Fyzikálna sekcia prírodovedeckej fakulty Masarykovej univerzity v Brne

FYZIKÁLNE PRAKTIKUM

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Study program: Astrophysics **Year:** II **Semester:** IV **Tested:**

Task No. **5:** **Forbbiden energy band in semiconductors**

1. Task

- Using photoelectric effect determinate the width of forbidden band of energy in Silicon and Germanium

2. Theory

One of the key difference between conductors, semiconductors and dielectrics is the energy gap between conductivity band and valence band. We will determine the width of the energy band using the photoelectric effect. If the energy of incident photon is higher than the energy gap, the electron from valence band gets into the conductivity band and the semiconductor will be able to lead electric current. Different wavelengths of radiation gets absorbed in different depths of the material. The absorption is defined by:

$$I(\kappa) = I_0(1 - R)e^{-a\kappa} \tag{1}$$

where $I(\kappa)$ is intensity in depth κ under the surface, R reflectivity and a coefficient of absorption. The energy gap can be evaluated from the equation:

$$S(\lambda) = \frac{U(\lambda)}{N(\lambda)} \tag{2}$$

The energy gap is equal to the FWHM (full width at half maximum) of $S(\lambda)$ as a function of energy. The relation between λ and E shows:

$$E = h\frac{c}{\lambda} \tag{3}$$

where c is speed of light and h is Planck constant.

3. Measurement

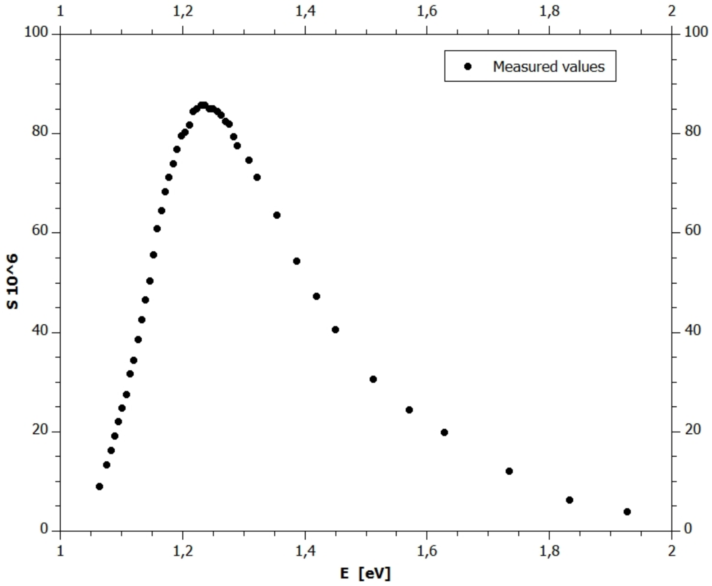

Figure 1: Sillicon
The energy gap: $E_{g(Si)} = 1{,}13$ eV

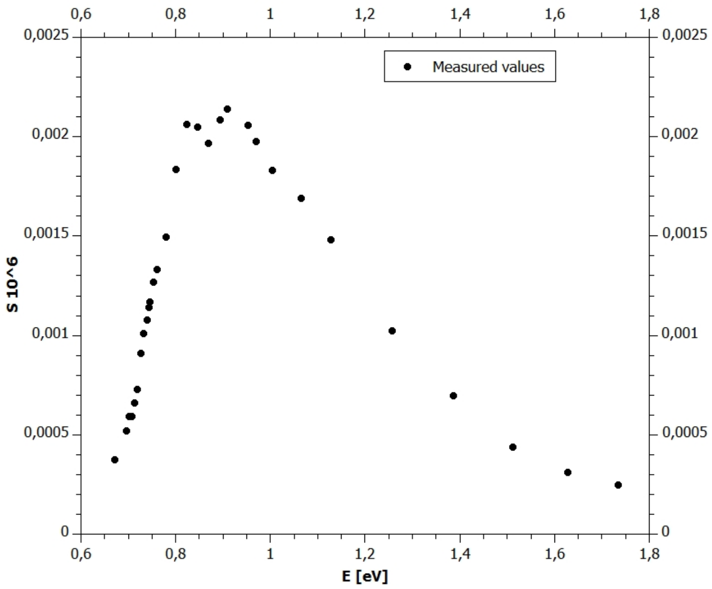

Figure 2: Germanium
The energy gap: $E_{g(Ge)} = 0{,}74$ eV

4. Conclusion

In this task we had to measure the energy gap between valence and conductivity band in Sillicon and Germanium. We did it by method called FWHM where we measured the width at half maximum. We got this results:

$$E_{g(Si)} = 1{,}13 \text{ eV}$$
$$E_{g(Ge)} = 0{,}74 \text{ eV}$$

Tabulated values are:

$$E_{gT(Si)} = 1{,}12 \text{ eV}$$
$$E_{gT(Ge)} = 0{,}69 \text{ eV}$$

Errors in our measurement could be caused mainly by not precise correlation between d and λ.