THE DISTRIBUTION OF MICROPLASMAS OVER THE AREA OF THE P-N JUNCTION.

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Abstract. *The appearance of mycoplasmas is accompanied by the emission of light and hot electrons. In this case, the type of the reverse branch of the VAC in the region of strong electric fields and the magnitude of the voltage V of the breakdown of the p-n junction are determined mainly by microplasmas. Each successive gap in the VAC curve is associated with the appearance of a new mycoplasma and with each inclusion the steepness of the VAC increases, since this leads to a decrease in dynamic resistance. The authors showed that the breakdown voltage of mycoplasmas V increases with increasing temperature, and the thermal voltage coefficient (TCN) of the breakdown of microplasma is greater the higher the value of the breakdown voltage of the diode.*

Keywords: *Temperature, silicon p-n junctions, Avalanche breakdown of real p-n, Since the microplasma breakdown, the most low-voltage, resistivity over the cross, distribution of power lines, high metal contact, dispersion resistance.*

РАСПРЕДЕЛЕНИЕ МИКРОПЛАЗМЫ ПО ПЛОЩАДИ P-N ПЕРЕХОДА.

Аннотация. *Появление микоплазм сопровождается эмиссией света и горячих электронов. При этом тип обратной ветви ВАХ в области сильных электрических полей и величина напряжения V пробоя p-n-перехода определяются преимущественно микроплазмой. Каждый последующий разрыв кривой ВАХ связан с появлением новой микоплазмы и с каждым включением крутизна ВАХ увеличивается, так как это приводит к снижению динамического сопротивления. Авторы показали, что напряжение пробоя микоплазм V увеличивается с ростом температуры, а коэффициент термонапряжения (ТКН) пробоя микроплазмы тем больше, чем выше значение напряжения пробоя диода.*

Ключевые слова: *Температура, кремниевые p-n переходы, Лавинный пробой реальных p-n, Так как микроплазменный пробой, самое низковольтное, удельное сопротивление по кресту, распределение силовых линий, высокий металлический контакт, дисперсионное сопротивление.*

In early studies of avalanche breakdown, it was noted that the first MP appear at the exit points of the p-n transition to the surface. In this case, the voltage at which they appeared was significantly lower than the voltage at which the first MP appeared in the volume. This was caused by the presence of OPZ near the surface due to various contaminants that are difficult to control during the manufacture of p-n junctions. Since surface MP have significantly reduced breakdown voltages, and the heat dissipation conditions for them are worse than for bulk MP, such p-n junctions were very sensitive to overvoltages in the opposite direction and easily failed [1-8].

The elimination of the surface breakdown of p-n junctions can be achieved by the "guard ring" method or by removing the "positive" chamfer.

In the first method, a shielded p-n junction with an avalanche breakdown voltage exceeding the breakdown voltage of the main p-n junction is created in the annular region around the main junction. In silicon, for example, this can be achieved by simultaneous diffusion of boron (in the central regions) and aluminum (in the ring region) [9-10].

In the second method, a certain profile of the structure is created at the exit point of the p-n junction to the surface. For example, if the area of the p-n junction decreases as a result of chamfering from a heavily alloyed area to a weakly alloyed one (positive chamfer), then a chamfer angle of several tens of degrees leads to the elimination of surface breakdown. The reason for this is the expansion of the OPZ near the surface with such a chamfer configuration.

Avalanche fans used as powerful rectifiers, the second method has been widely used.

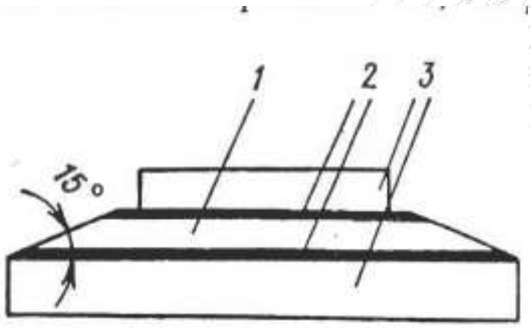

Fig. 1. 1-silicon; 2-solder; 3-tungsten thermal compensators

Since the microplasma breakdown is associated with imperfections of the p-n junction, the distribution of MP over the area of the pn junction correlates with the distribution of imperfections. As mentioned above, many researchers have noted that microplasmas often occur in areas with increased dislocation density.

This is especially true for the most low-voltage MP diodes. It is also obvious that the distribution of MP should depend on the distribution of resistivity. They cannot serve as the direct cause of the appearance of MP, they "manifest" the distribution of low-voltage MP.

Since the distribution of dislocations and resistivity over the cross section of the initial semiconductor ingot is often uneven, the distribution of low-voltage.

The MP along the p-p transition plane in avalanche fans of the large plane repeats the pattern of their distribution. However, with increasing voltage, when an increasing number of MP is included in the avalanche breakdown, the MP distribution becomes more uniform over the area [11-14].

As noted above, MP is caused by structural defects having geometric dimensions of the order of the width of the OPP at breakdown voltage. Therefore, in low-voltage p-n junctions, a greater number of imperfections can participate in the formation of MP than in high-voltage ones. This leads to the fact that the density of MP decreases with an increase in the breakdown voltage of the p-n junction, as a rule. For example, in silicon p-n junctions with a breakdown voltage of about 20V, the MP density is 106cm with a breakdown voltage of about 103V-3 103cm-2 [15], and with a breakdown voltage of 5 103V it decreases to 102- 103cm.

Overload capacity of avalanche valves. The mechanism of destructive valves.

As noted above, avalanche valves can withstand significant overvoltages in the opposite direction only for a short time. The destruction of the valve in the final stage always occurs due to the occurrence of a negative differential resistance (ODS) on the volt-ampere characteristic. The appearance of ODS causes the current to contract into the cord and the destruction of the device at the location of the cord due to the melting of the silicon disk. Indirect evidence of current lacing at the stage of destruction is the fact that there is always only one place of penetration on the surface of the p-n junction. These places of destruction can be easily detected after removal of thermal compensators and easy etching.

Large voltage drops along the chamfer are associated with the flow of avalanche current through the MP located under the chamfer of the avalanche current through the MP located under the chamfer of the avalanche valve.

If in the p-n junction there are only volumetric MP located under the upper metal contact, then the distribution of force lines and equipotential surfaces looks approximately as shown in Fig. 1.a

If in the p-n junction there are MP located under the chamfer, which are not "closed" by the upper metal contact, then the distribution of power lines and equipotential surfaces should be similar to that shown in Fig. 7, b. From such surface MP, the current spreads not into a hemisphere, as with volumetric MP, but into space, bounded by the p-n transition plane and the chamfer surface. In this case, the chamfer surface is almost parallel to the lines of force, and a significant drop should be observed along it. tension. The current flowing parallel to the chamfer surface can be significant. For example, in avalanche VL-10 fans, the area of the p-junction is about 0.5 cm2.

With an n-base thickness of 250 microns and a chamfer angle of 150, the area of the upper metal contact to the n-base is approximately 60% of the area of the p-n junction. If the avalanche current is distributed evenly over the area of the p-n junction, then about 40% of the current is pulled together to the edge of the upper metal contact, Besides, the spreading resistance of near-surface MP is approximately 180/α times (where α is the chamfer angle) exceeds the spreading resistance of volumetric MP. For example, at α = 150, the spreading resistance of near-surface MP increases by more than 10 times and becomes approximately equal to the resistance of the spatial charge.

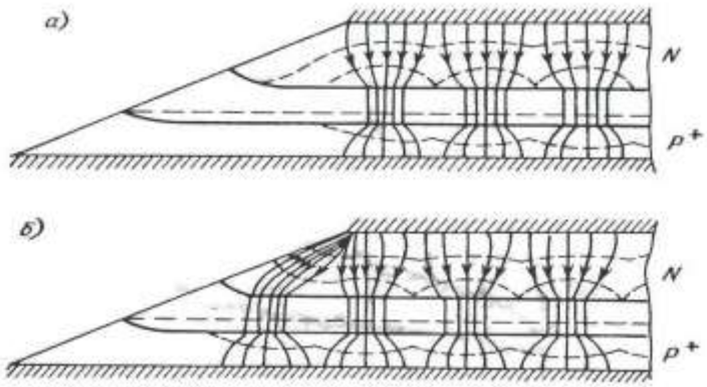

Fig. 2. Schematic representation of the distribution of power lines and Equipotential surfaces in the valve base when flowing Avalanche current: a- for "volumetric" microplasmas; b-in the presence "near-surface" microplasmas.

The occurrence of ODS is similar to how it occurs in avalanche transistors. The mechanism under discussion, for example, should take place in avalanche thyristors in which the nearest p-n junction is directly displaced. After the occurrence of ODS, the current is quickly pulled into the cord and the subsequent strong heating of the cord leads to a destructive breakdown of the valve.

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