# SENSITIVE PLANAR MICROWAVE DIODES ON THE BASE OF TERNARY $AL_XGA_{1-X}AS$ SEMICONDUCTOR COMPOUND

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Electromagnetic radiation in millimeter wavelength range attracts attention of scientists and engineers due to possible applications in modern fields of technology such as imaging of concealed objects, material homogeneity inspection, adaptive cruise control for automotive vehicles, as well as for future broadband cellular communication networks. Successive development of these technologies requires sensitive microwave detectors. For the commercial application of these technologies, microwave sensors must not only be sensitive and fast but also reliable and inexpensive. We have earlier proposed a simple design of inexpensive planar microwave (MW) diodes fabricated on the base of low resistivity gallium arsenide (GaAs) substrate [1]. The diodes were used to detect microwave continuous wave (CW) signals as well as to measure pulsed microwave power in nanoseconds time scale [2]. However, the fast diodes had low voltage responsivity, and more sensitive ones demonstrated high electrical resistance in the CW measurements. Therefore, the main issue of this report is the increase of voltage responsivity of the planar dual microwave diodes and the reduction of the spread of electrical parameters of the planar MW diodes on the base of epitaxially grown *n*-$Al_xGa_{1-x}As$ layer on semiinsulating (SI) GaAs substrate.

The *n*-$Al_xGa_{1-x}As$ layers of sub-micrometric thickness (0.4÷0.8 μm) with different aluminum arsenide (AlAs) mole fraction (x = 0; 0.15; 0.3) were grown onto semiinsulating SI GaAs substrate using liquid phase epitaxy technique. The layers were non-intentionally doped, and the charge carrier density varied from layer to layer within the range of $8 \cdot 10^{15} \div 2 \cdot 10^{17}$ $cm^{-3}$. First photolithography was made to define rectangular mesas of the MW diodes by means of etching the AlGaAs layer and opening the surface of the SI GaAs. The second photolithography step was used to create metallic contacts of the diodes. The thermally evaporated Ge/Ni/Au contacts were annealed in $H_2$ atmosphere for 2 minutes. Electrical resistance and voltage responsivity of the diodes were controlled by means of varying the area of the small contact in the vicinity of the border of the diode's mesa. Measurements of direct current and high frequency electrical parameters of separate MW diodes were carried out directly on the uncut substrate with the diode array using appropriate probe stations.

Investigation of detection properties of the dual MW diodes was performed in $K_a$ frequency range. The voltage responsivity strongly depended on the AlAs mole fraction. The lowest value of the responsivity ranging over several volts per watt had the diodes that were fabricated on the base of GaAs epitaxial layer (x = 0). The diodes on the base of $Al_{0.15}Ga_{0.85}As$ epitaxial layer revealed higher responsivity, from tens up to one hundred V/W, depending on the value of the small contact area. The highest values of the voltage responsivity demonstrated the dual MW diodes fabricated on the base of $Al_{0.3}Ga_{0.7}As$ layer; for the diodes with small contact area of several square micrometers it exceeded 500 V/W limit.

[1] A. Sužiedėlis, S. Ašmontas, J. Gradauskas, A. Šilėnas, A. Čerškus, A. Lučun, Č. Paškevič, M. Anbinderis, O. Žalys, Planar Asymmetric Dual Diode for Millimeter Wave Detection and Power Measurement, Lithuanian Journal of Physics Vol. 57 N 4, 225–231 (2017).
[2] A. Sužiedėlis, S. Ašmontas, J. Gradauskas, A. Šilėnas, A. Lučun, A. Čerškus, Č. Paškevič, O. Žalys and M. Anbinderis, Pulsed Microwave Sensor on Heavily Doped Semiconductor Substrate, Proceedings of The 2017 Progress in Electromagnetics Research Symposium, 1037-1042 (2017).