Isolation of responsive elements of coordinate *p-i-n* photodiodes by p^+-layer

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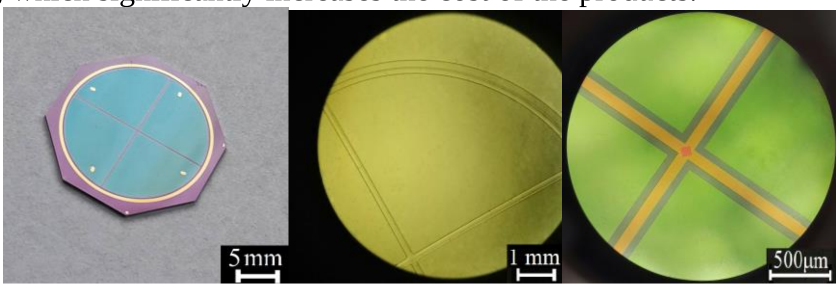
An urgent task of modern optoelectronics and photoelectronics is the development of systems for detecting the coordinates of various objects. Coordinate multi-element or matrix *p-i-n* photodiodes (PD) are most often used in such systems. The coordinate PD is usually a two- or four-element (sometimes more) photodiode on one semiconductor plate, and the responsive elements (RE) of photodiodes are separated by gaps smaller than the size of the light probe [1]. An important task in the manufacture of multi-element PDs is to ensure proper insulation of the REs among themselves, since the formation of inversion layers at the Si-SiO_2 interface can significantly deteriorate the insulation resistance of the active elements. There are various methods of isolation of REs. A classic option in planar technology is insulation with a base material and a dielectric gap on the surface, most often SiO_2 (Fig. 1a). This method provides insulation resistance between elements R_{con}=1-15 MΩ. But with an increase in the level of positive charge in the oxide, a sharp deterioration of this parameter is possible. A common method of isolation is the formation of a mesastructure, where the dielectric is air (R_{con}=6.7-20 MΩ) (Fig. 1b). But this method does not exclude the formation of inversion channels at the Si-SiO_2 interface. An effective method of isolation of the REs is the formation in the gaps between the active elements of areas of restriction of channels of leakage of charge carriers isotypic with the material of the substrate (in this case, p^+-type, R_{con}=18-50 MΩ) (Fig. 1c). In the case of *p-i-n* PD, this is embodied by the introduction of additional thermal operations - diffusion of boron into the gaps between the REs and oxidation, as well as one photolithography, which significantly increases the cost of the products.



a) b) c)

Fig. 1. Image of crystals of PDs: a) classic PD; b) PD with mesastructure; c) PD with p^+- area between REs.

We proposed to first carry out boron diffusion in the entire front surface of the substrate with a low concentration, and then the sequence of operations will correspond to the classical route [1]. Boron diffusion in this case was carried out at a temperature of 1073-1123 K for 1-2 min, the surface resistance after diffusion reached R_S=150-200 Ω/□. Accordingly, the formation of p^+-type areas was ensured by the introduction of one "low-temperature" thermal operation and without the introduction of additional photolithography. The insulation resistance between REs with such a crystal design reached R_{con}=15-30 MΩ. It was noted that the introduction of a small concentration of boron significantly reduces the density of dislocations that are formed during the diffusion of phosphorus. This is caused by the compensation of mechanical stresses introduced by phosphorus atoms, which have a larger diameter than silicon, since the diameter of boron atoms is lower than in silicon.

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