Contributed paper

OPTO-ELECTRONICS REVIEW 6(2), 151–152 (1998)

Microwave polarised infrared germanium photodetector

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In this paper the performance of infrared germanium photodetector with two l-h junctions is presented. The detector has been installed in the microwave cavity.

In the sixties several publications [1–3] describing a new type of photodetectors appeared. Such a photodetector consisted of h.f. polarised semiconductor crystal mounted in the microwave cavity and enabled to obtain very high sensitivity due to the effect of internal gain in the bulk of the crystal.

Later on, as a result of our own investigations a h.f. polarised photodetector using germanium photoresistor with two l-h junctions was developed [4–6]. The photoresistor was made as a separate semiconductor device installed in the microwave cavity. The design was described in details in [4]. The sensitivities obtained implied its practical usefulness and encouraged to search for a more compact design of the detector containing the microwave cavity with the photoresistor as well as the h.f. generator in one separate photodetecting head which can be easily placed on the optical bench.

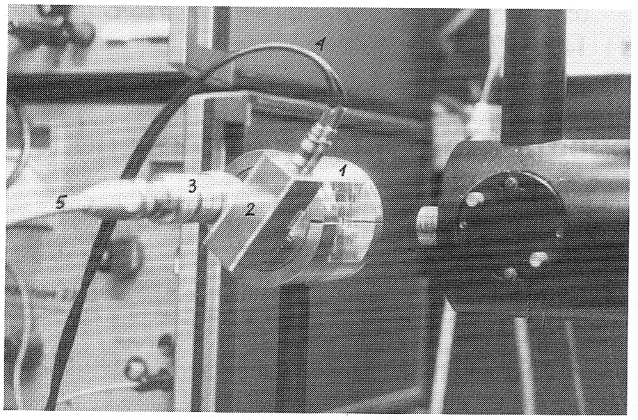

Fig. 1. Microwave polarised integrated photodetector: 1 – microwave cavity with the p^+–p–p^+ germanium photoresistor, 2 – h.f. generator, 3 – detector, 4 – connection to power-supply, 5 – connection to nanovoltmeter.

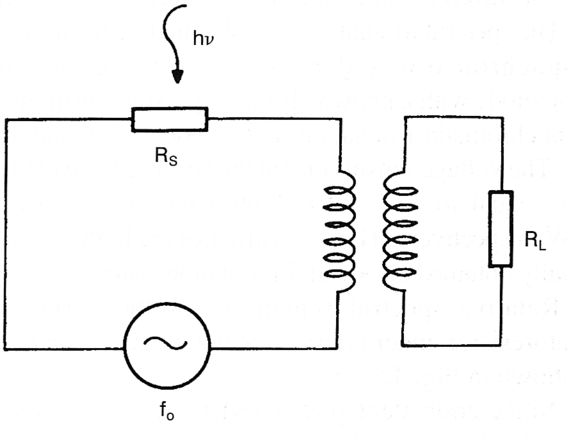

Fig. 2. Electronic scheme of photodetector: R_S – resistance of the semiconductor sample, f_o – h.f. generator polarising the sample, R_L – load resistance.

The development and miniaturisation of electronic circuits enabled us to bring the idea into life, and a compact photodetector was finally built (Fig. 1). The electronic scheme of photodetector is given in Fig. 2.

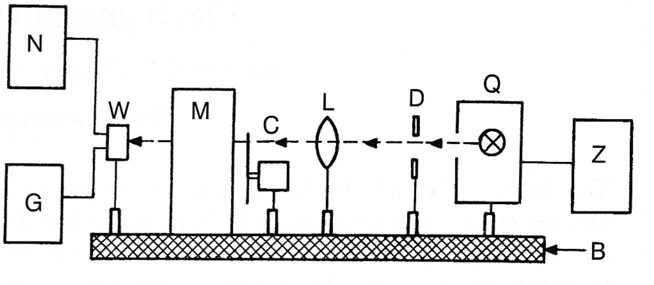

Fig. 3. Scheme of measuring system: W – microwave cavity with photoresistor, G – h.f. generator, N – selective nanovoltmeter, M – monochromator, C – optical chopper, L – optical focusing system, D – diafragme, Q – light source, Z – supply for the light source, and B – optical bench.

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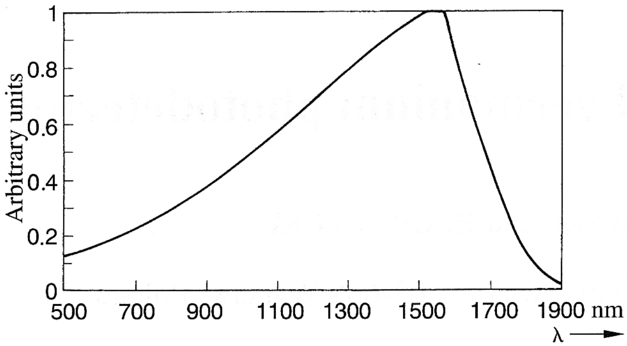

Fig. 4. Relative spectral sensitivity of microwave-biased germanium photoresistor.

The measurements performed on the stand whose scheme is presented in Fig. 3 confirm high sensitivity of the photodetector. A low frequency effective voltage for different spectral radiant power was measured.

The spectral irradiation was obtained by means of the monochromator and measured by a germanium photodiode with a known absolute spectral sensitivity for monochromatic irradiation at λ = 900, 1060, and 1550 nm. The voltage sensitivities at the specified wavelengths were equal to 1.97×10^5, 2.69×10^5, and 6.09×10^5 V/W, respectively. These sensitivities are higher than the usually obtained ones with PbS photoresistors.

Relative spectral sensitivity of the germanium photoresistor under microwave polarisation conditions is shown in Fig. 4.

Noise equivalent power (NEP) was measured by the selective nanovoltmeter (with the selectivity of 40 dB for one octave) for the optical signal modulated by the optical chopper with the frequency of 410 Hz and as a result NEP $\approx$ 40 pW was obtained.

For the irradiation at λ = 1.52 μm a detectivity $D^* = 8\times 10^{10}$ $\mathrm{cmHz^{1/2}W^{-1}}$ was obtained. The described photodetector features not only high sensitivity but also no necessity of using cooling as well.

Present-day works focus on application of circuits of higher polarisation frequencies to further enhancement of the sensitivity of the photodetector itself and to use different semiconductor materials in order to enlarge spectral range of photodetectors.

Acknowledgement

This work was partially supported by the State Committee for Scientific Research, Grant No. 8 T11B 081 10.

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