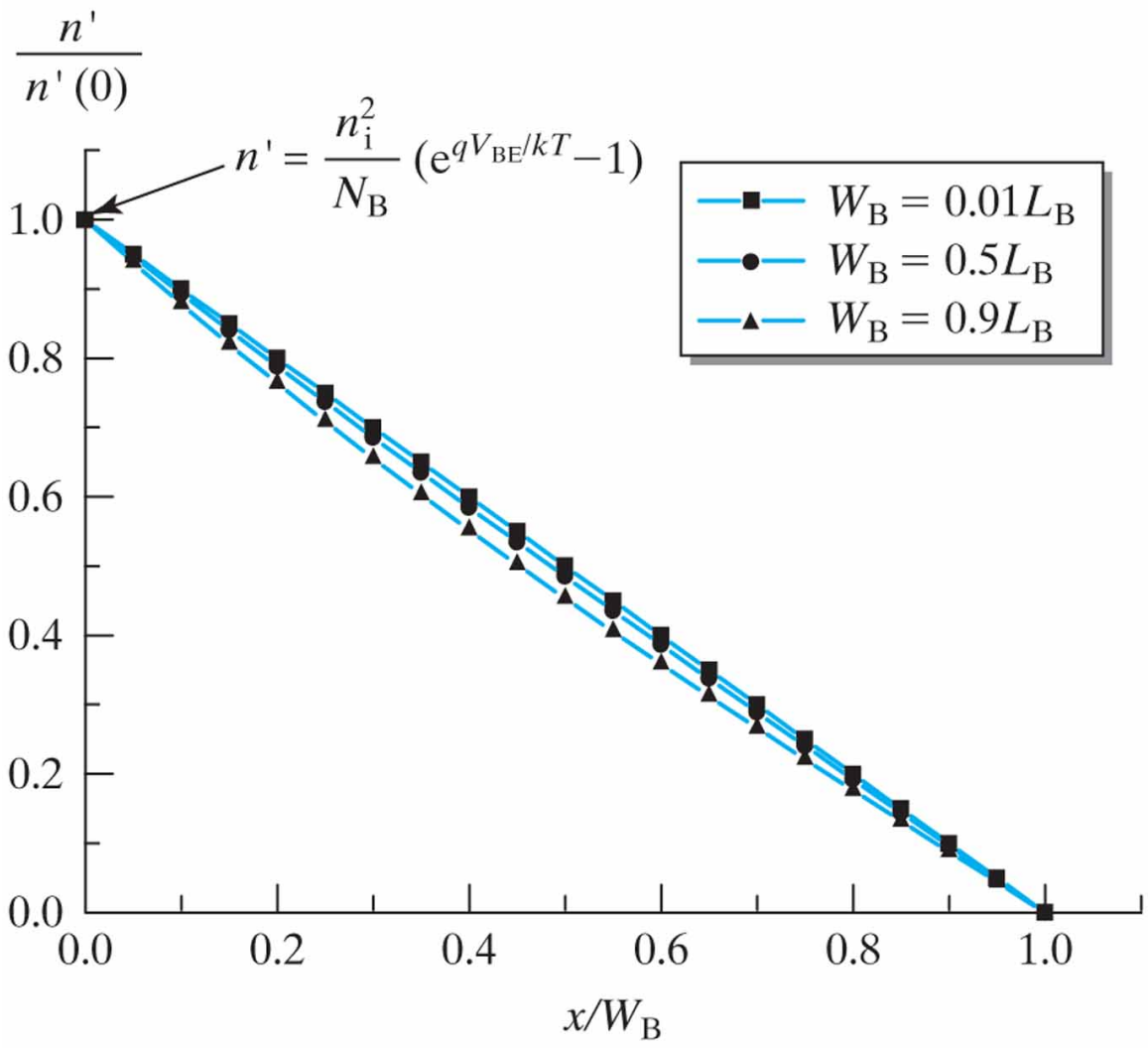


Figure 8.5 I_C is an exponential function of V_{BE}.

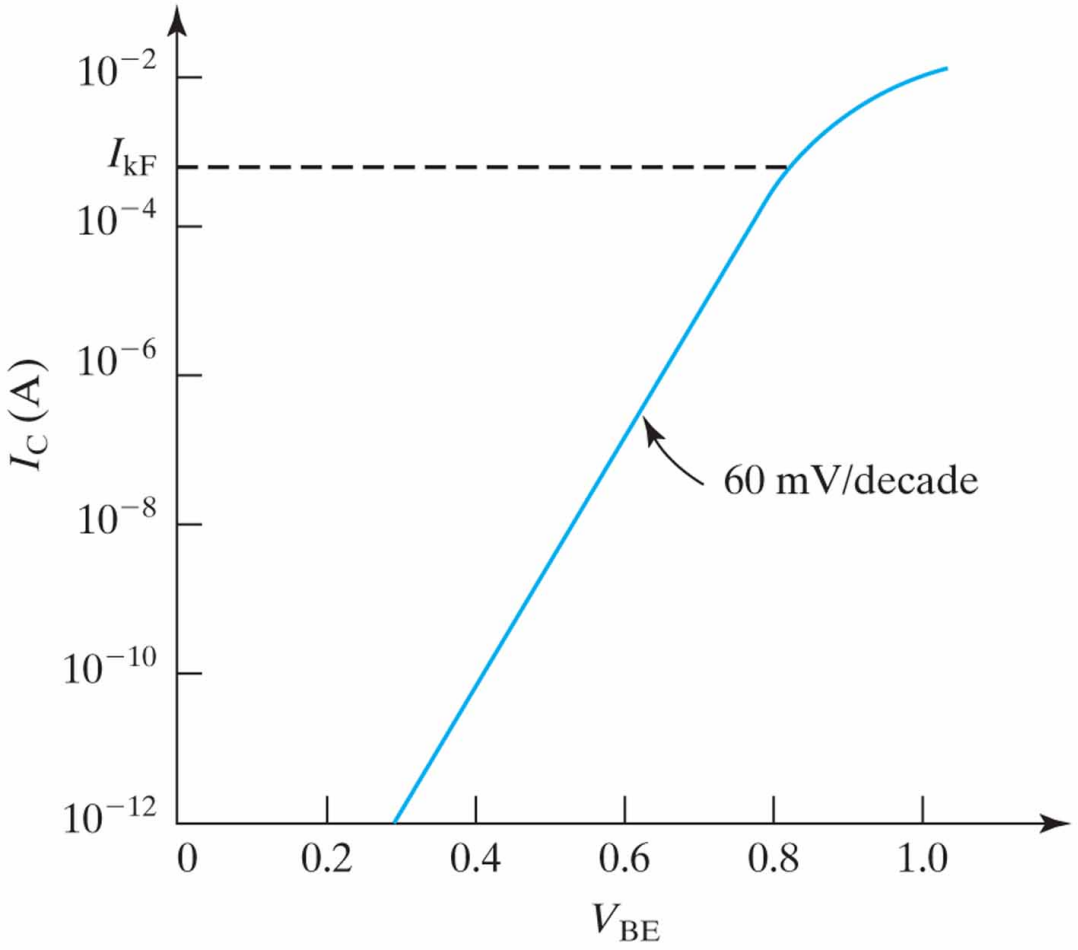
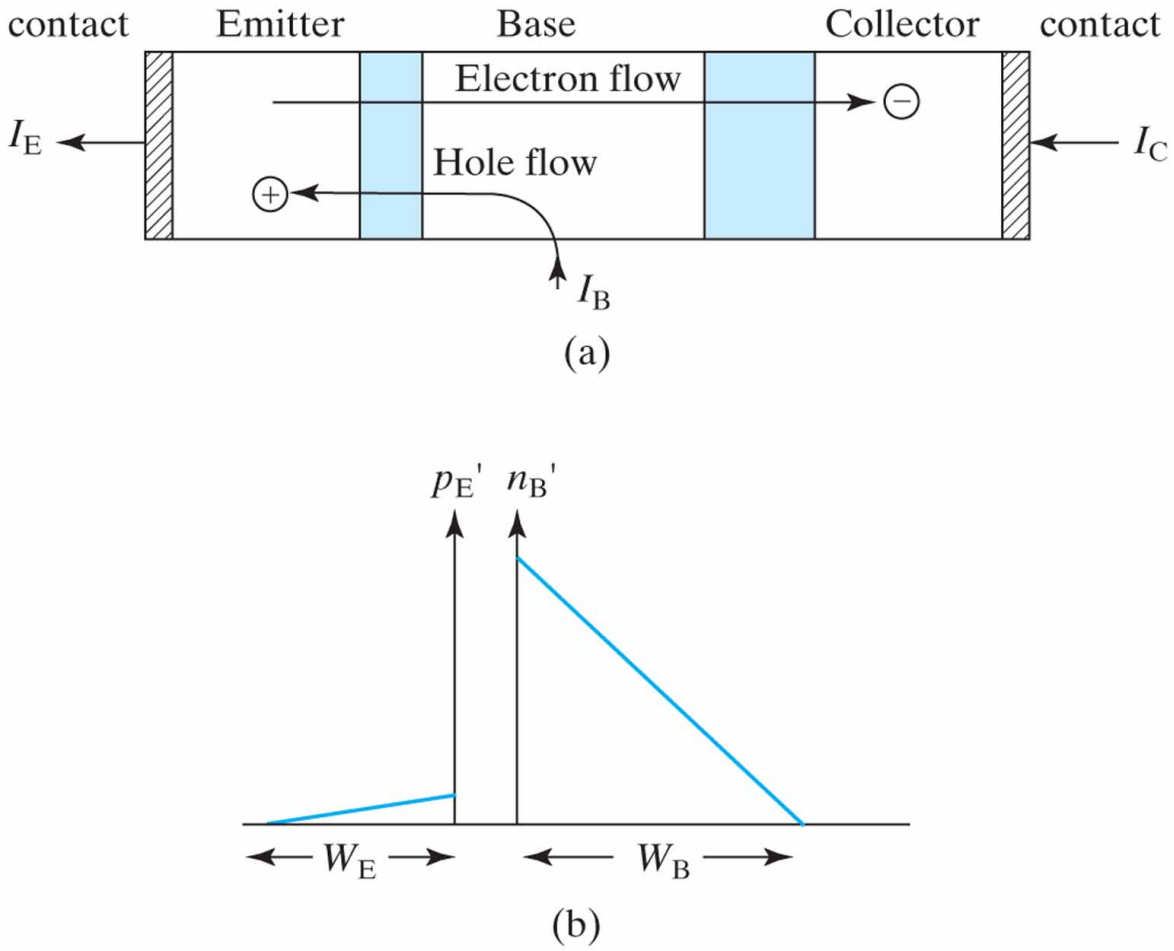


Figure 8.6 (a) Schematic of electron and hole flow paths in BJT; (b) hole injection into emitter closely parallels electron injection into base.[2]



[1] A good metal–semiconductor ohmic contact (at the end of the emitter) is an excellent source and sink of carriers. Therefore, the excess carrier concentration is assumed to be zero.

Figure 8.7 Schematic illustration of a poly-Si emitter, a common feature of high-performance BJTs.

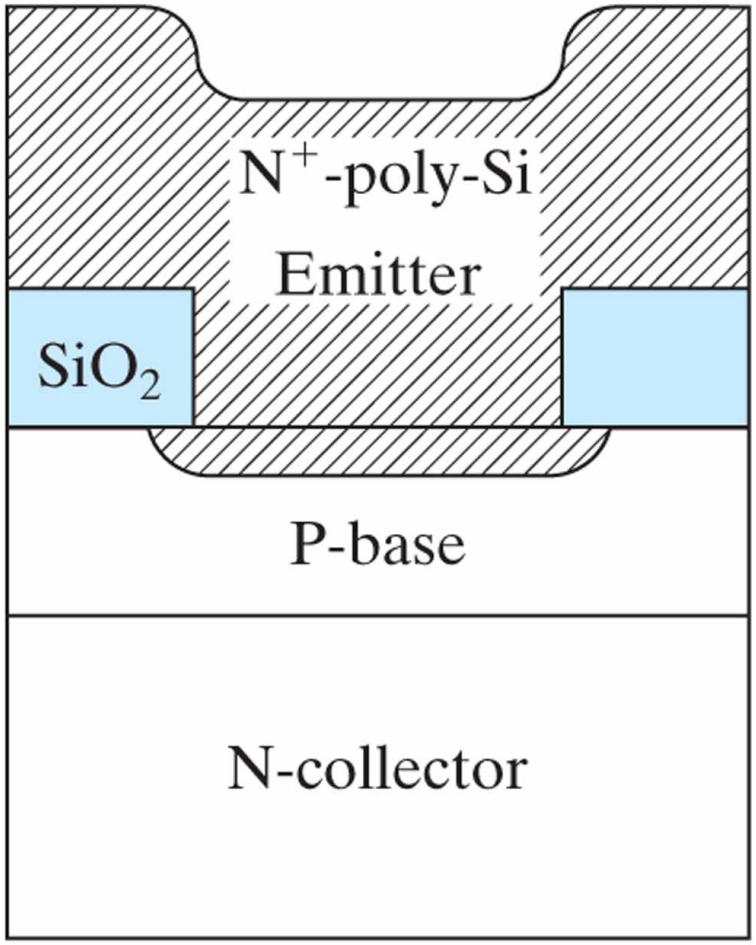


Figure 8.8 Gummel plot of I_C and I_B indicates that β_F (= I_C/I_B) decreases at high and low I_C.

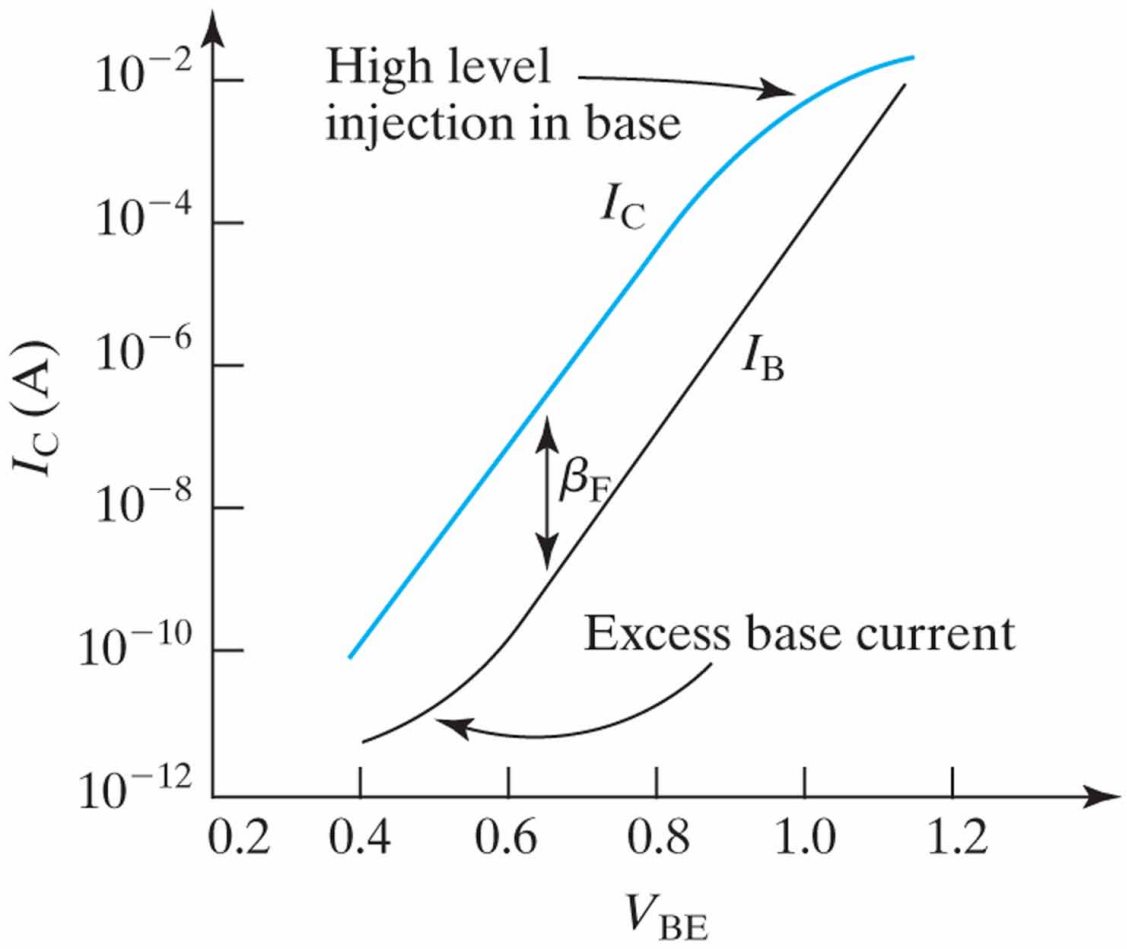


Figure 8.9 Fall-off of current gain at high- and low-current regions. A_E = 0.6 × 4.8 μm2. From top to bottom: V_{BC} = 2, 1 and 0 V. Symbols are data. Lines are from a BJT model for circuit simulation. (From [3].)

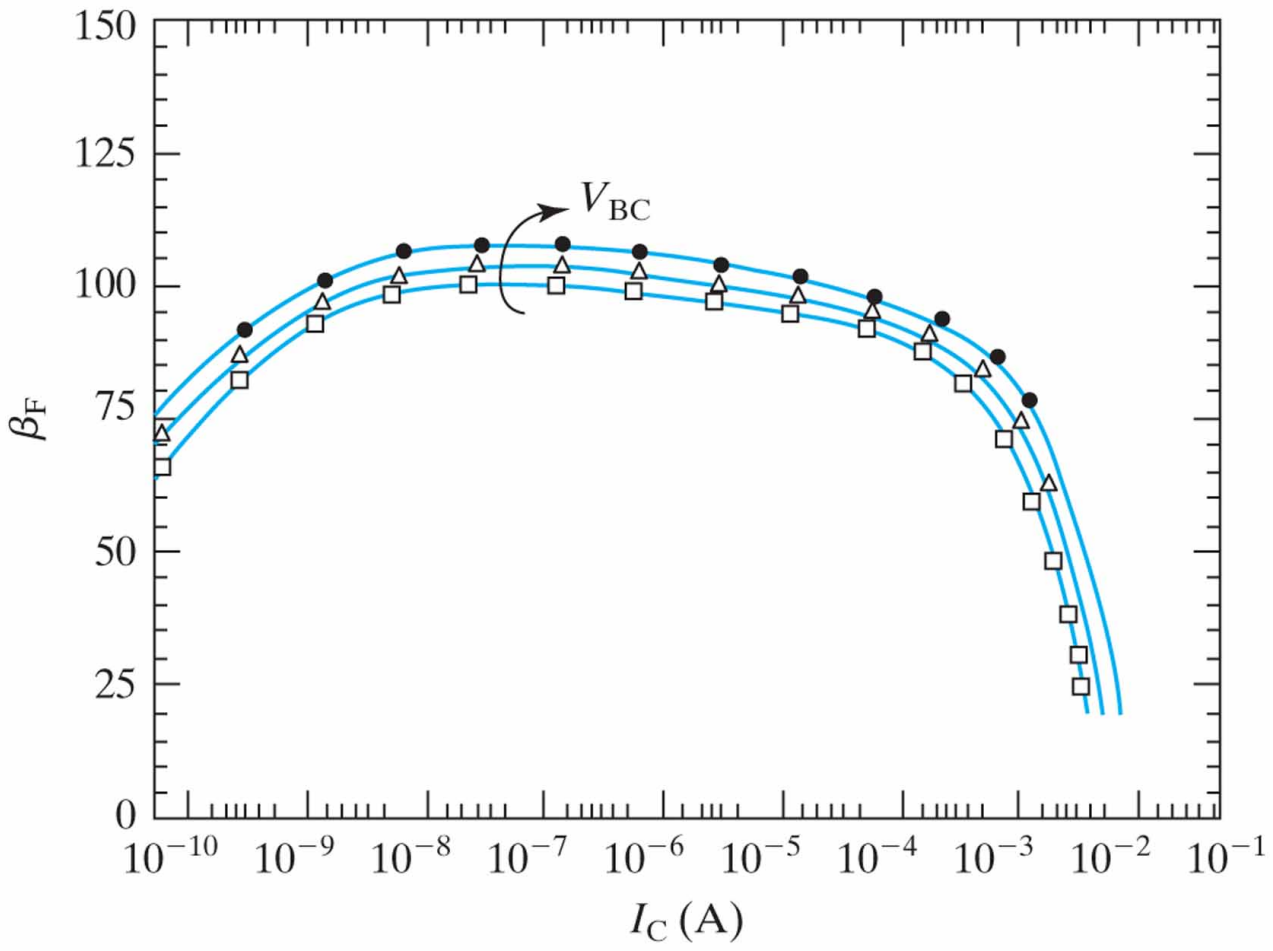


Figure 8.10 BJT output conductance: (a) measured BJT characteristics. I_B = 4, 8, 12, 16, and 20 μA. (From [3].); (b) schematic drawing illustrates the definition of Early voltage, V_A.

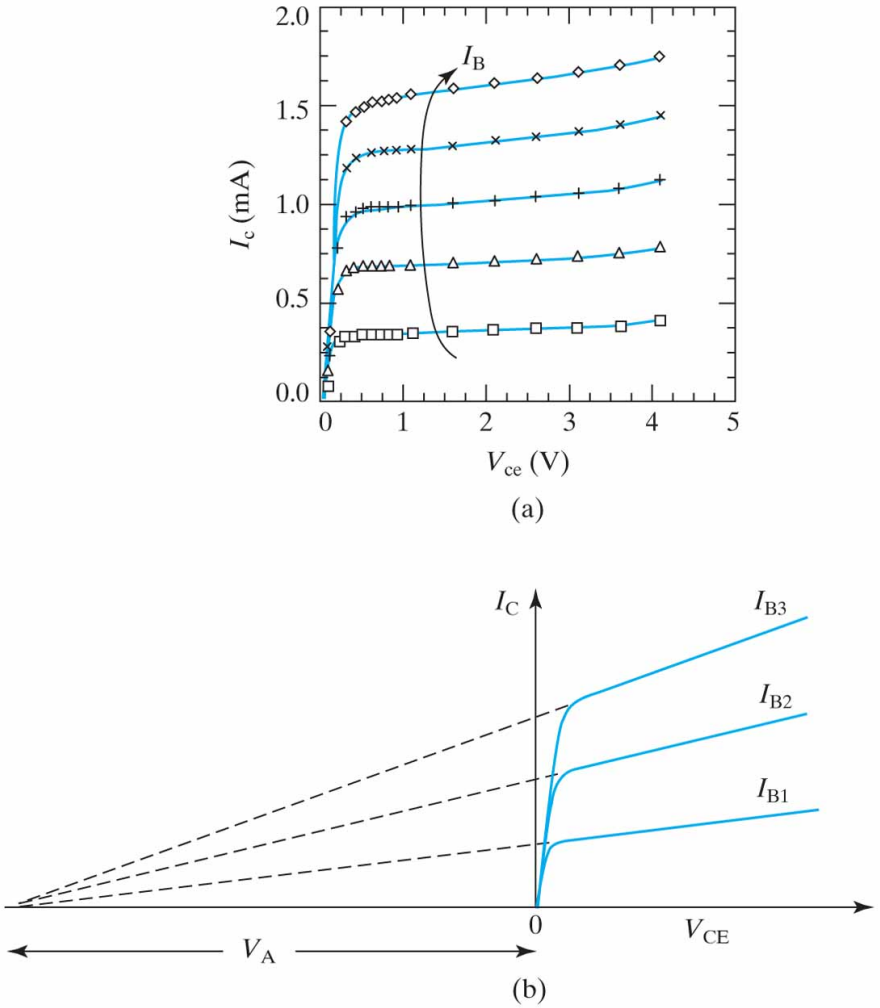


Figure 8.11 *As V_C increases, the BC depletion layer width increases and W_B decreases causing* d*n'*/d*x and I_C to increase*. In reality, the depletion layer in the collector is usually much wider than that in the base.

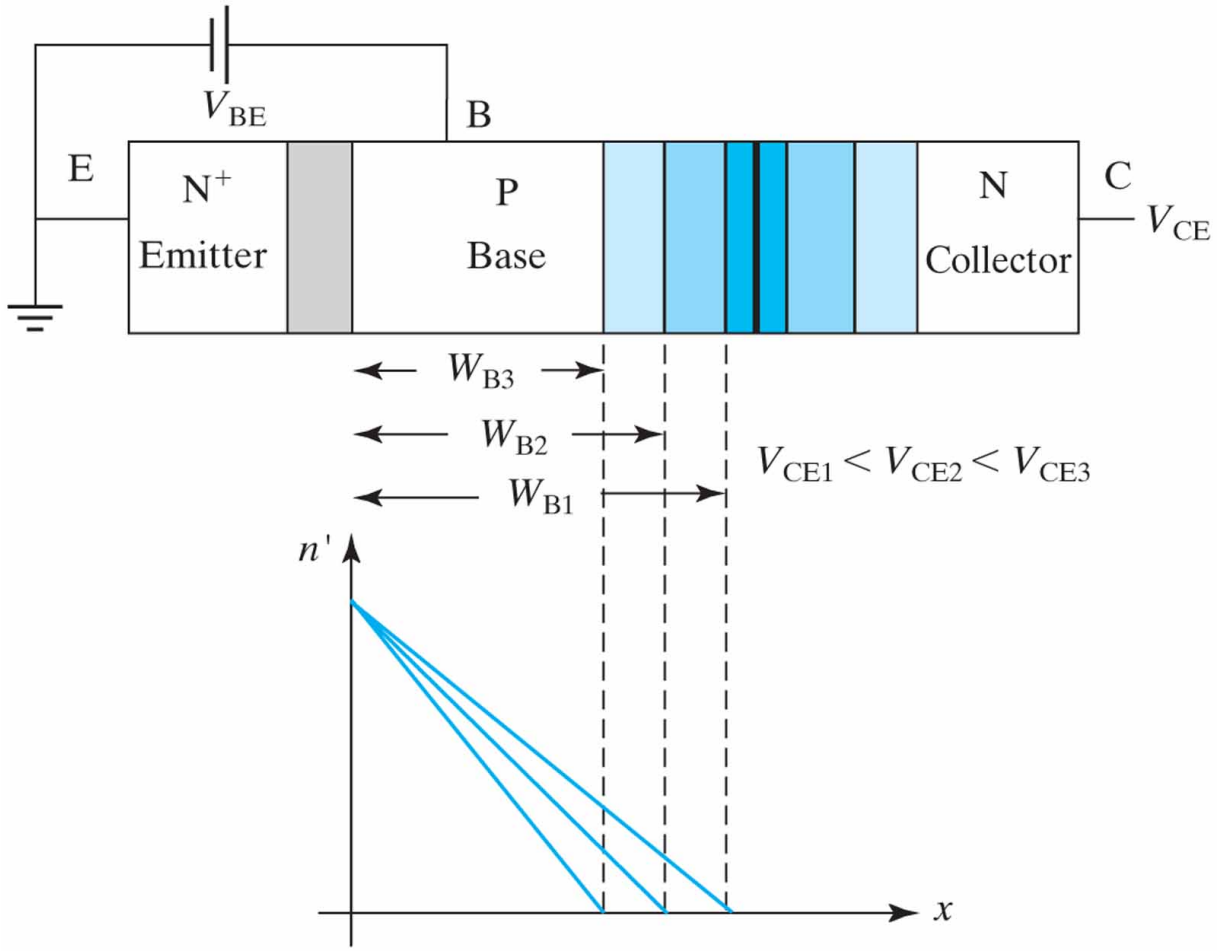


Figure 8.12 In the saturation region, I_C drops because the collector–base junction is significantly forward biased.

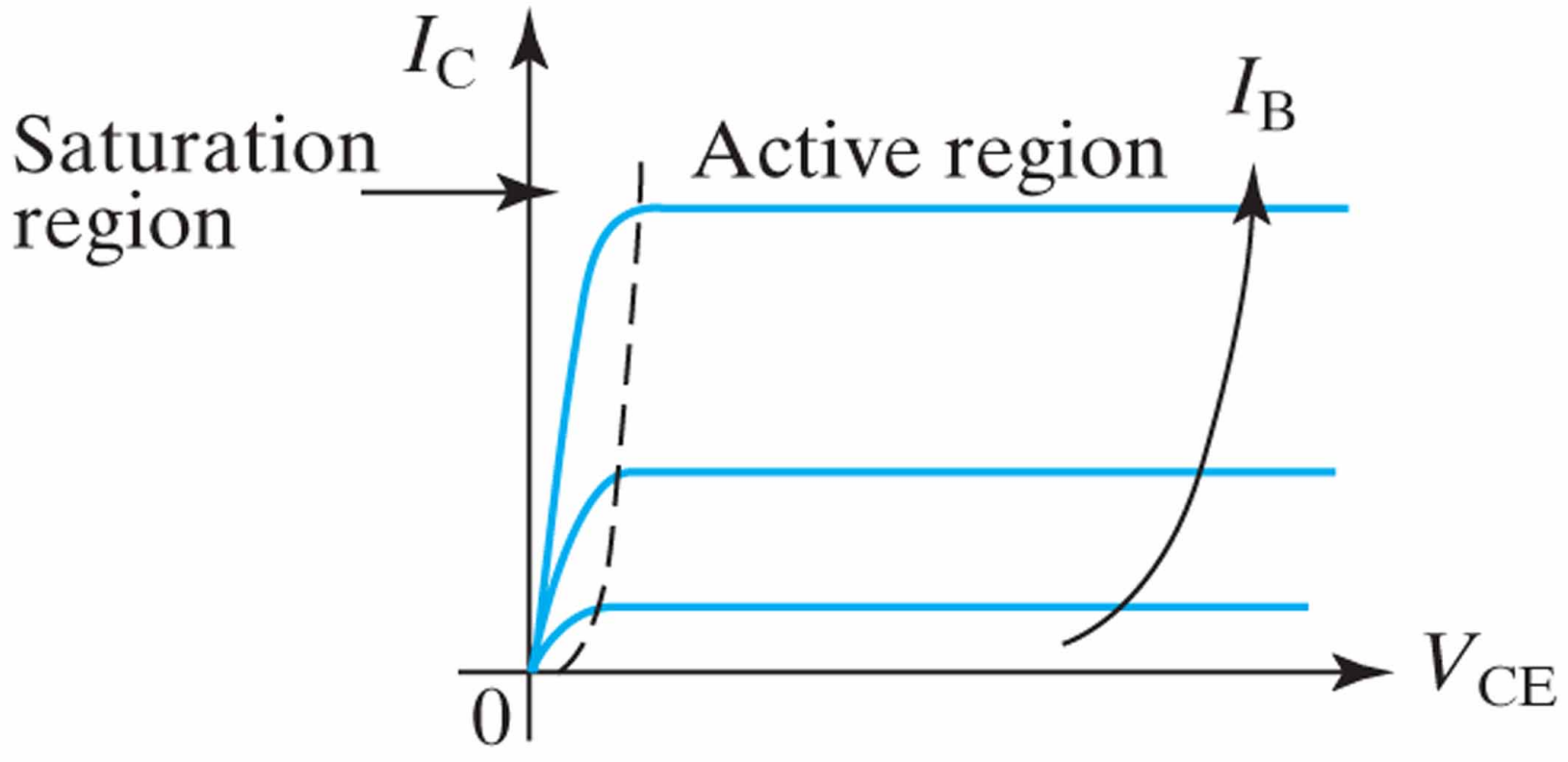


Figure 8.13 I_C is driven by two voltage sources, V_{BE} and V_{BC}.

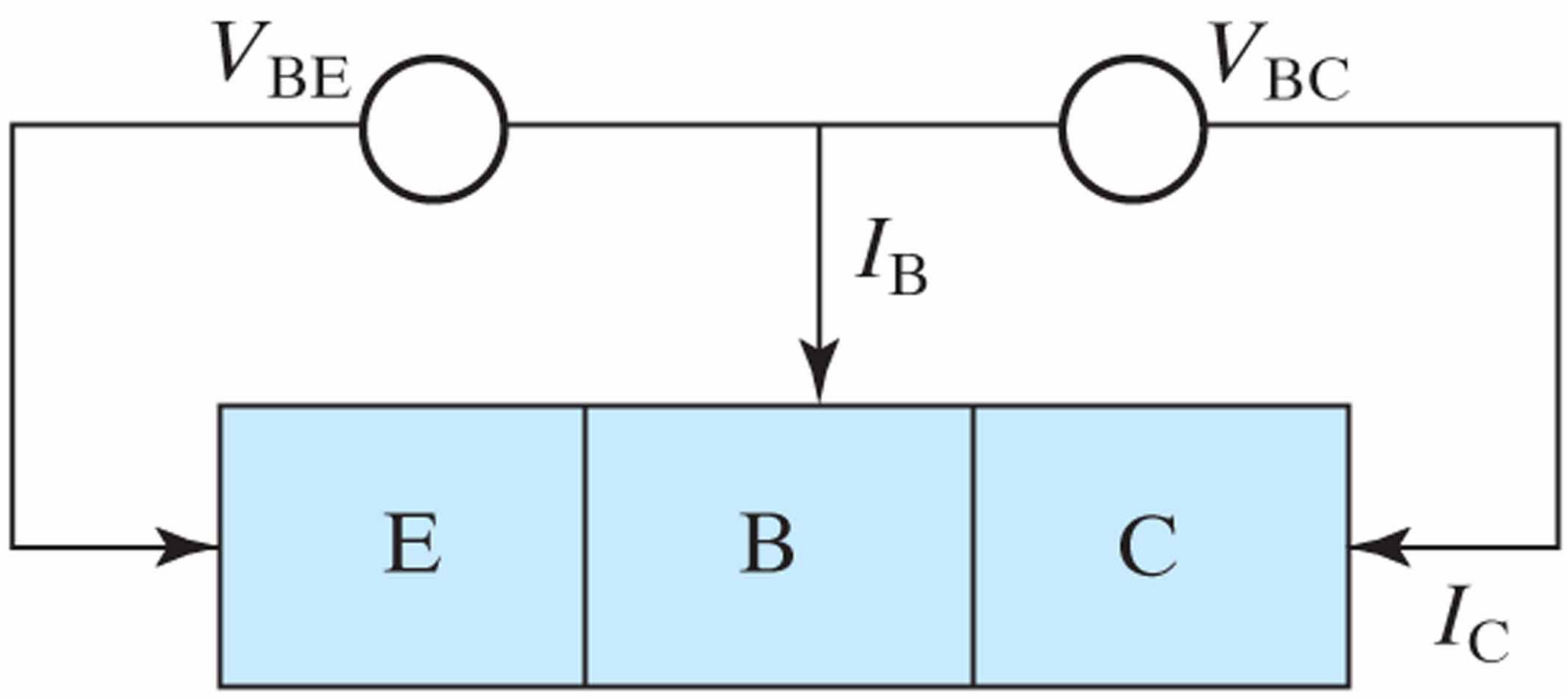


Figure 8.14 Ebers–Moll model (line) agrees with the measured data (symbols) in both the saturation and linear regions. I_B = 4.3, 11, 17, 28, and 43 μA. High-speed SiGe-base BJT. A_E = 0.25 × 5.75 μm^2. (From [3].)

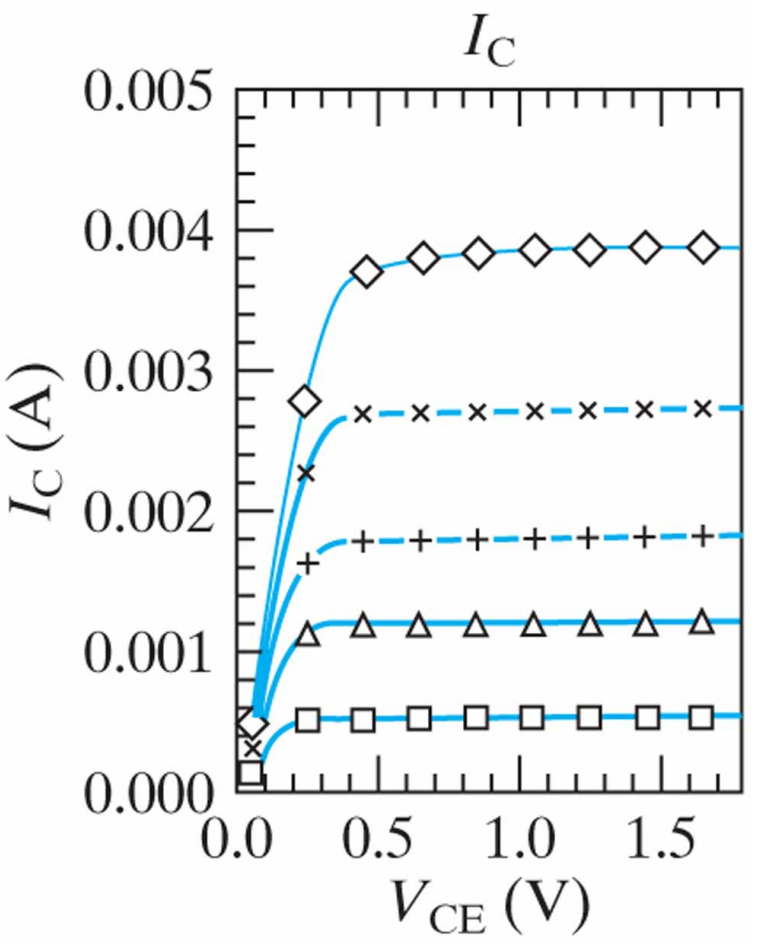


Figure 8.15 Excess hole and electron concentrations in the base. They are equal due to charge neutrality [Eq. (2.6.2)].

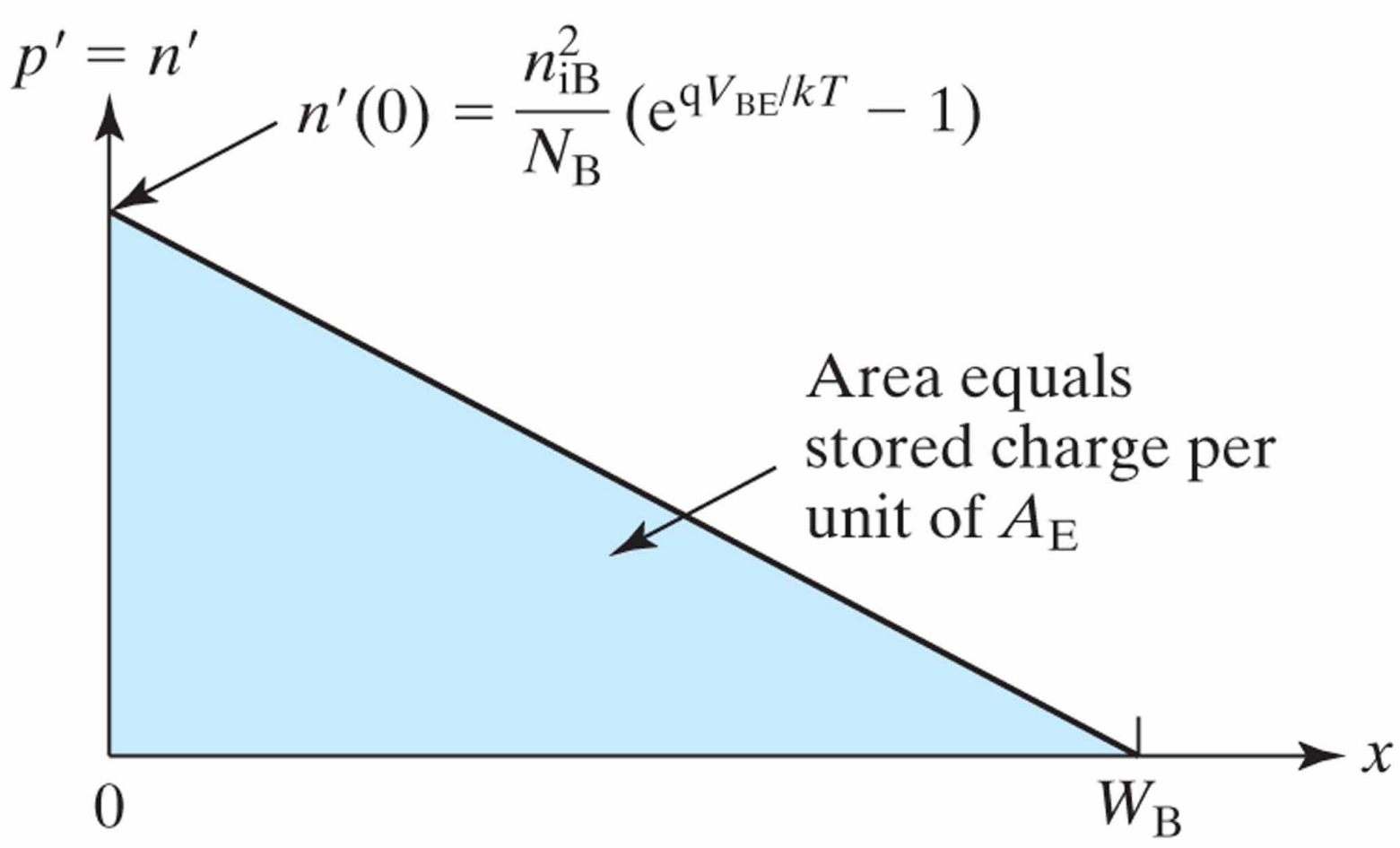


Figure 8.16 Two ways of building dE_C/dx into the base. (a) E_{gB} fixed, N_B decreasing from emitter end to collector end; (b) N_B fixed, E_{gB} decreasing from emitter end to collector end.

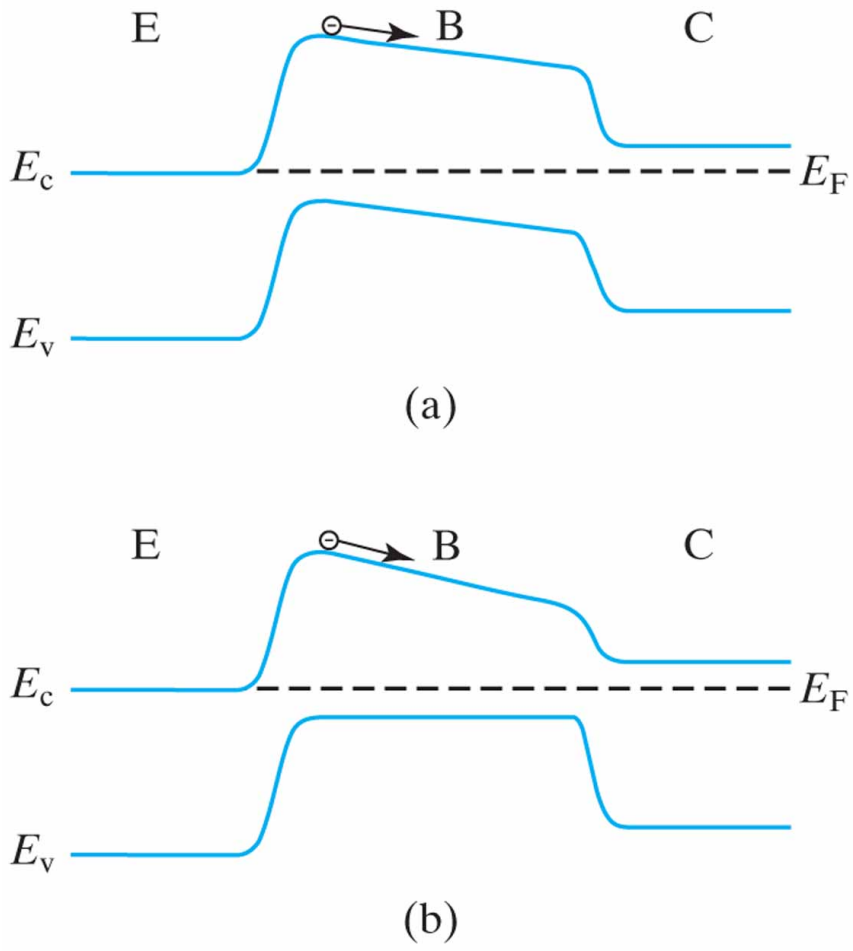


Figure 8.17 Transit time vs. I_C/A_E. From top to bottom: V_{CE} = 0.5, 0.8, 1.5, and 3 V. The rise at high I_C is due to base widening (Kirk effect). (From [3].)

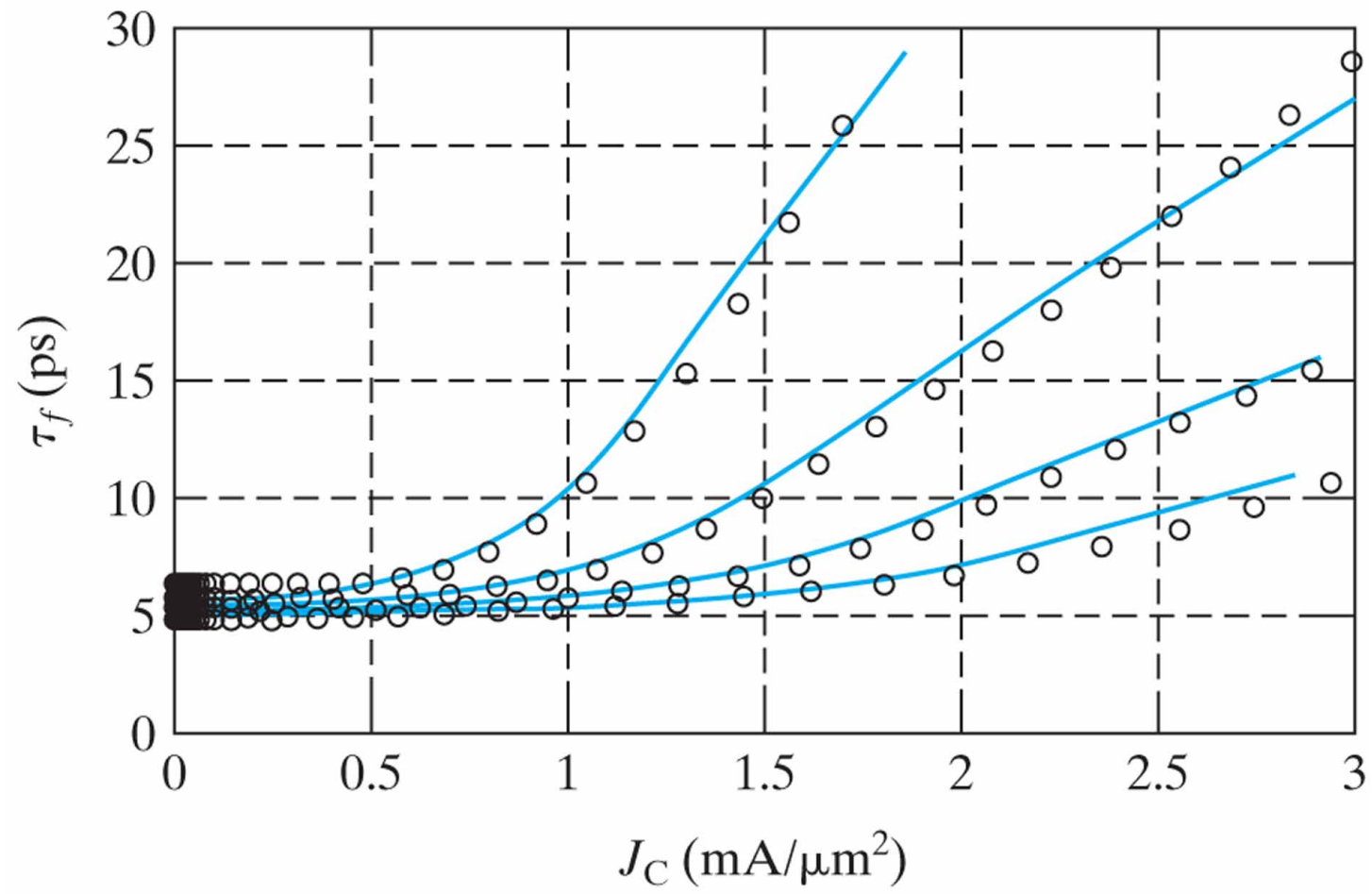


Figure 8.18 Electric field $\mathscr{E}(x)$, location of the depletion layer, and base width at (a) low I_C such as 0.1 mA/μm^2 in Fig. 8–17; (b) larger I_C; (c) even larger I_C (such as 1 mA/μm^2) and base widening is evident; and (d) very large I_C with severe base widening.

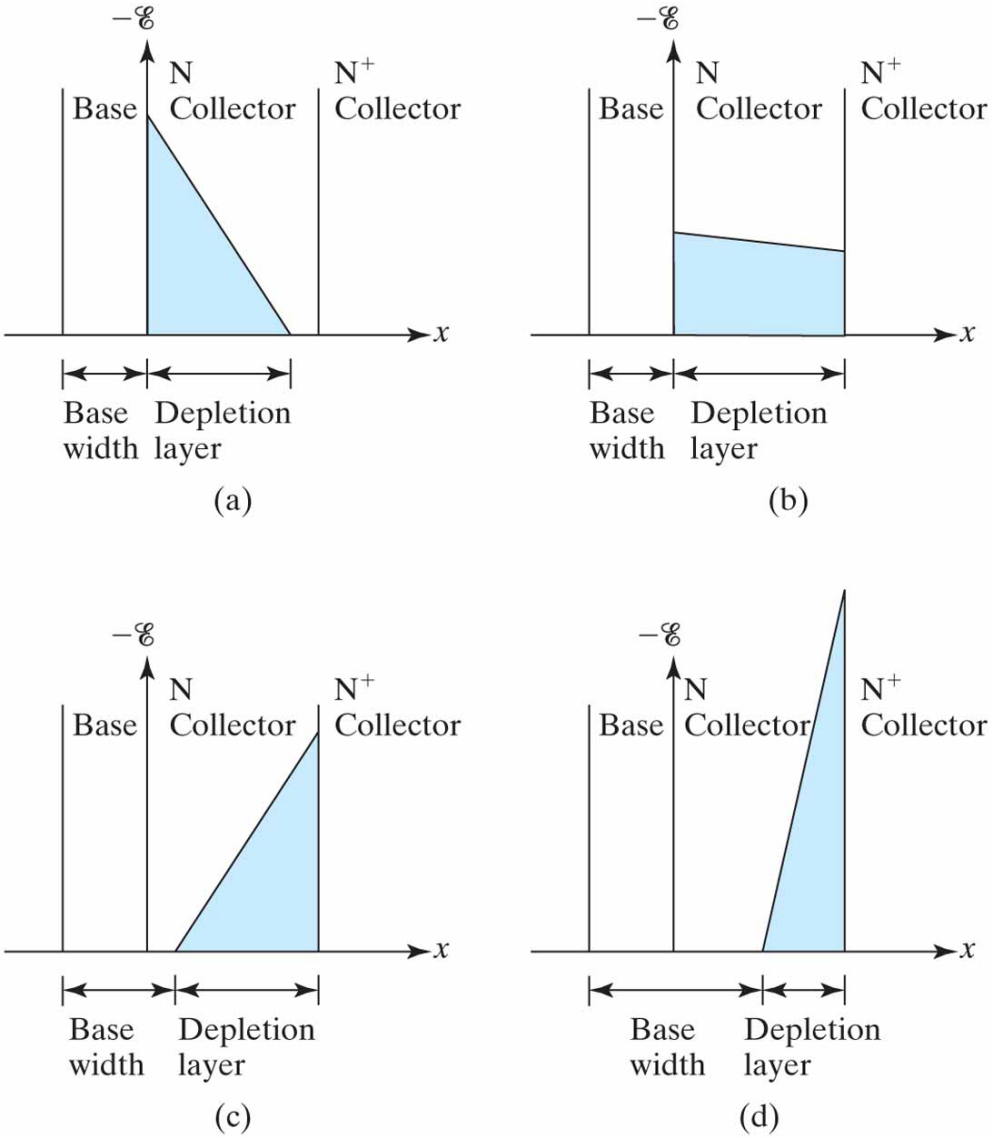


Figure 8.19 A basic small-signal model of the BJT.

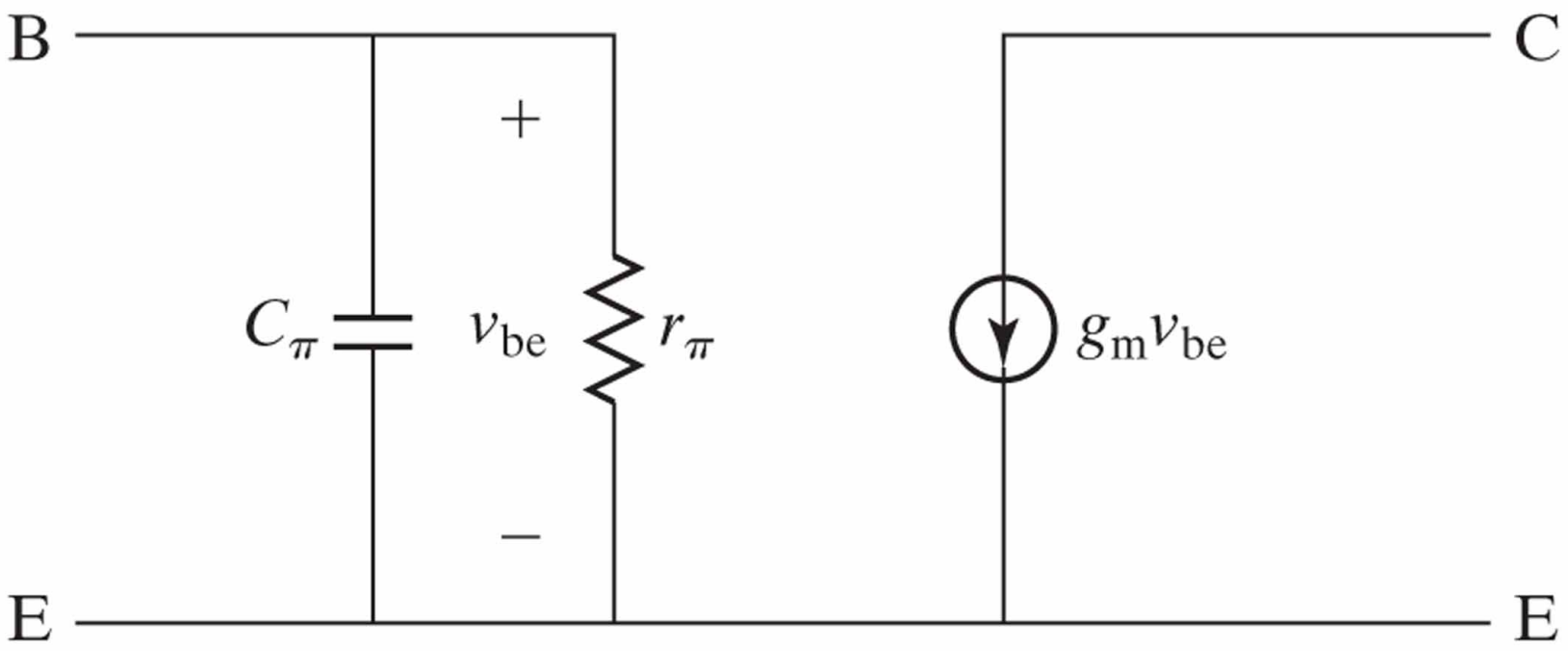


Figure 8.20 (a) The small-signal model can be used to analyze a BJT circuit by hand; (b) a small-signal model for circuit simulation by computer.

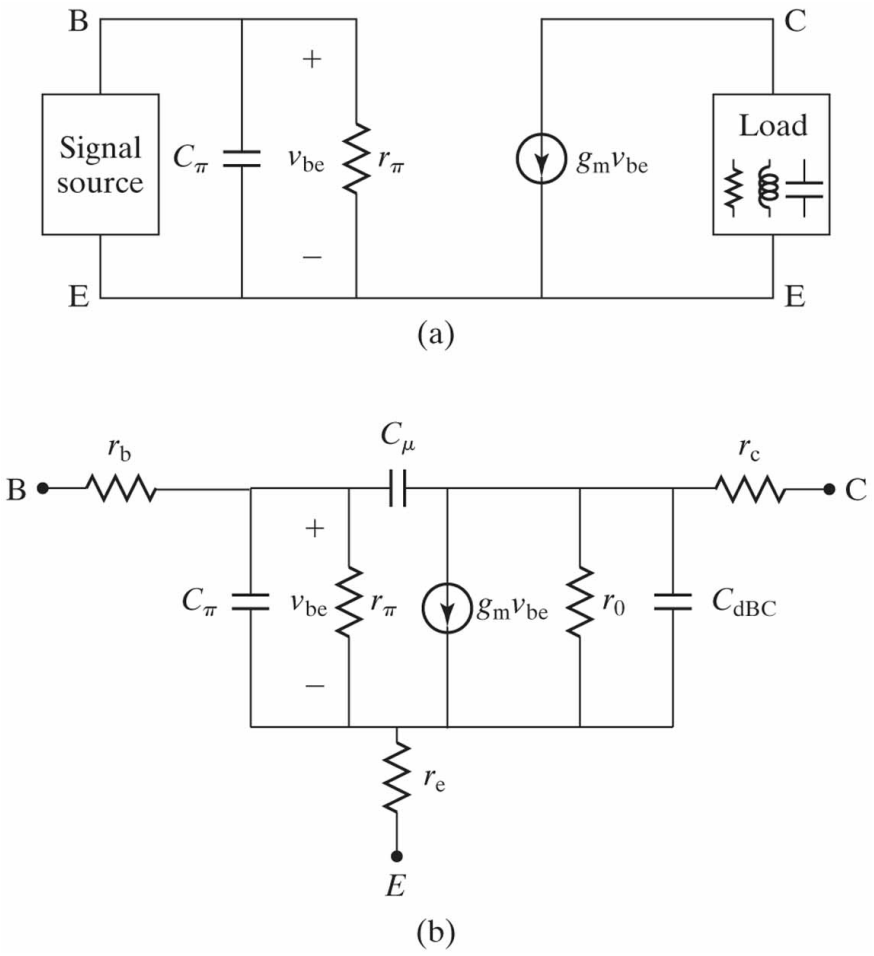


Figure 8.21 Cutoff frequency of a SiGe bipolar transistor. A compact BJT model matches the measured f_T well. (From [6]. © 1997 IEEE.)

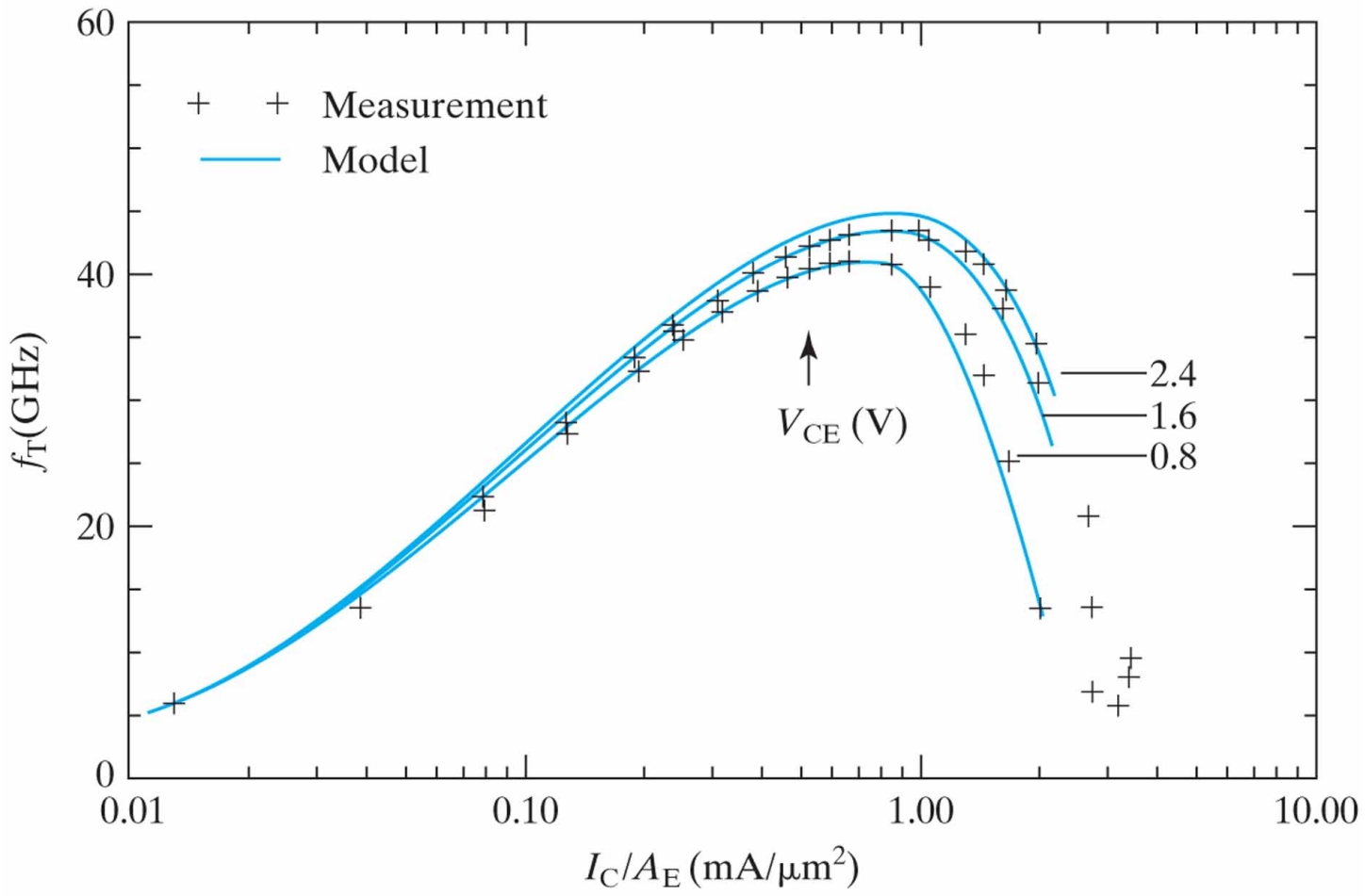


Figure 8.22 Schematic of a BJT with poly-Si emitter, self-aligned base, and deep-trench isolation. The darker areas represent electrical insulator regions.

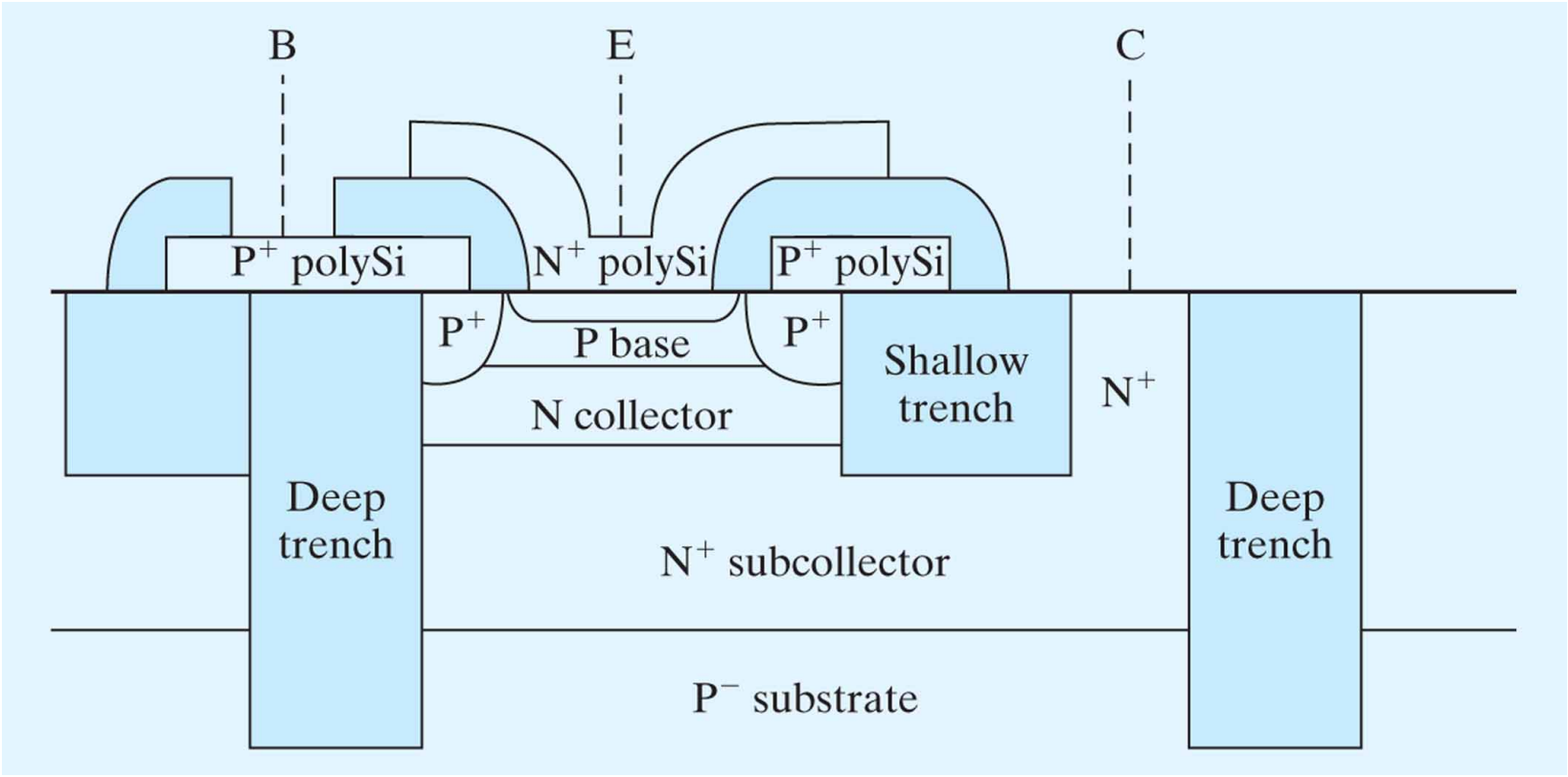


Figure 8.23 Water analogy of the charge control model. Excess hole charge (Q_F) rises (or falls) at the rate of supply (I_B) minus loss ($\propto Q_F$).

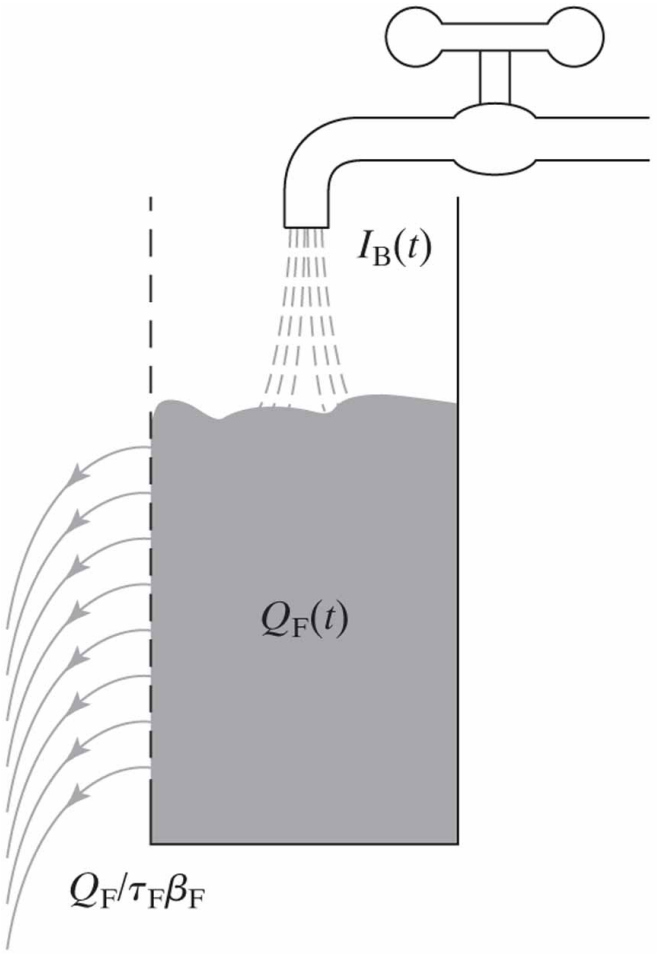


Figure 8.24 From the given step-function $I_B(t)$, charge control analysis can predict $I_C(t)$.

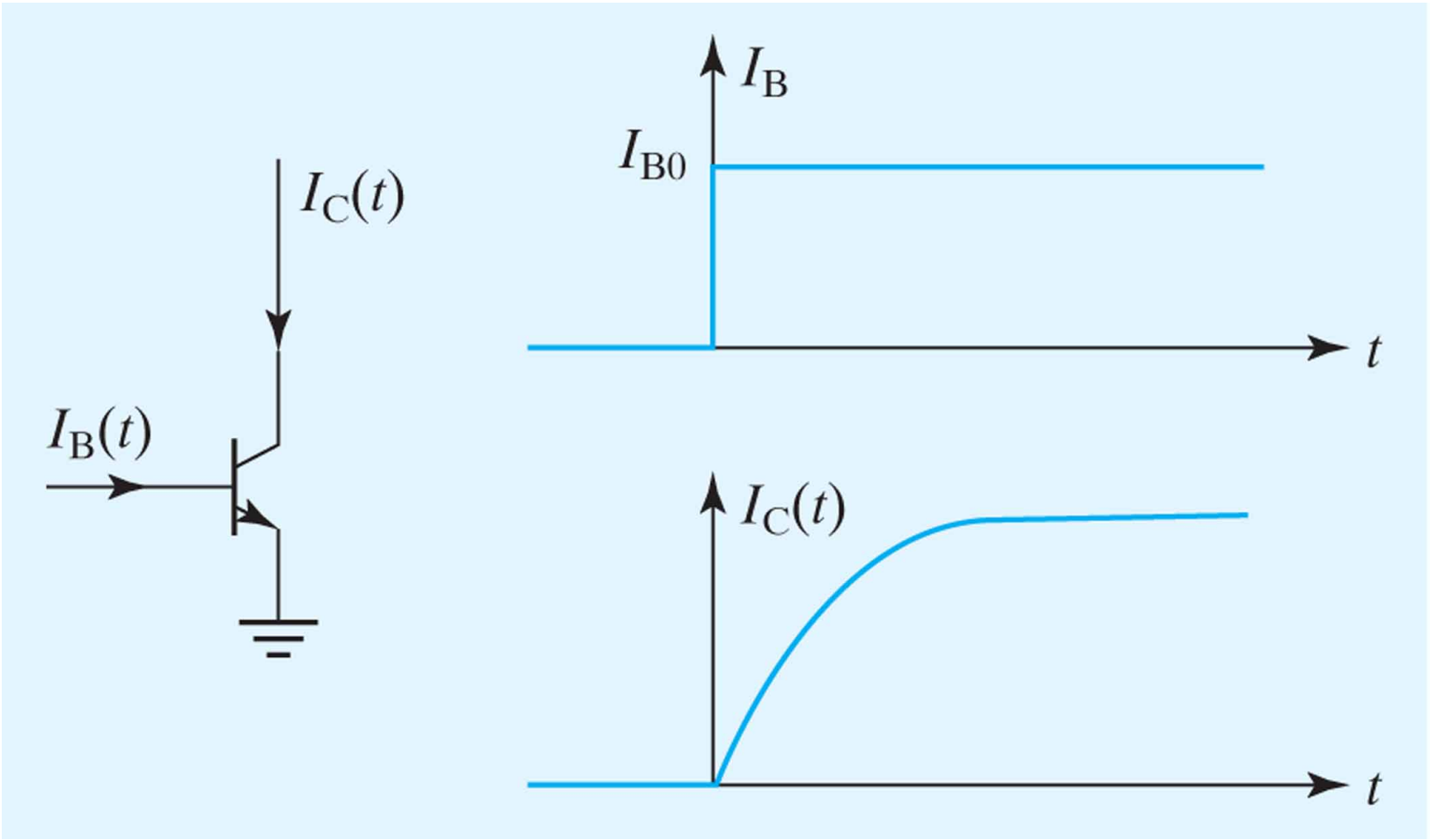


Figure 8.25 Illustration of a BJT model used for circuit simulation.

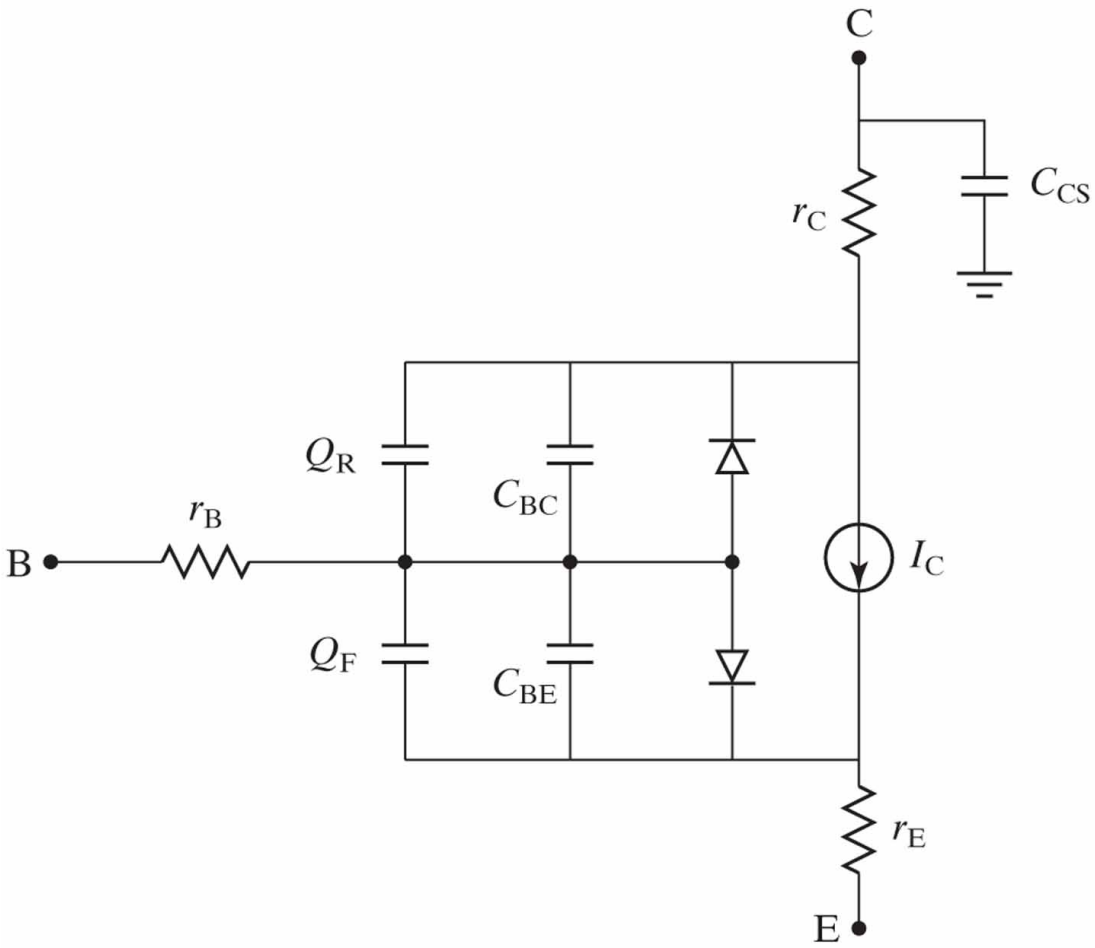


Figure 8.26

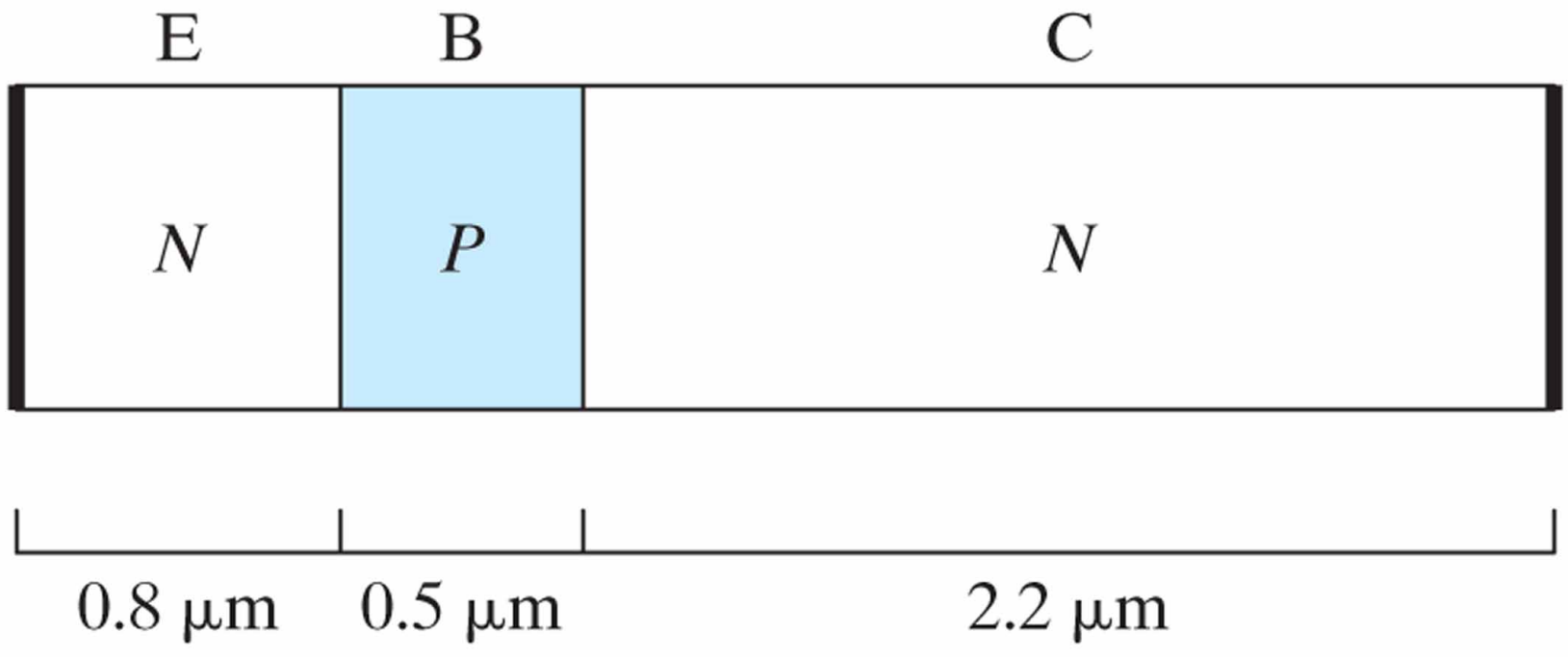


Figure 8.27

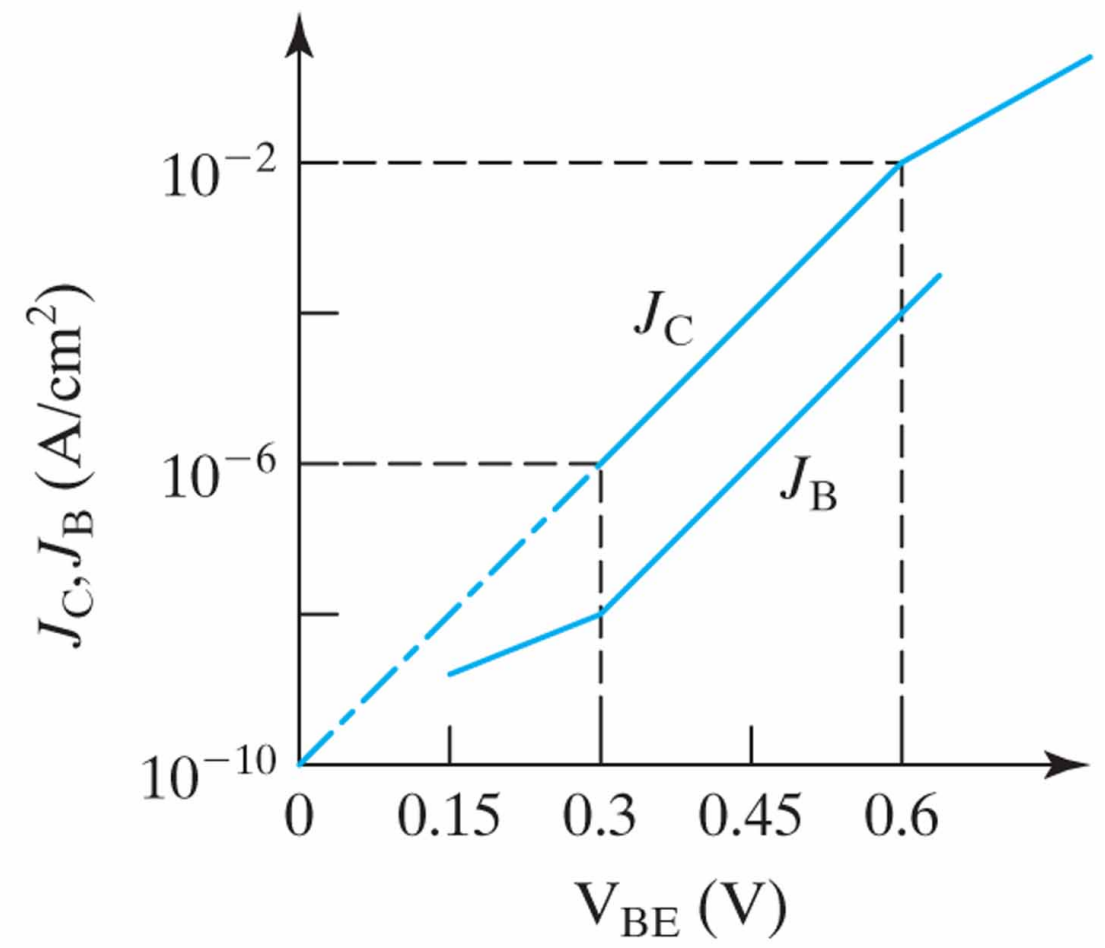


Figure 8.28

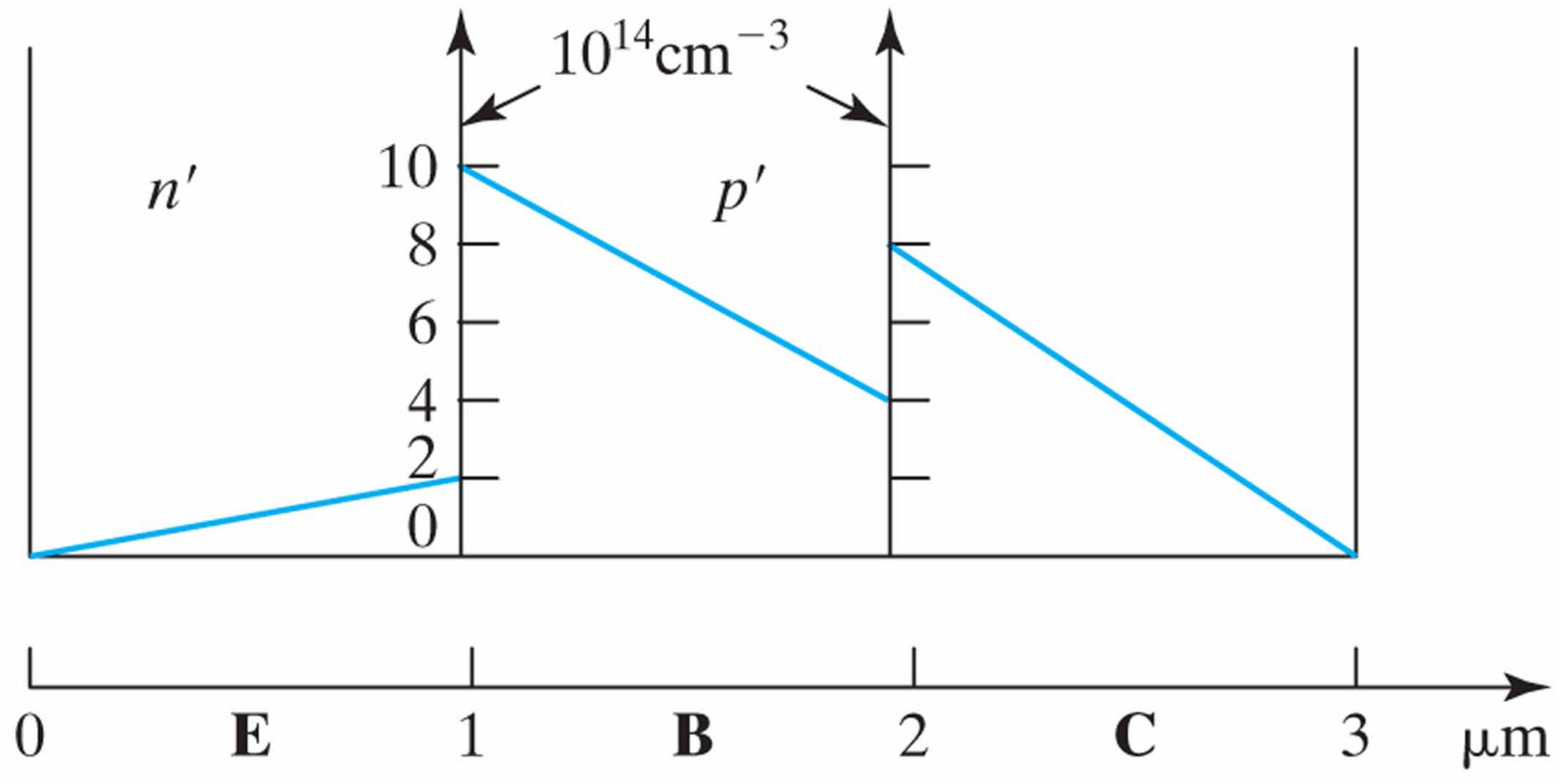


Figure 8.29