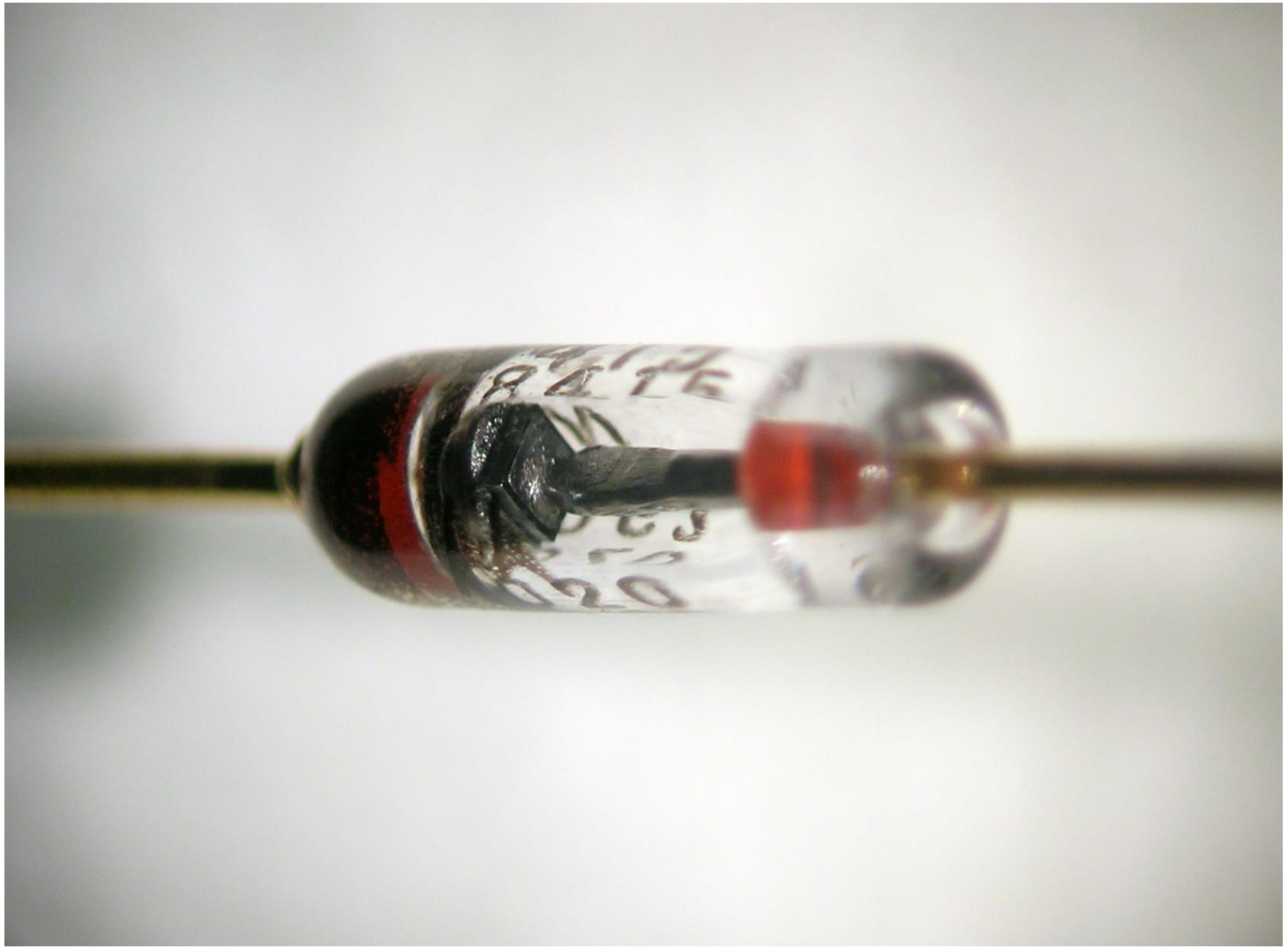
Elektronika

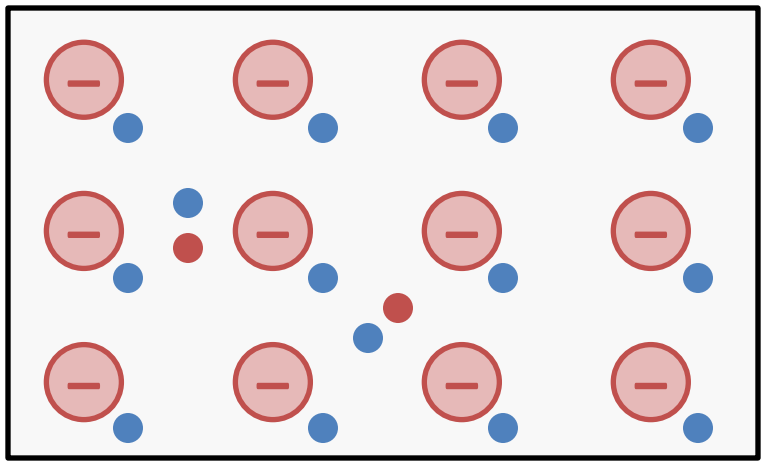
Auditorne vježbe 3

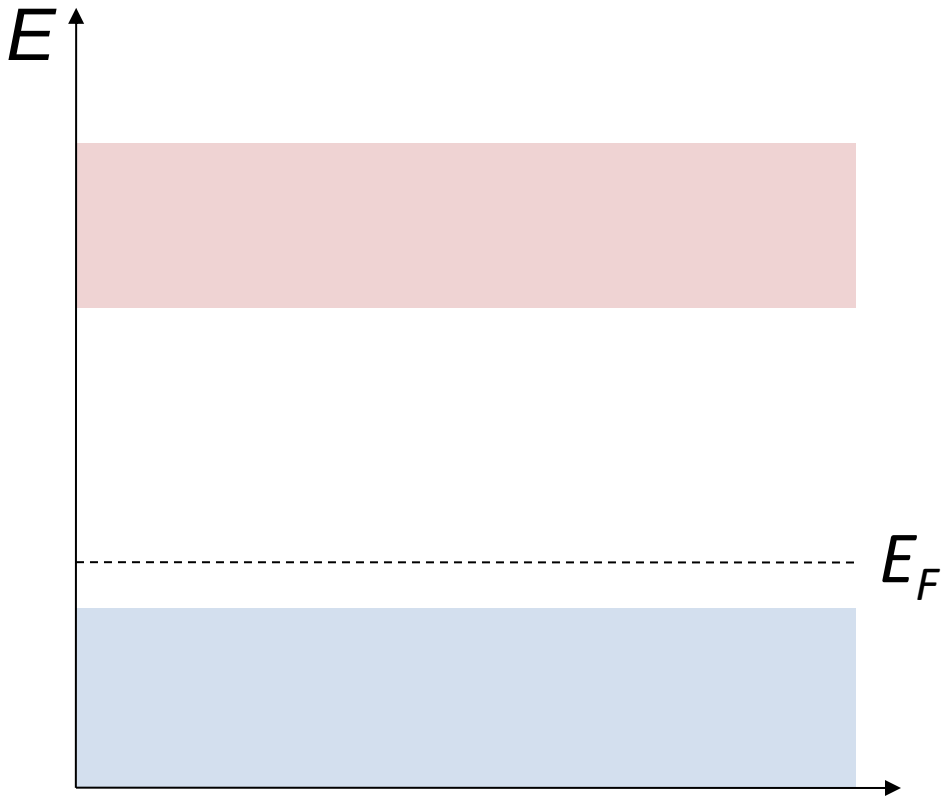
pn spoj – poluvodička dioda



pn spoj

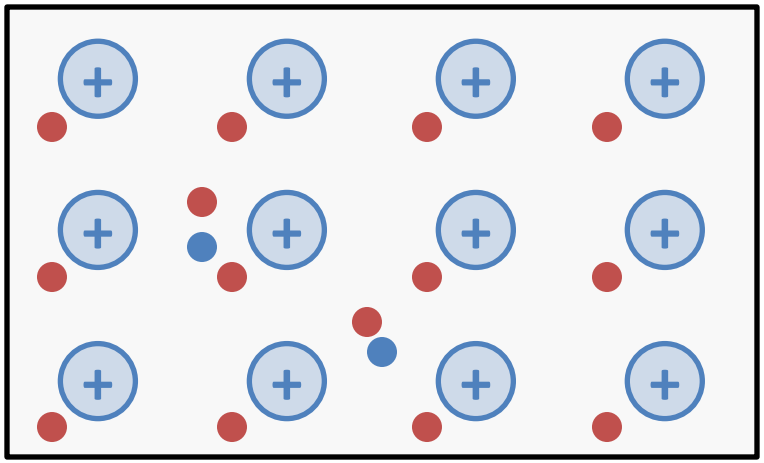
- p-tip

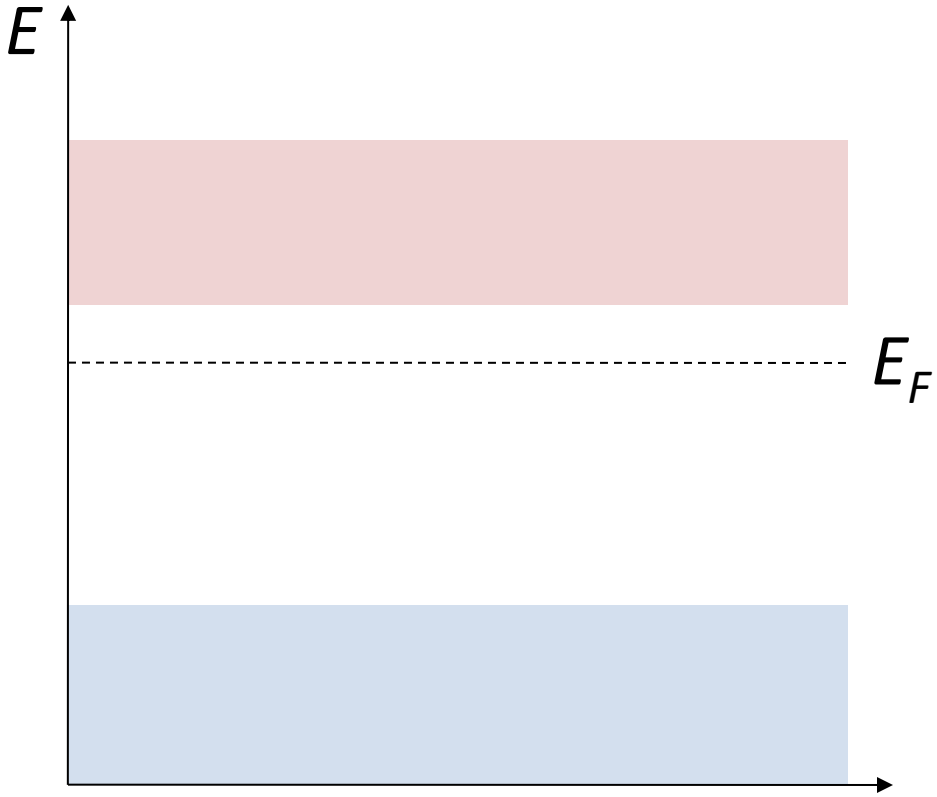




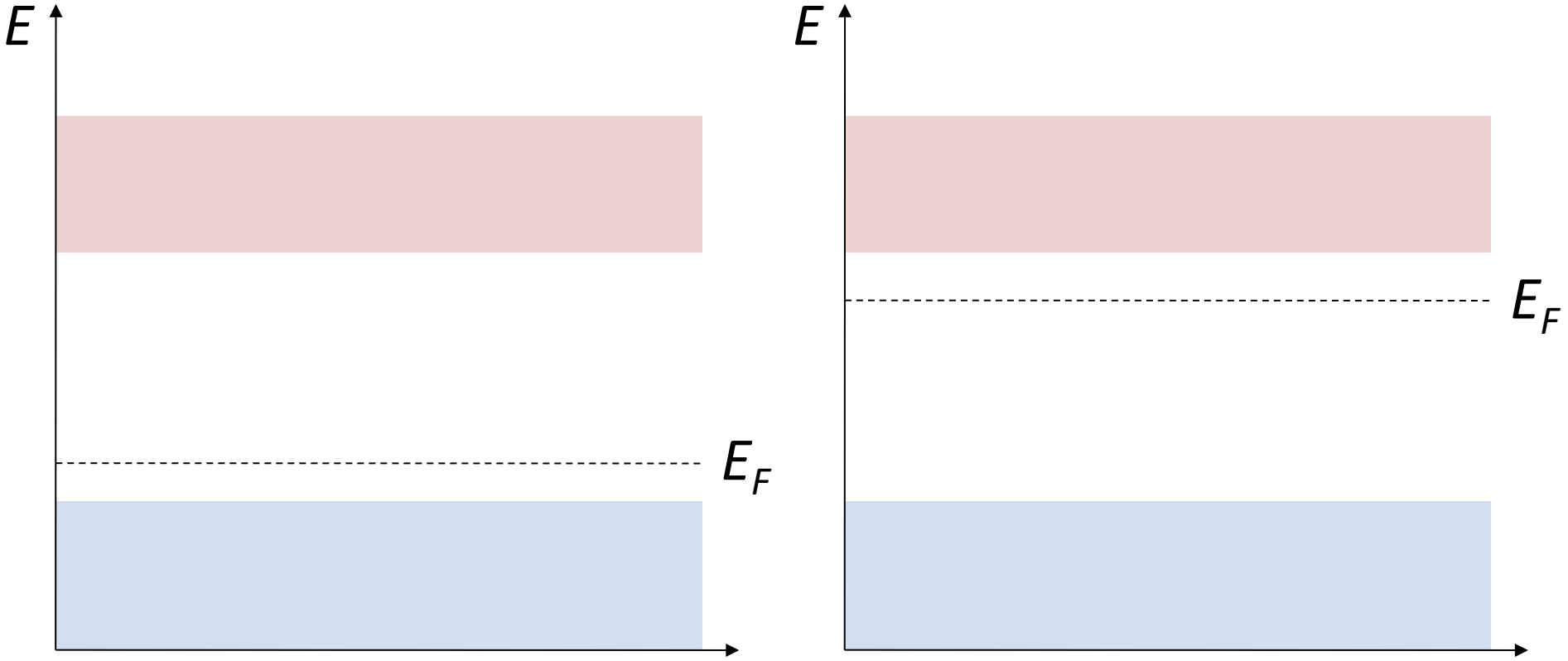
pn spoj

- n-tip



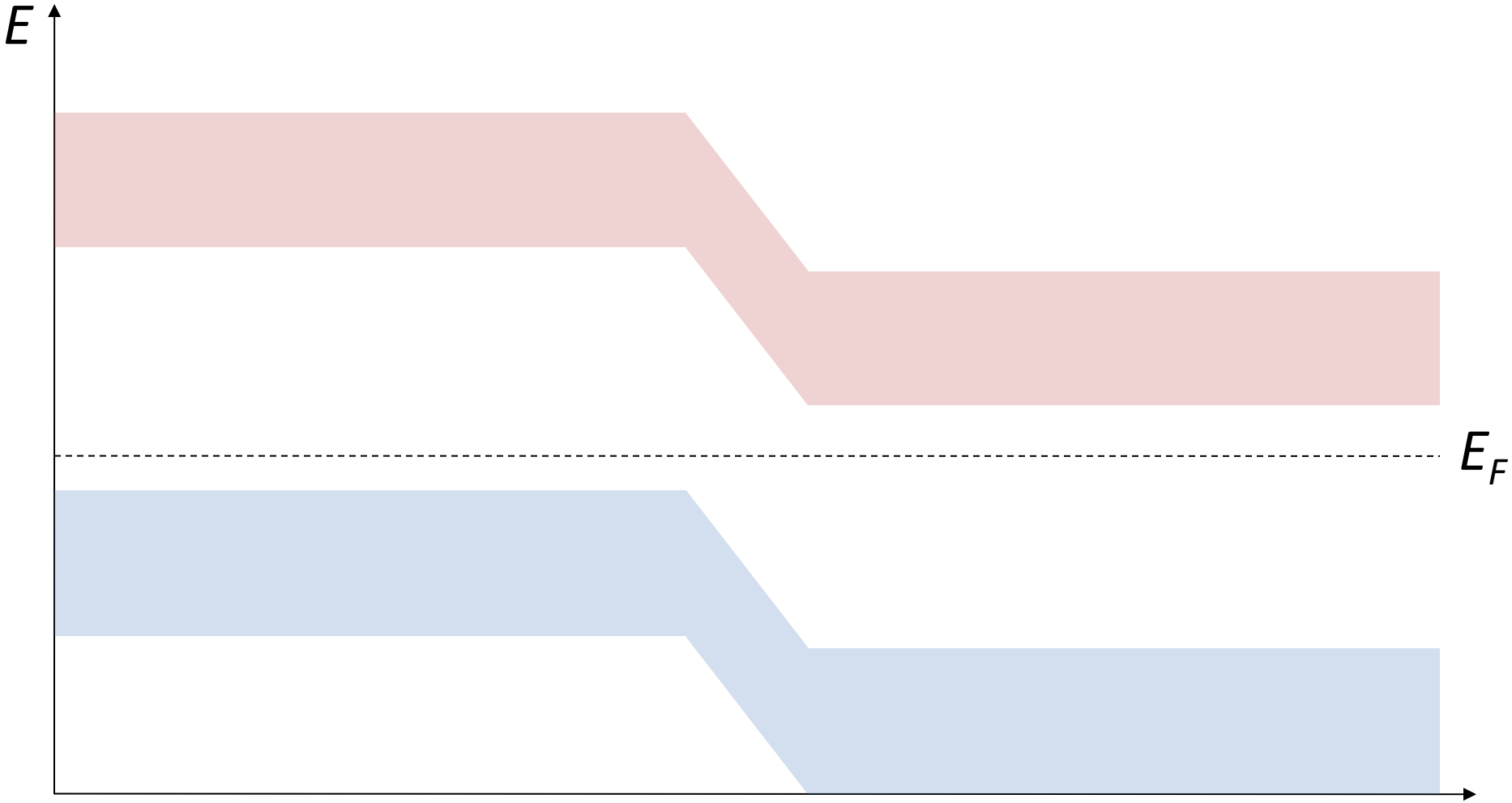


pn spoj



- Fermijeva razina mora biti ista u cijelom poluvodiču!!!

pn spoj



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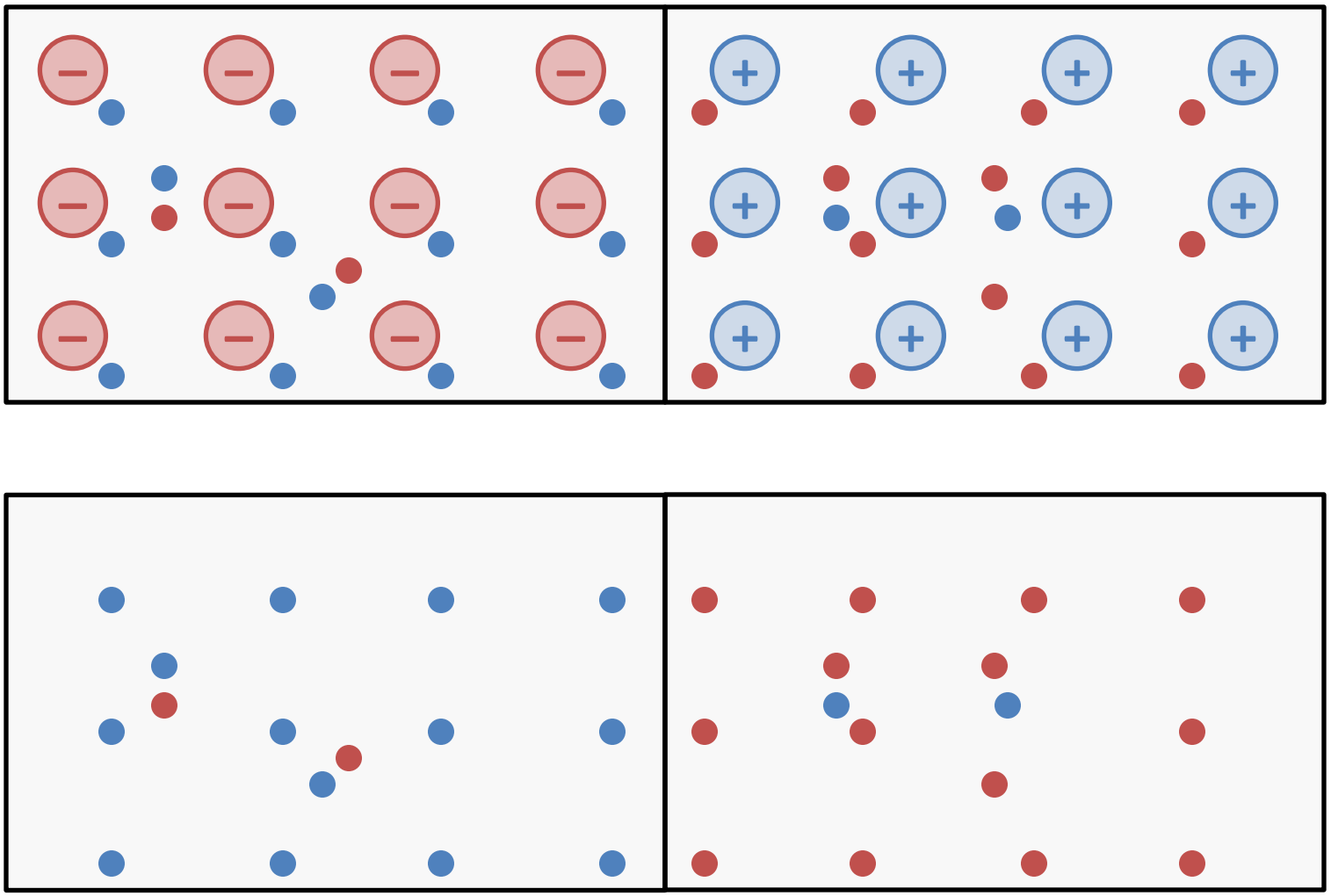

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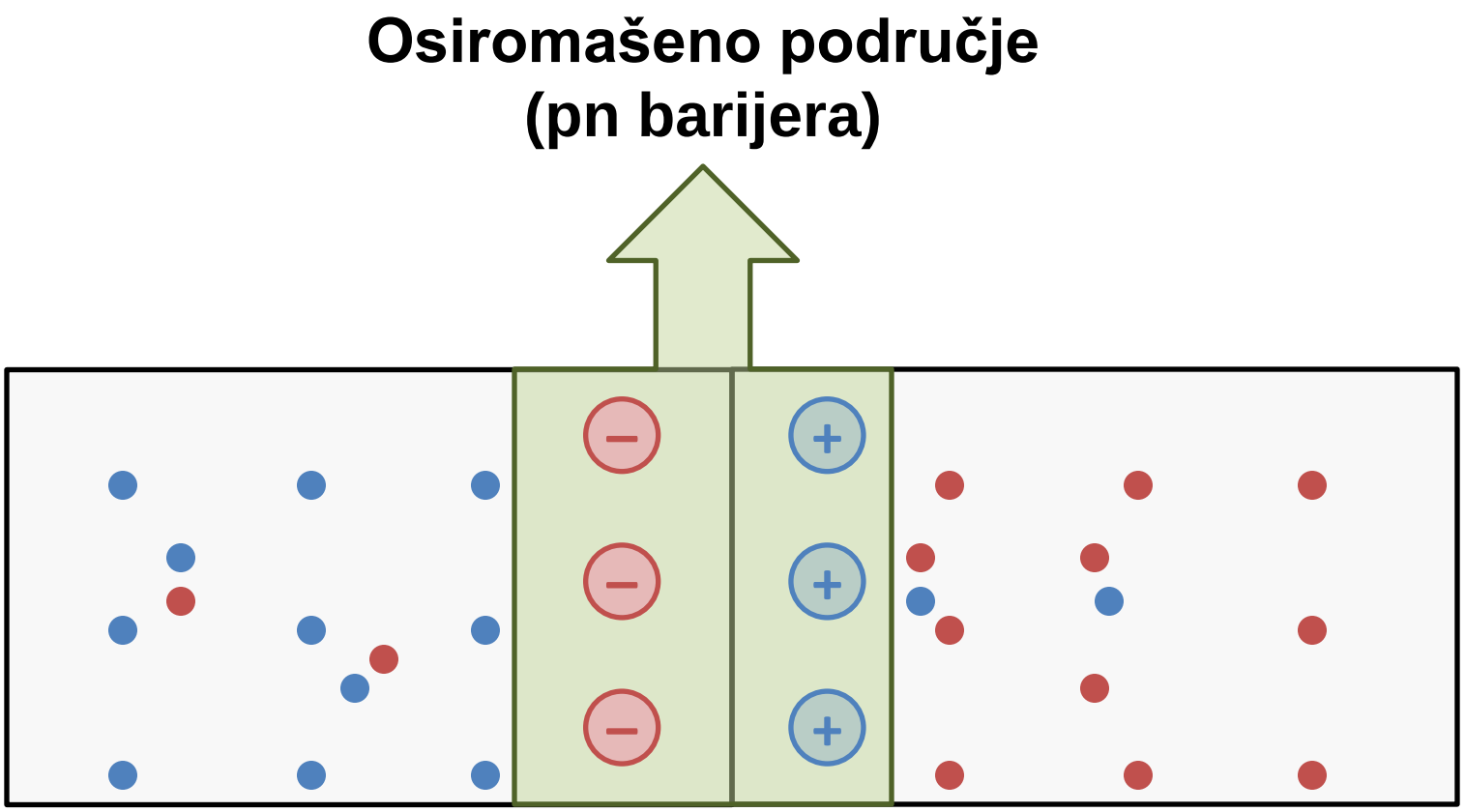
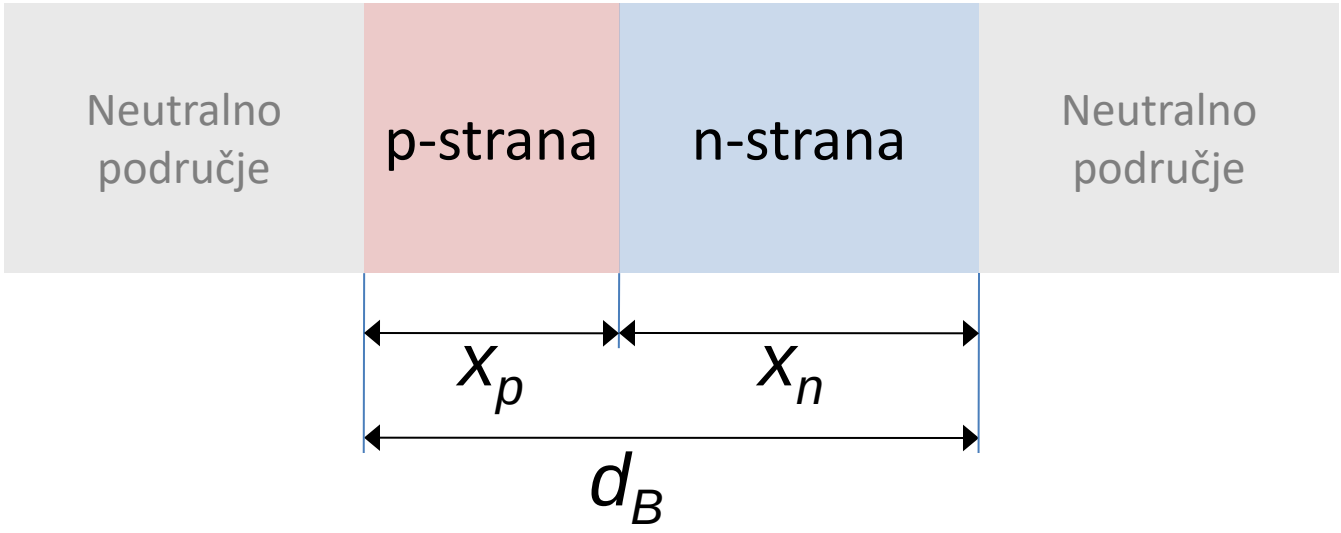


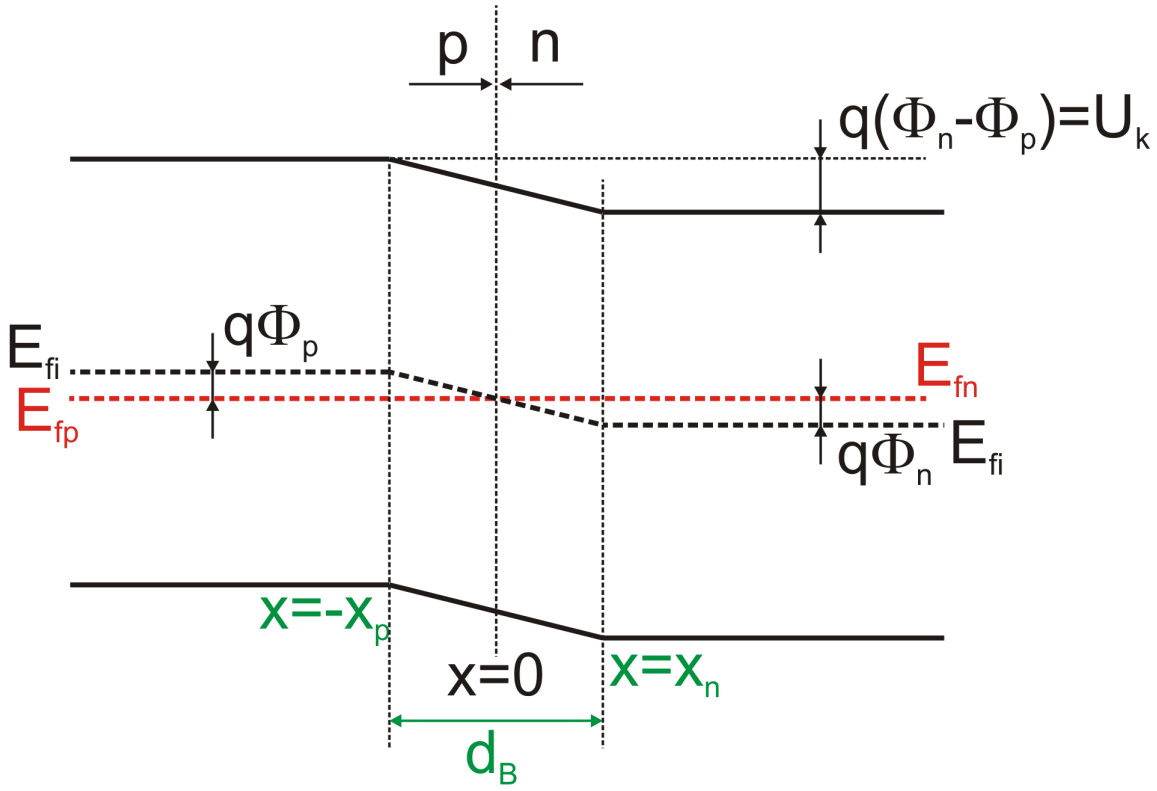
Osiromašeno područje



$$d_B = x_p + x_n$$

$$x_p = \frac{N_D}{N_A + N_D} \cdot d_B \qquad x_n = \frac{N_A}{N_A + N_D} \cdot d_B$$

Kontaktni potencijal



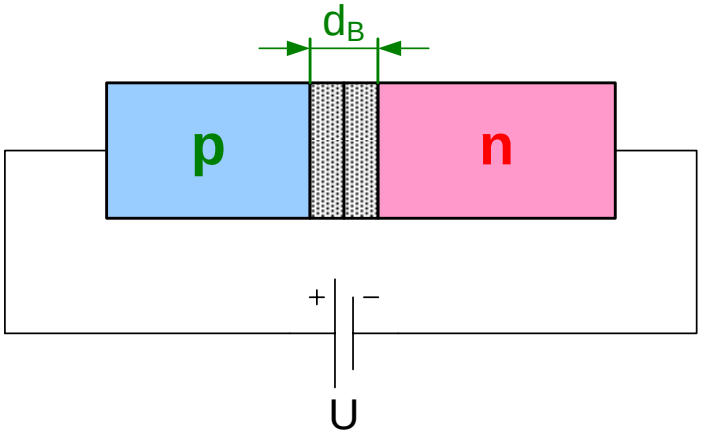
$$U_k = U_T \ln\left(\frac{p_{0p}}{p_{0n}}\right)$$

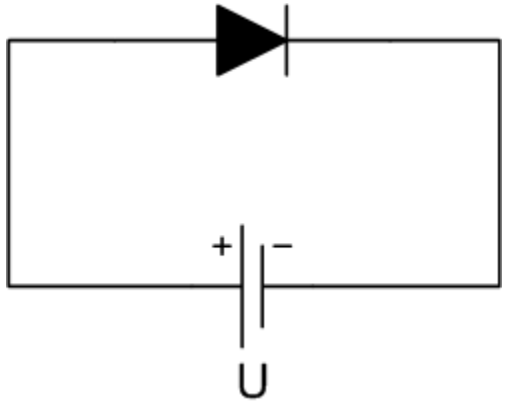
$$U_k = U_T \ln\left(\frac{n_{0n}}{n_{0p}}\right)$$

$$U_k = U_T \ln\left(\frac{N_A \cdot N_D}{n_i^2}\right)$$

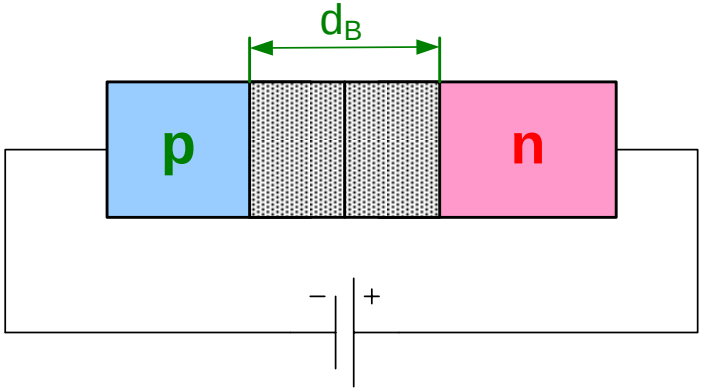
Polarizacija pn spoja

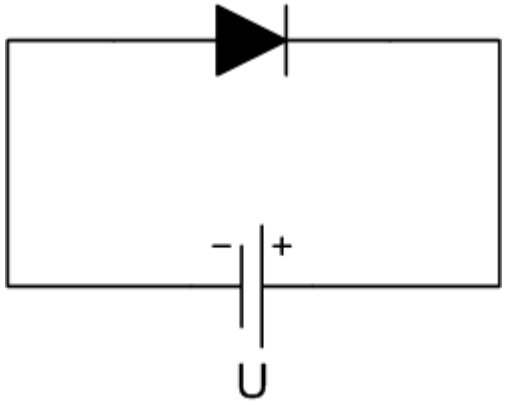
- Propusna polarizacija





- Nepropusna polarizacija





Polarizacija pn spoja

- Ukupni napon na diodi: $U_{TOT} = U_k - U$
- Širina barijere: $d_B = \sqrt{\frac{2\varepsilon}{q} \cdot \frac{\left(N_A + N_D\right)}{N_A \cdot N_D} \cdot U_{TOT}}$
- Maksimalna jakost el. polja: $E_{\max} = -\frac{2U_{TOT}}{d_B}$
- Barijerni kapacitet: $C_T = \varepsilon \cdot \frac{S}{d_B}$

Zadatak 10.

- Silicijski skokoviti pn spoj ima gustoće primjesa: $N_A=10^{15}$ cm^{-3}, $N_D=5\cdot10^{16}$ cm^{-3}. Izračunati širinu barijere, maksimalnu jakost el. polja i barijerni kapacitet ako je površina pn spoja S=1 mm^2, temperatura T=300 K i $\varepsilon_r=11,7$ kad je:

  a) U=0

  b) U=0,6 V

  c) U=-5 V

☑ Rješenje:

$U_K=0,696$ V;

a) $U_{TOT}=0,696$ V; $d_B=9,58\cdot 10^{-5}$ cm; $E_{max}=-14,53$ kV/cm; $C_T=108$ pF;

b) $U_{TOT}=0,096$ V; $d_B=3,57\cdot 10^{-5}$ cm; $E_{max}=-5,4$ kV/cm; $C_T=291$ pF;

c) $U_{TOT}=5,696$ V; $d_B=2,74\cdot 10^{-4}$ cm; $E_{max}=-41,56$ kV/cm; $C_T=37,8$ pF.

Zadatak 11.

- Širina osiromašenog područja skokovitog silicijskog pn spoja pri kontaktnom potencijalu U_k=0,65 V iznosi d_{B1}=0,34 µm. Odrediti maksimalnu jakost el. polja i širinu barijere pri priključenom naponu U=-6 V.

☑ Rješenje:

d_{B2}=1,087 µm; E_{max2}=-122,3 kV/cm.

Zadatak 12.

- Silicijska dioda sa širokim stranama ima širinu barijere na n-strani x_n=2 µm, a na p-strani x_p=1,2 µm. Na T=300 K kontaktni potencijal iznosi U_k=0,65 V. Izračunati ravnotežne gustoće većinskih i manjinskih nosilaca na obje strane diode te napon priključen na diodu.

☑ Rješenje:

$N_D=2{,}23\cdot10^{15}$ cm^{-3}; $N_A=3{,}72\cdot10^{15}$ cm^{-3};

$n_{0n}=N_D$; $p_{0n}=4{,}48\cdot10^{4}$ cm^{-3};

$p_{0p}=N_A$; $n_{0p}=2{,}69\cdot10^{4}$ cm^{-3};

U=-10,4 V.