

STUDY OF THE SWITCHING CHARACTERISTICS OF GAAS S-DIODES

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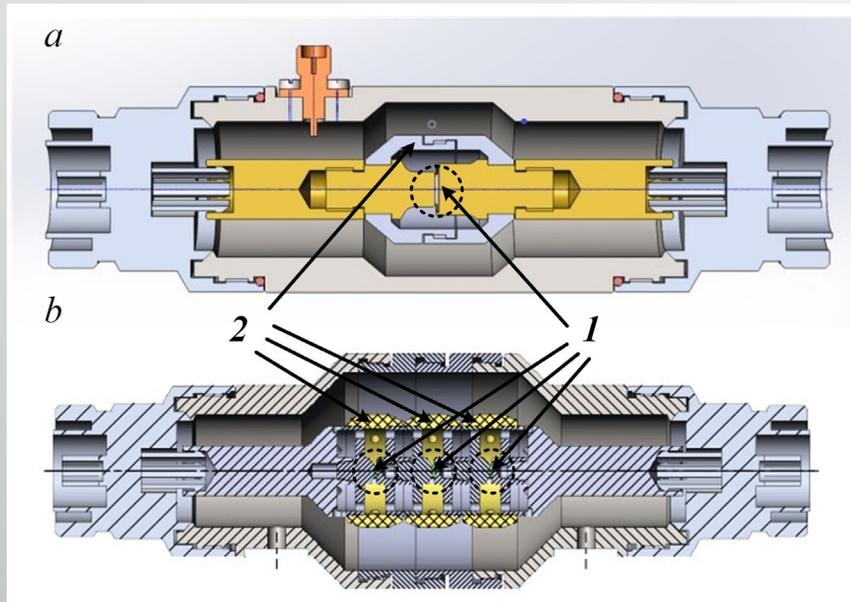
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I. INTRODUCTION

- Semiconductor switching diodes are used in many fields of electronics and electrical engineering [1]. Avalanche S-diodes based on gallium arsenide are used in voltage pulse shapers with amplitudes of the order of several kilovolts and a front duration of about 500 ps, for example. It is of interest to find solutions for using this type of diode as a sharpener of the voltage pulse front with an amplitude of the order of several kilovolts.

II. EXPERIMENTAL SETUP

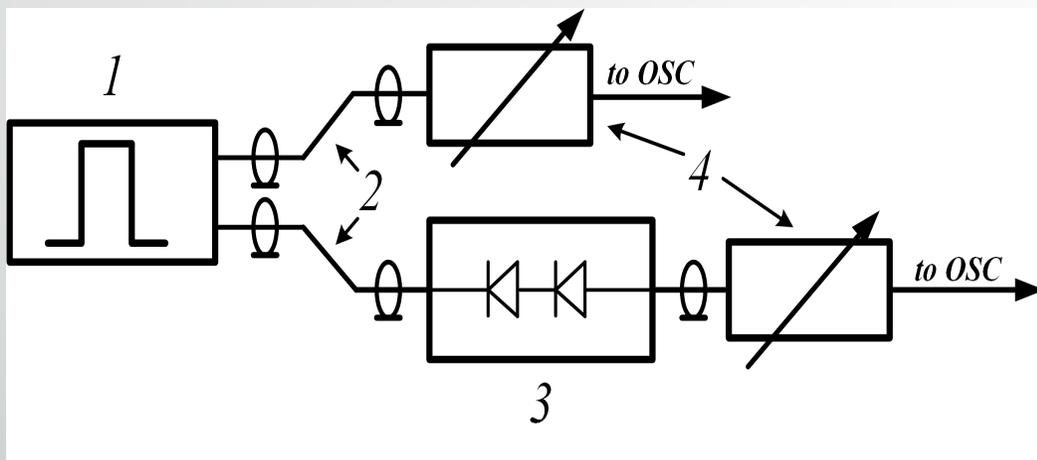


We used two coaxial chambers, the designs of which are shown on the slide.

Chamber №1, shown in Fig. a, was designed to work with voltage pulses with an amplitude of about 2 kV. This chamber allowed the use of diode assemblies consisting of two elements.

Chamber №2, shown in Fig. b, was designed for voltage pulses with an amplitude of about 8 kV. It can be converted to a chamber for one, two and three diodes connected in series.

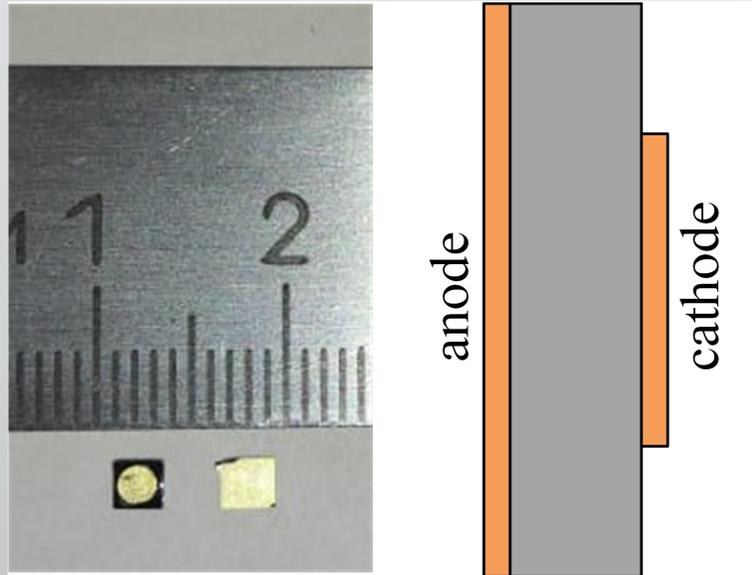
Block diagram of the measuring installation



- 1 - source of voltage pulses,
- 2 - high-voltage coaxial cables,
- 3 - S-diodes under test,
- 4 - coaxial attenuators

The work used a voltage pulse source, described in detail in [3]. The source of modulating pulses allows you to adjust their amplitude from 200 V to 5.5 kV at a 50-ohm load.

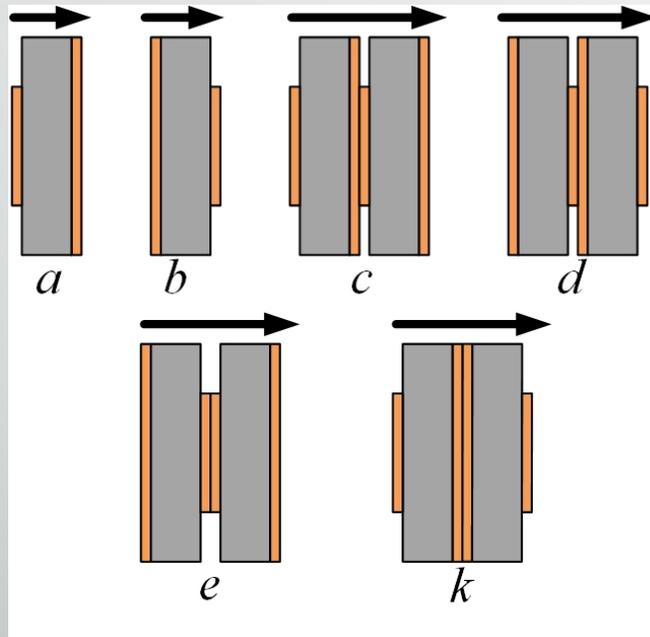
Description of the diodes used



In the experiments, the switching properties of GaAs avalanche diodes were studied, the photographs and schematic images of which are shown in slide.

III. EXPERIMENTAL RESULTS

Experiments with chamber №1



During the experiments, the switching times from the closed state to the conducting state of a single diode, which was placed in the gap of the central conductor in the chamber №1, were compared, depending on its orientation. An assembly of two diodes with various combinations of orientation of the diodes was also placed in the chamber. Possible ways of placing diodes in the chamber are shown in slide

The arrows show the direction of propagation of the voltage pulse.

a - reverse connection of a single diode,
b - direct connection of the diode,
c, d, e, k - combinations of switching on two diodes.

Experiments with chamber №1

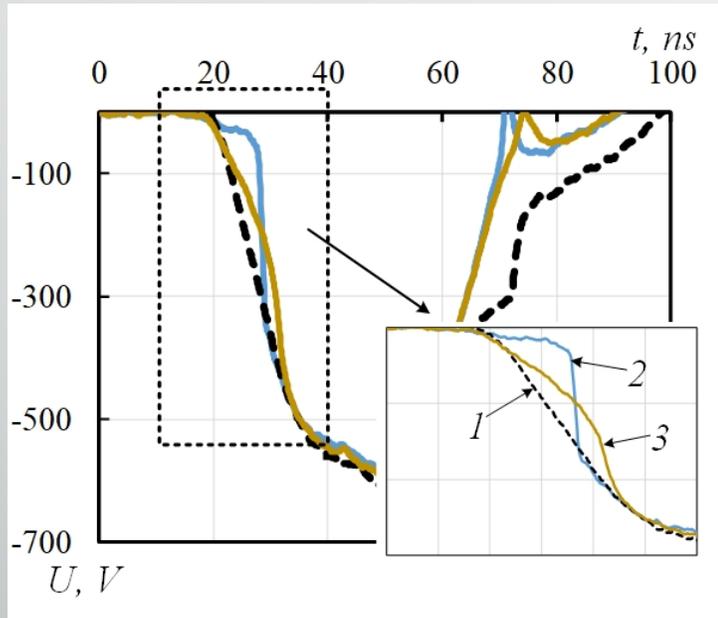
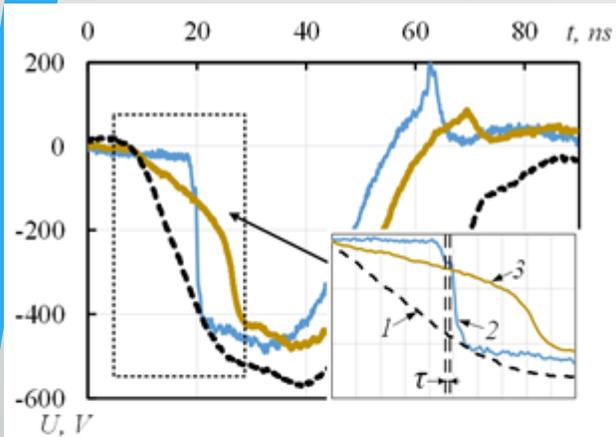


Figure shows the synchronized waveforms of the pulse incident on the diode and the passage of a single diode for cases *a* and *b*. It can be seen that in case *b*, the front of the transmitted pulse at a level of 0.1-0.9 is much shorter and amounts to 700 ps.

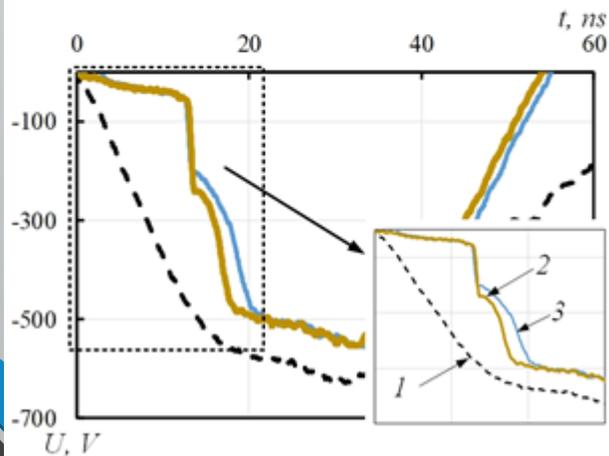
Oscillograms of voltage pulses:

- 1 - incident pulse to a single diode;
- 2 - pulse after a diode connected in the opposite direction;
- 3 - pulse after a diode connected in the forward direction.

Experiments with chamber №1



(a)

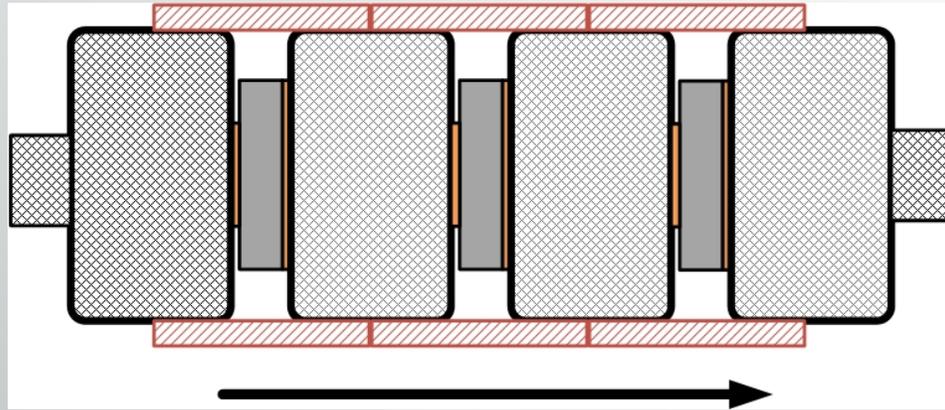


(b)

Figure shows the oscillograms of the diodes incident on the assembly and the transmitted voltage pulses corresponding to the switching configurations *c*, *d*, *e*, *k* in Fig. 5, respectively. It can be seen that the diode response delay (blue voltage pulse in Fig.7a and Fig.7b) does not exceed 0.8-1.0 ns. For the assemblies shown in Fig.5e and 5k, there is no section corresponding to the time delay.

1 - incident pulse to an assembly of 2 diodes, 2 - pulse after assembly, corresponding to Fig. 5c and Fig. 5e respectively, 3 - pulse after assembly, corresponding to slide 5 d and k

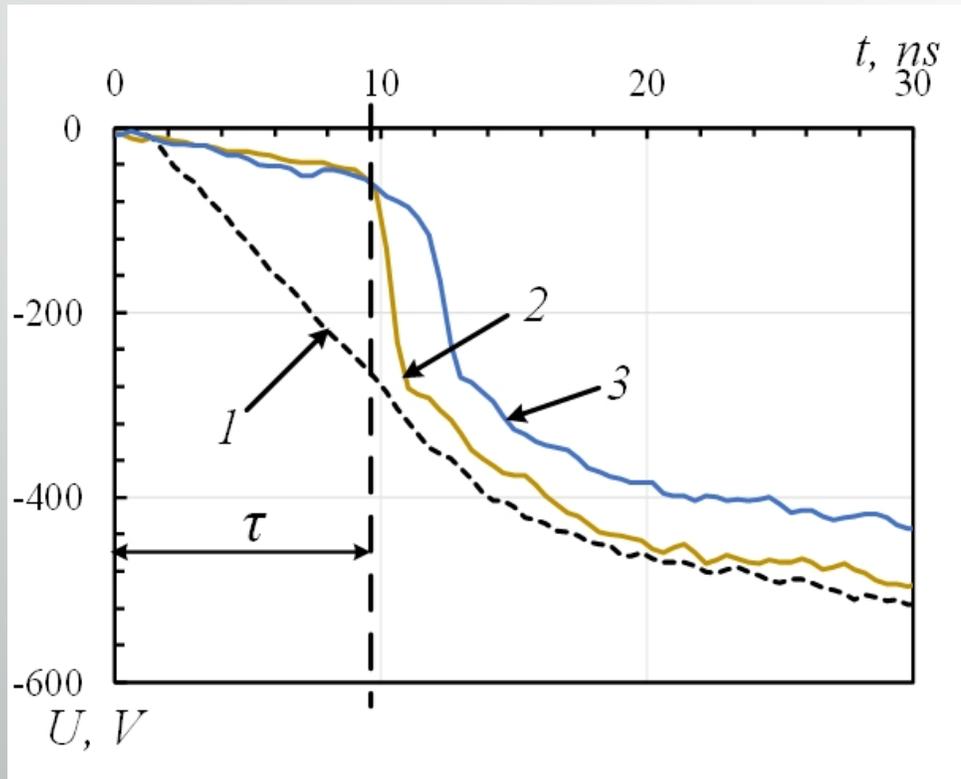
Experiments with chamber №2



The location of the diodes in the chamber №2. In burgundy, bushings made of plexiglass are indicated, gray shading indicates the center conductor

Figure schematically shows the option of turning on the diodes in chamber №2. The experiments were carried out with one diode, then with two and three. The recorded waveforms for each of the cases are presented in slide 10 and slide 11. In slide 10, the incident voltage pulse is indicated in blue for cases of one diode and an assembly of two diodes. In slide 11, the voltage pulse incident on an assembly of three diodes is shown in black. It can be noted that an increase in the number of diodes in the chamber leads to an increase in the breakdown voltage of the entire assembly, which in turn leads to an increase in the time delay τ between the incident pulse and the passing one. In the case of an increase in the amplitude of the incident pulse, the delay time decreases, but the risk of destruction of the diode structure increases. The durations of sharpened fronts do not exceed 2 ns in all cases.

Experiments with chamber №2



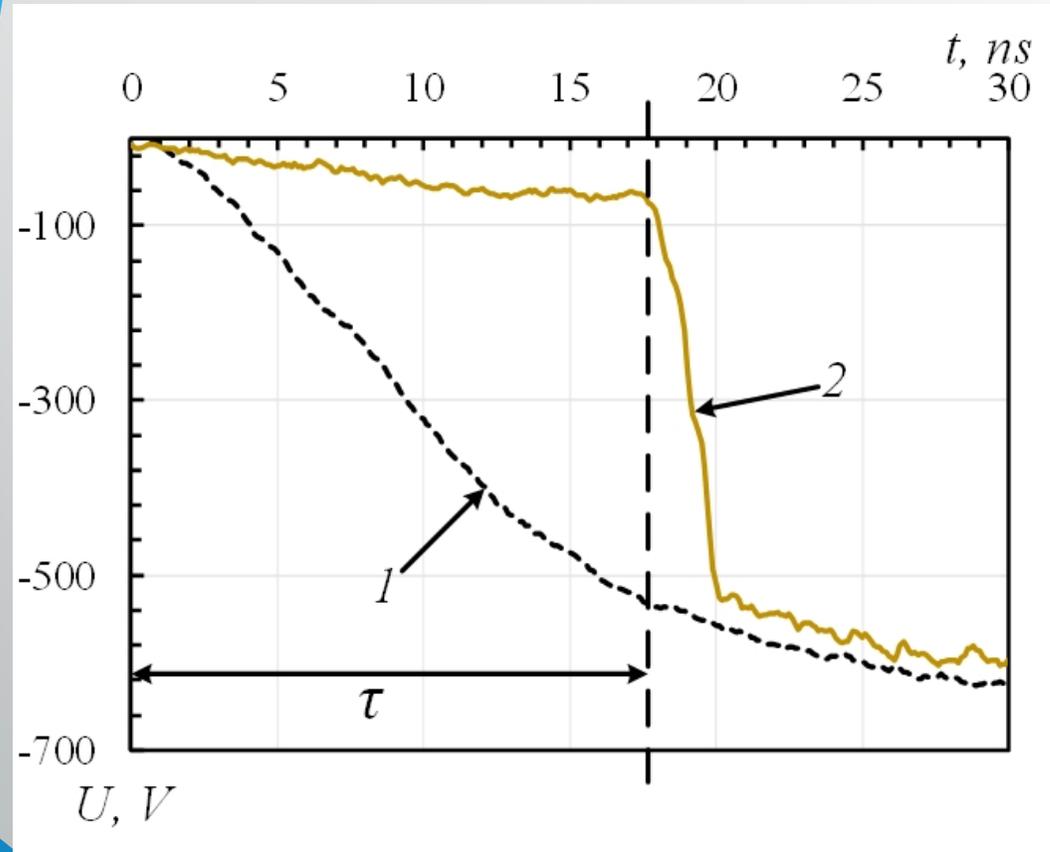
Oscillograms of voltage pulses:

1 - incident pulse to the diode assembly;

2 - pulse after assembly, including only one diode;

3 - pulse after assembly, including two diodes.

Experiments with chamber №2



Oscillograms of voltage pulses:

1 - incident pulse to the diode assembly;

2 - pulse after assembly, including three diodes.

DISCUSSION

The experiments showed that in the case of different configurations of the series connection of two and three avalanche gallium arsenide diodes in one resonator chamber, the process of switching the second diode to a highly conductive state has a significantly lower delay than in the case of a significant isolation between them. The duration of the edge of the sharpened pulse does not exceed 2 ns, and in the best case it can reach about 700 ps. This result means that assemblies of several gallium arsenide diodes connected in series can be used as sharpening elements in voltage pulse shapers with subnanosecond fronts.



THANK YOU!