# Determination Of The Energy Gap In Semiconductors

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Summary:

The aim of the laboratory:

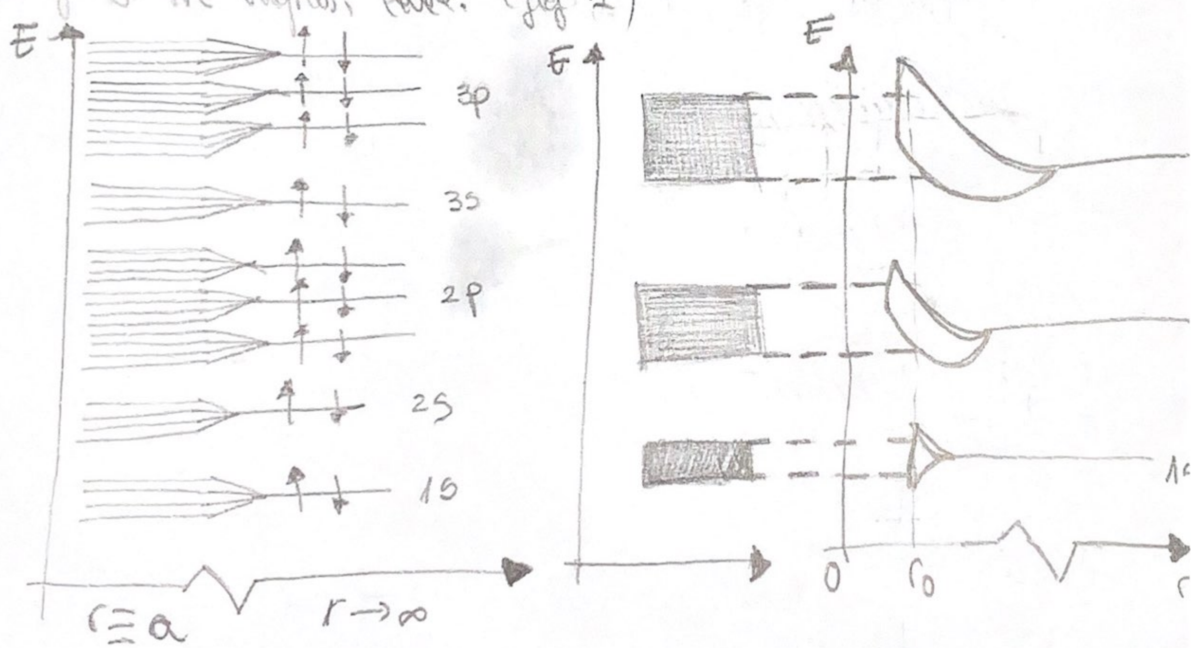
→ To observe the dependence of the resistance of a semiconductor function of temperature and to determine the energy gap for a given semiconductor.

→ at the room temperature, semiconductors present an electrical conductivity between $10^{-10} - 10^{2}$ $(\Omega cm)^{-1}$; they are very important in technology

→ These semiconductors are esential in modern devices, like phones, PC's and more.

→ the electron crystals can only have values within permited bands, separated by energy gaps of forbidden values.

→ At 0K the electrons will occupy the permited levels starting low going to the highest level. (fig 1)




→ $E_g = 0$ if the solid is a conductor

→ $E_g < 2$ eV if the substance is a semiconductor

→ $E_g > 2$ eV for an isulator

$$E_g = E_c - E_V$$

Types of semiconductors

→ Intrinsic semiconductors have no impurities and thus, no additional energy levels in the forbidden band (fig 3)

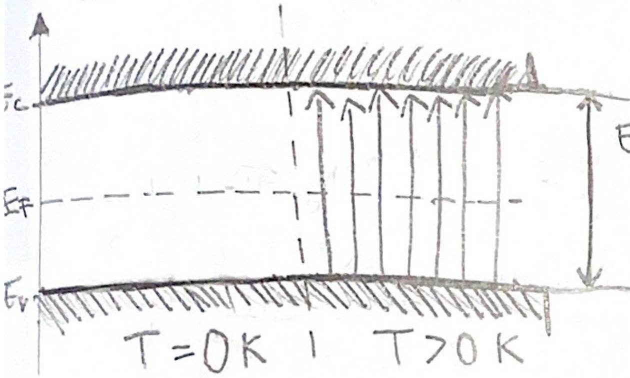
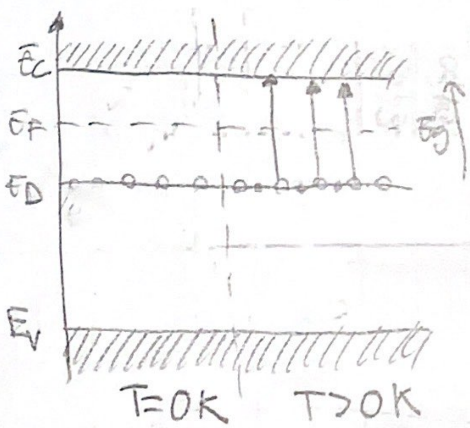



fig 3

→ Extrinsic (or doped) semiconductors have some additional allowed energy levels, between CB and VB. These additional energy levels are due to the impurities or ~~to~~ the lattice defects present in the semiconductor crystal (Fig 4)




$$\sigma = \sigma_0 \cdot e^{\frac{E}{2KT}} \quad (1)$$

$$\ln\sigma = \ln\sigma_0 - \frac{E_g}{2KT} \quad (2)$$

$$\rho = \rho_0 \cdot e^{\frac{E_g}{2KT}} \quad (3), \qquad R = \rho \cdot \frac{l}{S} \quad (4)$$

$$R = R_0 \cdot e^{\frac{E_g}{2KT}} \quad (5), \qquad \ln R = \ln R_0 + \frac{E_g}{2KT} \quad (6)$$

$$\ln R = \ln R_0 + 0.43 \cdot \frac{E_g}{2KT} \qquad \tan(\alpha) = 0.43 \cdot \frac{E_g}{2KT} \Rightarrow E_g = \frac{2K}{0.43} \cdot \tan(\alpha)$$

$$\ln R = a + b \cdot \frac{10^3}{T} \quad (7), \qquad E_g = 0.2 \cdot \frac{\lg R_2 - \lg R_1}{\frac{10^3}{T_2} - \frac{10^3}{T_1}} \quad (8)$$

| $t$ [°C] | $T$ [K] | $\frac{10^3}{T}$ [$K^{-1}$] | $R$ [kΩ] | $\lg R$ | $\Delta E$ [eV] | $\frac{\Delta(\Delta E)}{\Delta E}$ [%] |
|---|---|---|---|---|---|---|
| 23,4 | 296,55 | 3,1372 | 16,09 | 4,20 | 0,18 | |
| 30 | 303,15 | 3,1298 | 11,15 | 4,05 | | |
| 40 | 313,15 | 3,1193 | 6,95 | 3,84 | | |
| 50 | 323,15 | 3,094 | 4,55 | 3,65 | | |
| 60 | 333,15 | 3,001 | 3,06 | 3,48 | | |
| 70 | 343,15 | 2,919 | 2,10 | 3,32 | | |
| 80 | 353,15 | 2,831 | 1,44 | 3,15 | | |
| 90 | 363,15 | 2,753 | 1,02 | 3 | | |
| 99,06 | 372,29 | 2,679 | 0,76 | - 2,88 | | |

Lab 5

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