Front surface illuminated InAsSb PDs ($\lambda_{0.1}$ = 4.5 μm) for operation 25-80 ºC.

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Photodiodes (PDs) for the 3–5 μm spectral range are demanded in the NDIR optical monitoring of a number of natural and industrial gases. Most commonly used for the above purpose are PDs based on HgCdTe or InAsSb alloys, the latter being attractive due to stability of metallurgical heterojunctions – important feature for applications at elevated temperatures. As temperature increases the collection efficiency of the photogenerated carriers in PDs with finite contact dimensions degenerates due to lowering of the p-n junction barrier height, e.g. in the front surface illuminated (FSI) PDs [[1]].

The report contains data on 2D distribution of reverse and forward current and collection efficiency of the photogenerated carriers as well as analysis of sensitivity S_I and detectivity $D^*_{\lambda max}$ dependence on contact perimeter in FSI PDs based on *n-InAs/n-InAsSb/p-InAsSbP* structures with $\lambda_{0.1}$ = 4.5 μm (25 ºC) in the temperature range of 25-80ºC.

Samples of 0.4x0.4 mm dimensions with *Cr/Au/Ni/Au* bottom broad contact to *n-InAs* had 4 types of the *Cr/Au/Ni/Au(Zn)* anode onto a *P-InAsSbP* layer: disk of ~80 μm diameter in the mesa centre and three other contacts with 10x300 mm stripes of different density (see schematic in Fig.1 on the right). Current sensitivity S_I as well as Jones detectivity $D^*_{\lambda max}$ were calculated for active area equal to (0.35x0.35 mm^2) – mesa area for all samples. Spectral sensitivity peaked at λ_{max} = 4 μm (25^{o}C) with a broad shoulder towards short wavelengths due to shallow position of the p-n junction, on a temperature increase the λ_{max} grew as fast as 4.8 nm/K.

Let us mention decrease of the current spreading length and collection efficiency decline as reasons responsible to the S_I degradation at elevated temperatures for all for types of PDs. Anode perimeter increase (in the row from point contact to contact with many stripes) resulted in a zero bias resistance decrease, but on the other hand to a sensitivity enhancement as high as 5 at 80^{o}C. However as seen from data in Fig.1 even the most sophisticated anode (with maximum perimeter) did not provide 100% collection efficiency as there were no saturation tendency in the S_I *vs perimeter* dependence. In other words current spreading length was still higher than the distance between contact elements. This feature manifested itself in the negative luminescence 2D intensity distribution that showed local minimums and the areas between contacts. In spite of the R_o decrease the increase of the perimeter enabled us to achieve 2- fold detectivity $D^*_{\lambda max}$ increase up to $2 \cdot 10^8$ cm $Hz^{1/2}$ W^{-1} at 80°C (see Fig.1 b). The latter makes FSI InAsSb PDs attractive for various high temperature applications.

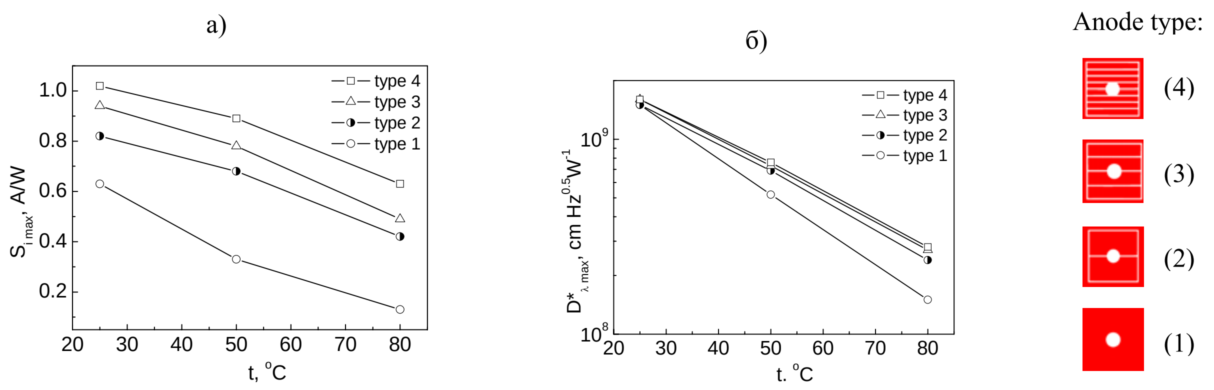

Fig.1 Temperautre dependence of sensitivity (a) and detectivity (b) in *InAsSb* PDs with four different type of contacts to *p-InAsSbP* (1-4).

References

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[1] N.D. Il'inskaya, A. L. Zakgeim, S.A. Karandashev, B.A. Matveev, V.I.Ratushnyi, M.A. Remennyy, A.Yu.Rybal'chenko, N.M. Stus', A. E. Cherniakov, "Surface Illuminated InAsSb Photodiodes ($\lambda_{cut-off}$ = 4.5 μm) Operating at 25-80 ºC", Semiconductors 2012 (in press)