Germanium Photo Detectors

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Abstract – **The design and technology of Germanium based photo detectors are described. The main laboratory works are made using the system nGe – Metal(Ag) Schotky junction. The photo parameters are measured in the range of 0.6 – 2.0 micrometer.**

Keywords – **photo detectors, germanium, infrared detectors.**

I. Introduction

Germanium is one of the first semiconductor materials for electron devises (p/n junctions). The distance between E_C and E_V, $\Delta E = 0.65\,eV$ makes germanium suitable for photo detectors in infrared range of light - $\lambda > 0.8\mu m$ [1]. Under cooling in liquid nitrogen germanium photo detectors can work up to $\lambda = 4 \div 5\mu m$ [2].

There are several types of germanium detectors:

- Ge photo resistors;
- Ge photodiodes;
- Ge avalanche photodiodes – Fig. 1 [3, 4].

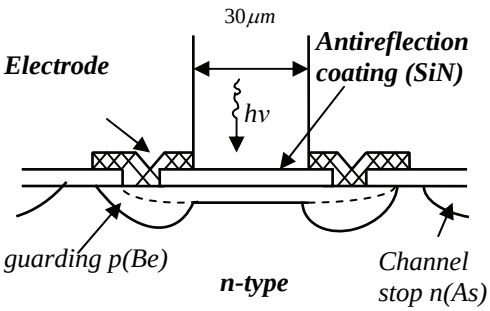

Fig. 1. Typical germanium avalanche photodiode.

The last ones have the best parameters but very complicated technology.

The advantages and disadvantages are connected with price, construction and the area of application.

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The goal of this work are germanium photo detectors – resistors and diodes.

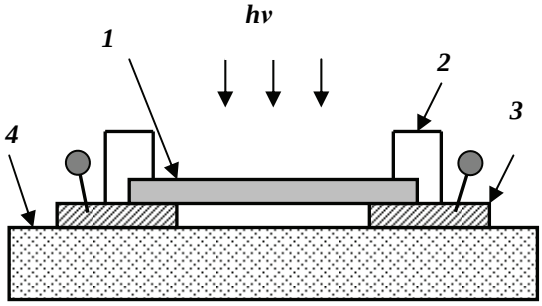
The last ones are based on the system Ag – Ge which is not classical p/n junction but metal – semiconductors barrier.

The samples have been prepared for student laboratory classes and for laboratory use.

II. Design and technology of Ge - photo detectors

A. Germanium photo resistors

The most popular construction of Ge photo resistors is a rectangular plate with two electrical contacts at the opposite ends -Fig. 2.



1- Ge crystal – detectors; 2 – Ohm contacts;
3 - External leads; 4 – Insulating substrate.

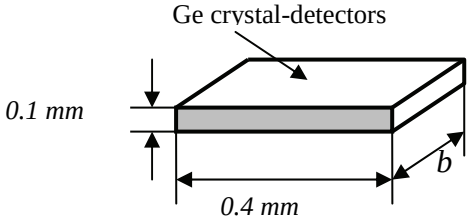


Fig. 2.

The nominal value of the resistance ($T = 20^0 C$ without light) can be calculated as $R_0 = \rho_{Ge} A$ (where ***A*** is coefficient of the geometry).

The germanium used in the experiments are crystals (size $0.4 \times b \times 0.1\,cm$), *n* - type and specific resistance - $\rho = 0.1 \div 10\ ohm.cm$.

It is clear (Table 1) that the nominal values of R_0 are between $10 \div 8000$ *ohms* .

The electrical (ohm) contacts are made using eutectic Au – Ge plus Sb.

TABLE I.
VALUES OF R_0 (OHMS)

ρ	*b(cm)*			
(ohm.cm)	0.05	0.1	0.2	0.4
0.1	80	40	20	10
0.2	160	80	40	20
0.5	400	200	100	50
1.0	800	400	200	100
2.0	1000	800	400	200
5.0	4000	2000	1000	500
10.0	8000	4000	2000	1000

B. Germanium Schotky photodiodes

The cross - section of germanium Schotky photo diodes is shown on Fig. 3:

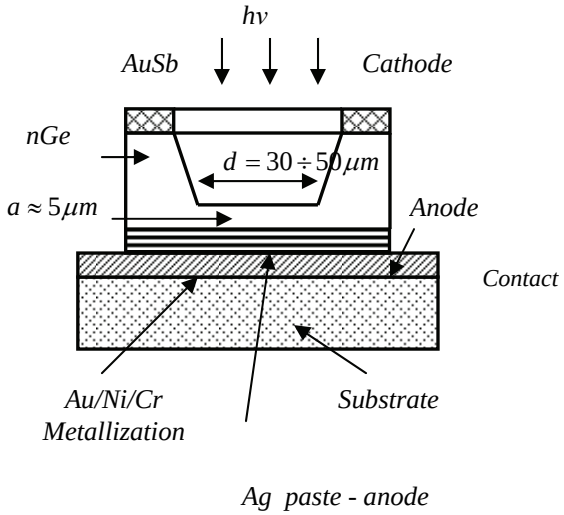


Fig. 3.

Usually, it is considered that Ge – Ag barrier is "sharp" p/n junction and parameters such as U_{BR}, I_S and C_O will depend only on Ge properties (ρ). It could be calculated that $U_{BR} = 83.4\rho^{0.61}$. The technology consist next important steps - Fig. 4:

III. CONCLUSION

The measurements of so prepared photo detectors show that the response in infrared light is sufficient for laboratory use and student education - Fig. 5.

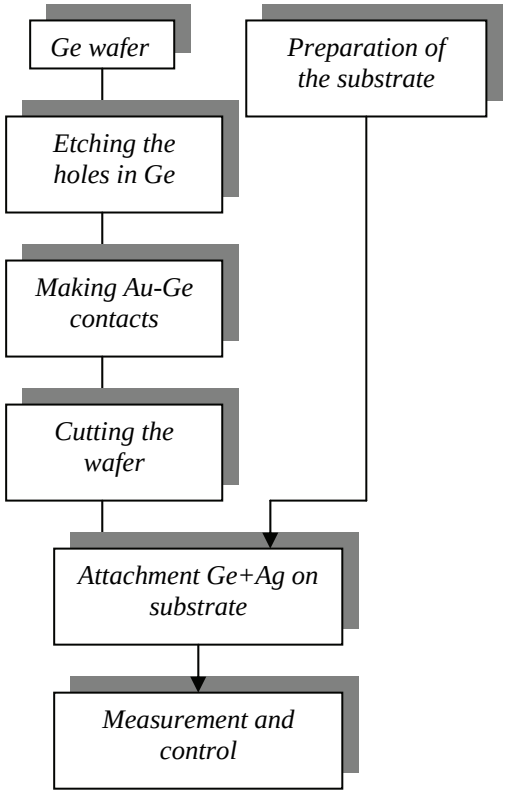


Fig. 4.Ge – Ag photo detectors fabrication.

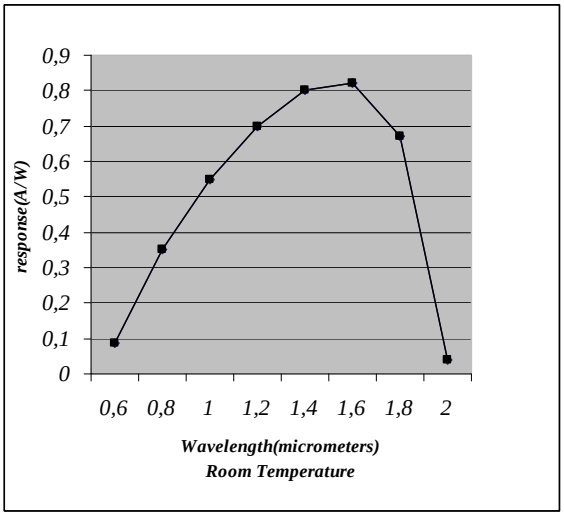


Fig. 5.

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