固物 2017 期末

Deschain

2022 年 6 月 17 日

1.

(1) ①玻色子②$\frac{1}{e^{\frac{\hbar\omega}{k_BT}}-1}$

(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$3N$③$3(n-1)N$

(9) ①OA 上存在②不存在

(10) ①高②N③P

(11) ①$[-\frac{\pi}{2a},\frac{\pi}{2a}]$②$\sqrt{17}:1$

(12) ①独立②统一

(13) ①0.804

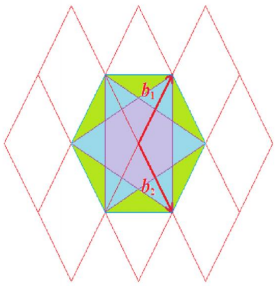
(14) ①正②下降

(15) ①自由电子②$\lambda<\frac{h}{E_g}$

(16) ①V②导带

2.

(1)



(2)

$$k_F = \sqrt{2\pi n} = \sqrt{\frac{4\pi}{3\sqrt{3}a^2}}$$

(3)

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

(4)

$$\sqrt{N}k_F = r, N = \frac{\pi}{\sqrt{3}}$$

3.

(1)

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

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

$$\sigma_p = \mu_p P_p q = 1.52 cm/\Omega$$

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

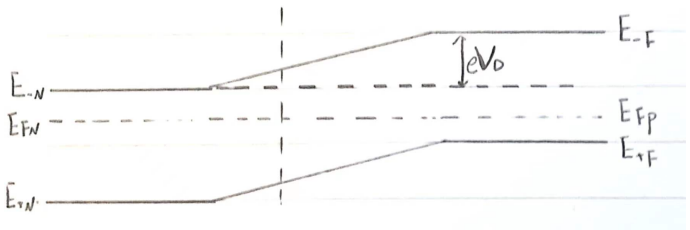
$$\sigma_n = \mu_n n_N q = 14.4 cm/\Omega$$

(2)

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

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

$$V_D = 0.796V$$



(3)

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

4.

(1)

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

(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)

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

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

(3)

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

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

(4) 向 Si 中掺杂 P 的方案更好