

固物 2017 期末

Deschain

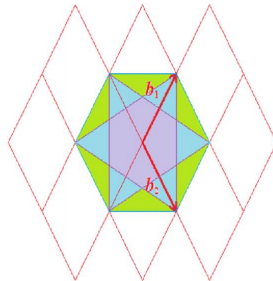
2022 年 6 月 12 日

1.

- (1) ①玻色子② $\frac{1}{e^{\frac{\hbar\omega}{k_B T}} - 1}$
- (2) ①体心立方② $\frac{2\pi}{\|2\vec{\beta}_1 + 3\vec{\beta}_2 + \vec{\beta}_3\|}$
- (3) ①2 : 1② $2V_0$
- (4) ①声学波②升高
- (5) ①间接② $\hbar\vec{k} - \hbar\vec{q}$
- (6) ①电子的轨道磁矩②电子的自旋磁矩③感生磁矩④铁磁性⑤亚铁磁性⑥反铁磁性
- (7) ①抗磁性
- (8) ① $3nN$ ② nN ③ $2nN$
- (9) ①OA 上存在②不存在
- (10) ①高②N③P
- (11) ① $\frac{\pi a}{\sqrt{17}}$ ② $\sqrt{17} : 1$
- (12) ①独立②统一
- (13) ①0.804
- (14) ①正②下降
- (15) ①自由电子② $\lambda < \frac{h}{E_g}$
- (16) ①V②导带

2.

(1)



(2)

$$k_F = (3\pi^2 n)^{\frac{1}{3}} = \left(\frac{2\pi^2}{\sqrt{3}a^2}\right)^{\frac{1}{3}}$$

(3)

$$r = \frac{2\pi}{3a}$$

(4)

$$Nk_F = r, N = \left(\frac{4\sqrt{3}\pi}{a}\right)^{\frac{1}{3}}$$

3.

(1)

$$N_p = N_A + N_D = 2.5 \times 10^{17} \text{ cm}^{-3}, \mu_n = 450, \mu_p = 190$$

$$P_p = \frac{N_A - N_D}{2} + \sqrt{\left(\frac{N_A - N_D}{2}\right)^2 + n_i^2} = 5 \times 10^{16} \text{ cm}^{-3}$$

$$\sigma_p = \mu_p P_p q = 1.52 \text{ cm}/\Omega$$

$$N_n = 10^{17} \text{ cm}^{-3}, \mu_n = 900, \mu_p = 330$$

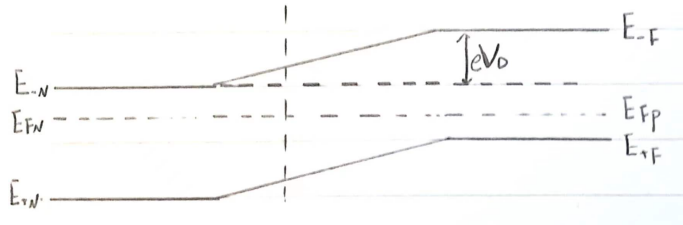
$$\sigma_n = \mu_n n_N q = 14.4 \text{ cm}/\Omega$$

(2)

$$E_{F_p} = E_{F_i} - k_B T \ln\left(\frac{P_p}{n_i}\right) = E_{F_i} - 0.389 \text{ eV}$$

$$E_{F_n} = E_{F_i} + k_B T \ln\left(\frac{N_D}{n_i}\right) = E_{F_i} + 0.407 \text{ eV}$$

$$V_D = 0.796 \text{ V}$$



(3)

$$j = -q\left(\frac{D_n}{L_n}n_P^0 + \frac{D_p}{L_p}p_N^0\right) = \frac{I}{S}$$

4.

(1)

$$E(0,0,0) = A - 3B, E\left(\frac{\pi}{a}, \frac{\pi}{a}, \frac{\pi}{a}\right) = A + 3B, \Delta V = 6B = 3eV$$

(2)

$$v_k = \frac{1}{\hbar} \nabla E_k = \frac{aB}{\hbar} (\sin(k_x a), \sin(k_y a), \sin(k_z a))$$

(3)

$$\frac{1}{m^*} = \frac{1}{\hbar^2} \frac{\partial^2 E}{\partial k^2} \begin{bmatrix} \cos(k_x a) & 0 & 0 \\ 0 & \cos(k_y a) & 0 \\ 0 & 0 & \cos(k_z a) \end{bmatrix}$$

$$m_{top}^* = -\frac{\hbar^2}{a^2 B}(1, 1, 1), m_{bottom}^* = \frac{\hbar^2}{a^2 B}(1, 1, 1)$$

(4)

$$\frac{dk}{dt} = \frac{eE}{\hbar}, t = \frac{\hbar\pi}{aeE} = 6.898 \times 10^{-8} s$$

(5)

$$k = \frac{Eet}{\hbar} = 1.518 \times 10^7$$

$$v_k = \frac{aB}{\hbar}(\sin(k_x a), \sin(k_y a), \sin(k_z a)) = 1.037 \times 10^3(1, 1, 1)m/s$$

5.

(1)

$$E_{g_{Si}}(100) = 1.101eV, E_{g_{Si}} = 0.6345eV$$

(2)

$$n_{iSi} = (N_- N_+)^{\frac{1}{2}} e^{-\frac{E_{g_{Si}}}{2k_B T}} = \frac{2}{h^3} (2\pi k_B T)^{\frac{3}{2}} (m_n^* m_p^*)^{\frac{3}{4}} e^{-\frac{E_{g_{Si}}}{2k_B T}} = 9.015 \times 10^{11} cm^{-3}$$

$$n_{iGe} = (N_- N_+)^{\frac{1}{2}} e^{-\frac{E_{g_{Ge}}}{2k_B T}} = \frac{2}{h^3} (2\pi k_B T)^{\frac{3}{2}} (m_n^* m_p^*)^{\frac{3}{4}} e^{-\frac{E_{g_{Ge}}}{2k_B T}} = 4.660 \times 10^{14} cm^{-3}$$

(3)

$$\Delta E_{F_{Si}} = k_B T \ln\left(\frac{N_D}{n_i}\right) = 0.1516eV$$

$$n_{Ge} = \frac{N_D}{2} + \sqrt{\left(\frac{N_D}{2}\right)^2 + n_{iGe}^2} = 5.187 \times 10^{14} cm^{-3}, \Delta E_{F_{Ge}} = k_B T \ln\left(\frac{n_{Ge}}{n_i}\right) = 3.448 \times 10^{-3} eV$$

(4) 向 Si 中掺杂 P 的方案更好