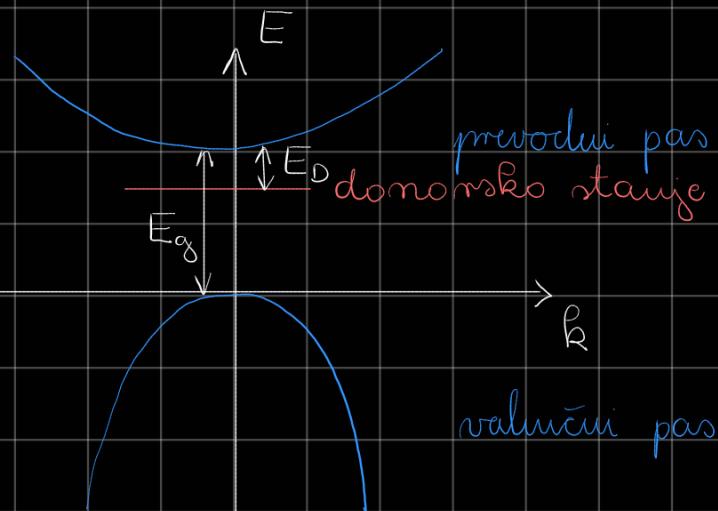


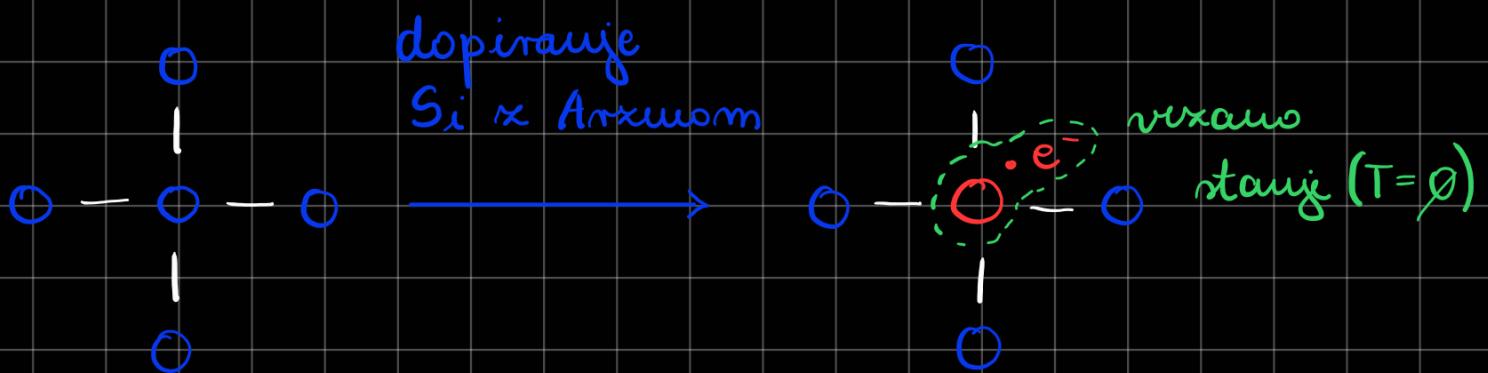
Doperani polprevodnik

→ tip m (stvar, ki prevaja, je negativen, možici naboja so e^-)

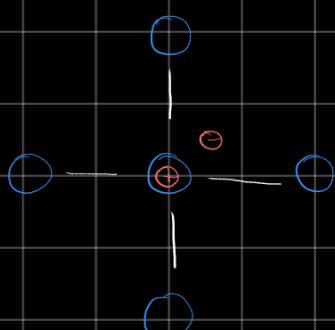


velja $E_g \gg E_D$

○ arzen ($5e^-$)



Lahko si mislimo, da manjšo Arsenico vname Si, ki mu dodamo en p^+ in en e^-

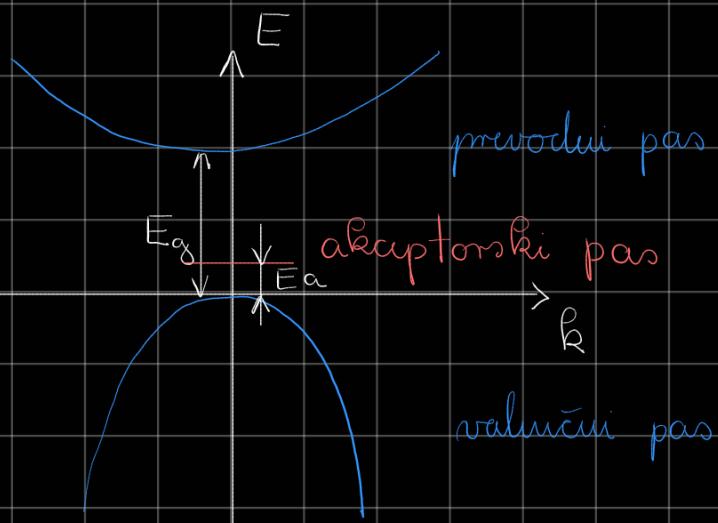


Pri $T=\emptyset$ je doperani polprevodnik izolator in prvotni pas

prevzem.

Ž majhniu dvigom T začne prevajati zaradi preskoka e- iz donorskega pasu (do visoke temp. bo večino e- za prevajanje izhajalo iz donorskega pasu, potem pa iz valnčnega)

→ tip p (proto ne)



$$E_a \ll E_g$$

e- skoči v akceptorški pas → nastavijo vezeli, ki potem prevajajo.

Fermi - Diracova porazdelitev za doperane polprezročnike

$$f_D(E) = \frac{1}{e^{\beta(E_g - Ed - \mu)} + 1}$$

↳ posledica Coulombske interakcije med e- vezanimi na mestostocene

Izpeljava

ε laikko zasidijo 0, 1, 2 elektrone

$$\hat{H} = \sum_i (\hat{m}_i + \hat{m}_\delta) + U \hat{m}_i \hat{m}_\delta \quad \text{Hamiltonian}$$

$$\langle m \rangle = \dots \Rightarrow \text{povp. st. stavy}$$

$$\text{uz STD: } \langle m \rangle = \frac{T_\mu [\hat{H}_M]}{T_\mu [\hat{H}]} = \frac{\sum_\delta m_\delta e^{-\beta(E_\delta - \mu m_\delta)}}{\sum_\delta e^{-\beta(E_\delta - \mu m_\delta)}} \quad \{ \text{momemtum}$$

Imaus $\emptyset e^-$:

$$\text{praznu pas } E_0 = \emptyset$$

1 e^- :

$$\begin{array}{c} \text{dve stavy} \\ \uparrow \\ \downarrow \end{array} \quad \text{degenerirana} \quad E_{1\uparrow} = \varepsilon \quad E_{2\downarrow} = \varepsilon$$

$$2 e^-: \quad \downarrow \uparrow \quad E_2 = 2\varepsilon + \overbrace{U}^{\exp[\cdot]}$$

$$\langle m \rangle = \frac{m_\delta \exp[-\beta(E - \mu)] + 2 \cdot 1 + 2 \cdot 1 \cdot e^{-\beta(E - \mu)} + 2 \cdot e^{-\beta(2\varepsilon - U - 2\mu)}}{1 + 2 e^{-\beta(E - \mu)} + e^{-\beta(2\varepsilon - U - 2\mu)}}$$

Velyka $U > \varepsilon$ xa necistocene

(Coulombska interakcia jo mareci neugodna)

$$\langle n \rangle = \frac{1}{2} e^{\beta(\epsilon - \mu)} + 1$$

analogno za akuptonje

Se vedno velja:

$$n_e \cdot n_v = n_0^2(T) \cdot e^{-\beta E_g}$$

$$n_0(T) = 2 \left(\frac{2\pi m_e m_v k_B T}{h^2} \right)^{3/2}$$

→ Čisti polpravnik:

$$n_{e,0} = n_{v,0} = n_0 = n_0(T) e^{-\beta E_g/2}$$

→ Dopiran polpravnik:

$$n_e = n_0(T) \left(\frac{m_e^*}{m_e} \right)^{3/2} e^{-\beta(E_g - \mu)}$$

$$n_v = n_0(T) \left(\frac{m_v^*}{m_v} \right)^{3/2} e^{-\beta \mu}$$



Zadko 4.15

$$T_0 = 200 \text{ K}$$

$$\gamma = 3'6 \cdot 10^9 / \Omega \text{ m}$$

$$n_D = 1'1 \cdot 10^{22} \text{ m}^{-3}$$

$$E_D = 0.054 \text{ eV}$$

$$E_{g\gamma} = 1.12 \text{ eV}$$

$$m_e^* = 1.08 m_0$$

$$m_v^* = 0.156 m_0$$

$$\eta_e = 0.40 \text{ m}^2/\text{V}_0$$

$$\eta_v = 0.22 \text{ m}^2/\text{V}_0$$

$$\mu = ?$$

$$\frac{m_{ion}}{m_D}$$

$$\dot{y} = \beta E$$

$$\dot{y} = m_e \langle v \rangle = m_e \gamma E, \quad \beta = m_e \gamma$$

$$\beta = m_e \gamma e_0 + m_v \gamma_v e_0 \quad // e^- v \text{ prenese en paru / vrzeli}$$

$$+ m_v \gamma_v e_0 + \underbrace{m_D \left[1 - \frac{\beta_D}{\beta} (E_g - E_d) \right]}_{m_{ion}} \gamma e_0$$

e^- , ki predijo
iz valenčnega
paru

e^- , ki predijo iz donornškega
paru

Dokaz, da lahko $m_v \gamma_v e_0$ (lastno prevodnost) zame=marimo

$$\text{Cisti polprevodnik: } m_e = m_0(T) e^{-\frac{\beta E_g}{2}} = 7 \cdot 10^{10} / \text{m}^3$$

$$\beta_e = m_e e_0 (\gamma_e + \gamma_v) \sim 10^{-9} / 2 \text{ m}$$

$$v \text{ prienjavi } \times \text{damu } \beta = 10^4$$

$$\Rightarrow m_{ion} = \frac{\beta}{\gamma_e e_0} \Rightarrow \frac{m_{ion}}{m_D} = 0'51$$

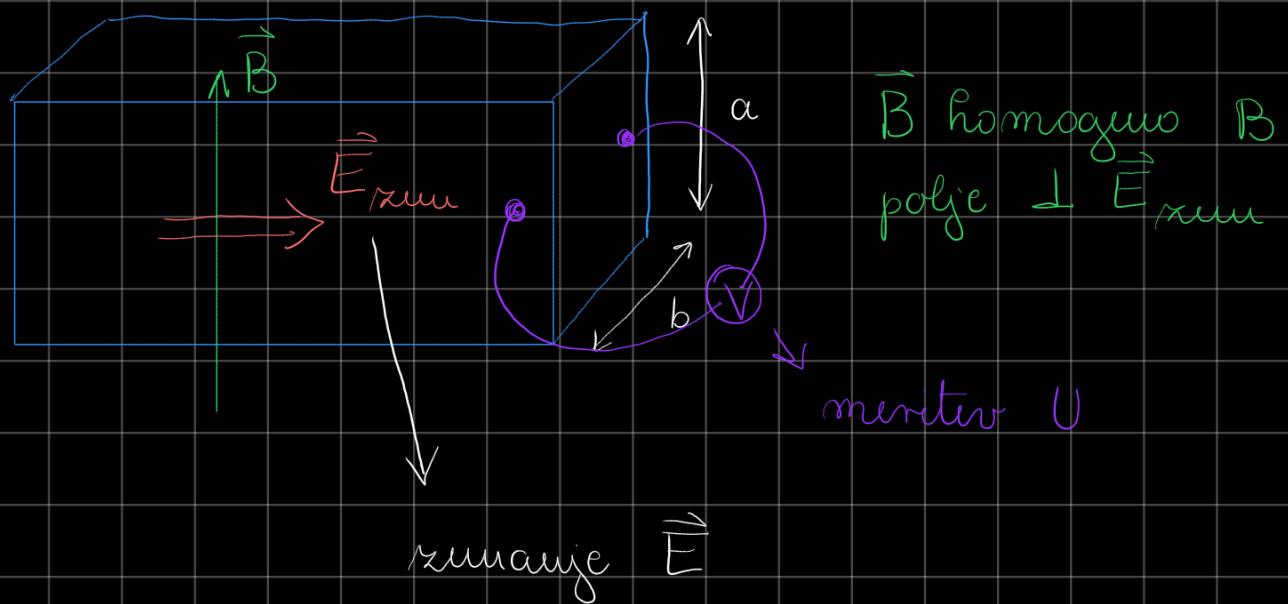
$$1 - \frac{\beta_D}{\beta} = 0'51,$$

$$\beta_D = \frac{1}{\frac{1}{2} e^\beta (E_g - E_D - \mu) + 1} \quad // \text{vrzeli v en } \mu$$

$$\mu = 1'058 \text{ eV}$$

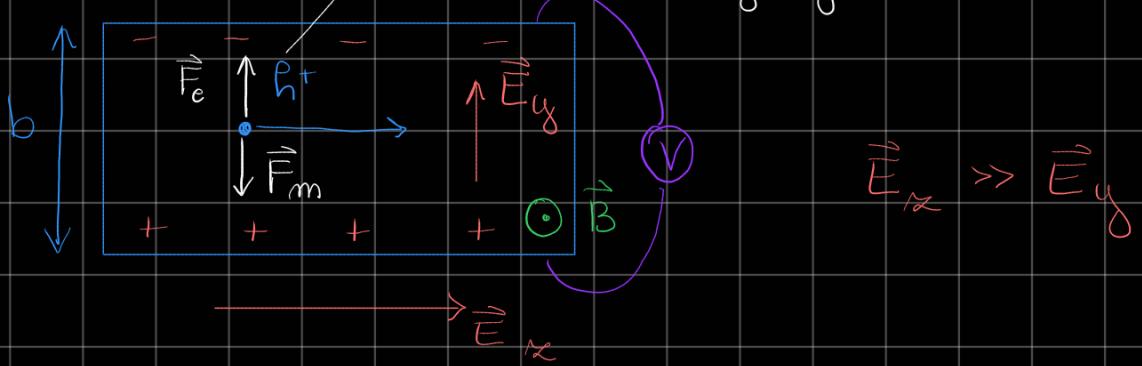
Hollow pojan

Či meriuo mapetost, laiko določimo įt. gosto to nosikur
maloya ir nijono predznač maloya



tip p: tlomis

vuzel, kūn aži bly (stacionarno stauje)



tip m: analogino, ampfak $h^- \leftarrow$, iu $+ \leftarrow -$ ne xameugta

Za stac. stauje, velja mehansko ravnovesje

$$F_e = F_m$$

$$e_0 E_y = e_0 \langle v \rangle B \Rightarrow E_y = \langle v \rangle B , \quad j = n e_0 \langle v \rangle$$

$$E_H = \frac{\delta B}{me}, \quad U_H = E_H b \quad \text{Hallova napěť}$$

$$\delta = \frac{I}{S} = \frac{I}{ab}$$

$$\Rightarrow U_H = \boxed{\frac{IB}{mea}}$$

Hallov koeficient

$$R_H = \frac{E_H}{\delta B} = \frac{1}{me}$$

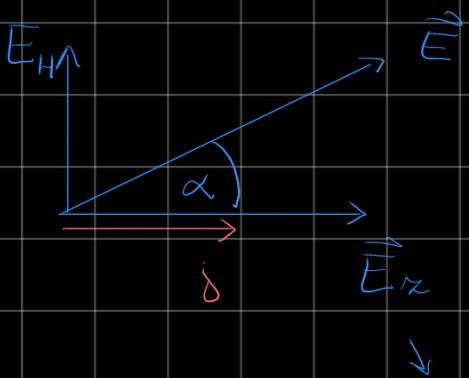
Topic V/50

tip m

$$B = 0,3 T$$

$$\alpha = 5,7^\circ$$

$$z = 100 / \sqrt{2} m$$



$m_e = ?$ schelivost e-

mer toka

$m_e = ?$

$$\tan \alpha = \frac{E_H}{E_x} = \frac{\langle v \rangle B_0}{E_x}$$

Upostaveno $\langle v \rangle = m_e E_x$



samo zvazne polje, kde povzroca tok

$$\tan \alpha = n_e B_0$$

$$\Rightarrow n_e = \frac{\tan \alpha}{B_0} = 0.33 \text{ m}^2/\text{Vs}$$

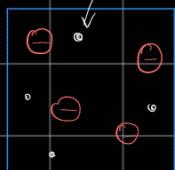
št. hustota e^-

$$\text{prevodivo} \ \beta = n_e m_e e \Rightarrow m_e = \frac{\beta}{n_e e} = 1.9 \cdot 10^{21} / \text{m}^3$$

P-N stik (dioda)

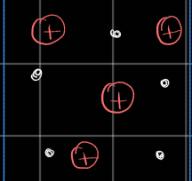
Več PN stikov \Rightarrow tranzistor

h^+ vrzel



tip p

e^-

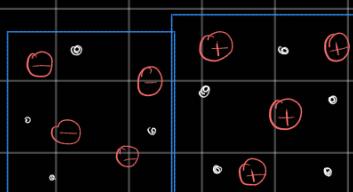


tip m

Risivo sám nečistoty, na klijecu ± naboj

homogeno razpacan naboj, neperiodiční
stik

\downarrow

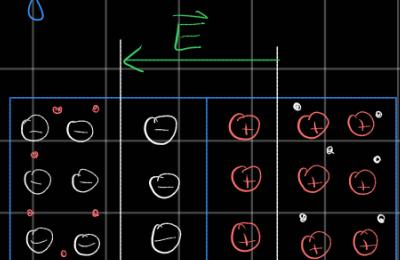


e^-

Prehod se zapozi k aradi drugacich
kemickich potencialov

e^- anihiliraju h^+ vrzeli

Na myj dobrus



zapoma plast