«Saint Petersburg OPEN 2019»

BOOK of ABSTRACTS

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Crystal growth and structural properties of nanostructures

Spintronics, Electro- and Magnetooptics

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Determation of dV/dt values for domestic SiC Schottky diodes

S V Sedykh, S B Rybalka, A Yu Drakin, A A Demidov, E A Kulchenkov
Bryansk State Technical University, Brynask, 50 let Oktyabrya 7, Russia

Abstract. In this study the dV/dt values for 4H-SiC commercial diodes have been determined experimentally. The experimental measuring tester for determination of dV/dt values of diodes at amplitude of impulse of reverse voltage V_A (V_A=100÷950 V) applied across the Schottky diode was constructed. It was determined that the dV/dt value linearly increase with increase of impulse of reverse voltage V_A (in interval of V_A=100÷900 V) applied across the 5DS402A9 diode for the first time. It is determined experimentally that at the maximal impulse of reverse voltage (900 V) applied across the domestic SiC commercial 5DS402A9 diode the dV/dt value (148 V/ns) is comparable with others commercial diodes and therefore domestic SiC commercial Schottky diode can stably function in electric power circuit.

1. Introduction

Nowadays Schottky diodes on the base of silicon carbide (SiC) widely using in high-temperature power electronics [1]. Some type of SiC Schottky diodes have been designed earlier [2,3] and now the commercial for power electronics is produced by domestic company the ZAO «GRUPPA KREMNY EL» (Bryansk, Russia). The one of the important characteristics for silicon carbide Schottky diodes is value of dV/dt when the impulse of reverse voltage (V_A) applied across to diode. Devices with lower dV/dt capability are more susceptible to failure from large in-rush currents [4-6]. The number of some investigations with discussion about dV/dt effect is very limited and presented in general investigations of diodes by Infineon Technologies [4] and Wolfspeed (Cree) [5,6]. Study of the Infineon SiC diodes it is shown that for diodes with breakdown voltage of 600 V the value of dV/dt equals ~90 V/ns and for diodes with breakdown voltage of 1200 V ~120 V/ns, respectively [4]. In C3D03060A type Wolfspeed diode value of dV/dt=295 V/ns (amplitude of V_A=800 V) and for C4D10120A diode dV/dt=495 V/ns (V_A=1000 V) [5,6]. dV/dt value limit for domestic SiC diodes is unknown to present and therefore main goal of this work is to obtain experimentally the dV/dt values.

2. Materials and methods

The experimental measuring tester is shown in Fig. 1a. The parameters for tester allows carrying out measurement of dV/dt value in interval from 50 V/ns up to 200 V/ns at amplitude of impulse of reverse voltage applied across to diode V_A=300÷950 V. Analyses of oscillogram has been carried out with used Hantek DSO5102P oscillograph (bandwidth 100 MHz, refresh rate 1×10^9 s^{-1}). As an object for testing was used the 5DS402A9 (1 A, 1200 V) type domestic 4H-SiC Schottky diodes (ZAO «GRUPPA KREMNY EL», Bryansk, Russia).

3. Results and discussion

In Fig. 1b are shown testing results for 5DS402A9 domestic silicon carbide Schottky diode (Kremny) and C4D10120 diode (Wolfspeed) where value of dV/dt for 5DS402A9 diode equals 148 V/ns at

applied amplitude of impulse of reverse voltage across to diode 900 V. For C4D10120 diode value of dV/dt at the same conditions equals 204 V/ns. It is determined that dV/dt value almost linearly increase with increase of impulse of reverse voltage V_A applied across the 5DS402A9 diode in voltage interval from 100 V up to 900 V. It is determined that dV/dt value almost linearly increase with increase of impulse of reverse voltage V_A applied across the 5DS402A9 diode in voltage interval from 100 V up to 900 V. In addition, it is established that value of dV/dt can be increase by using of diode's module. For diode's module (consist of four diodes of the 5DS402A9 type) the dV/dt value increase up to 184 V/ns (V_A=900 V) that is more than on ~28% than for one 5DS402A9 diode. Moreover, the carried out dV/st analysis also shown that Kremny diodes demonstrate the stable work after 10,000 cycles of impulse without failure.

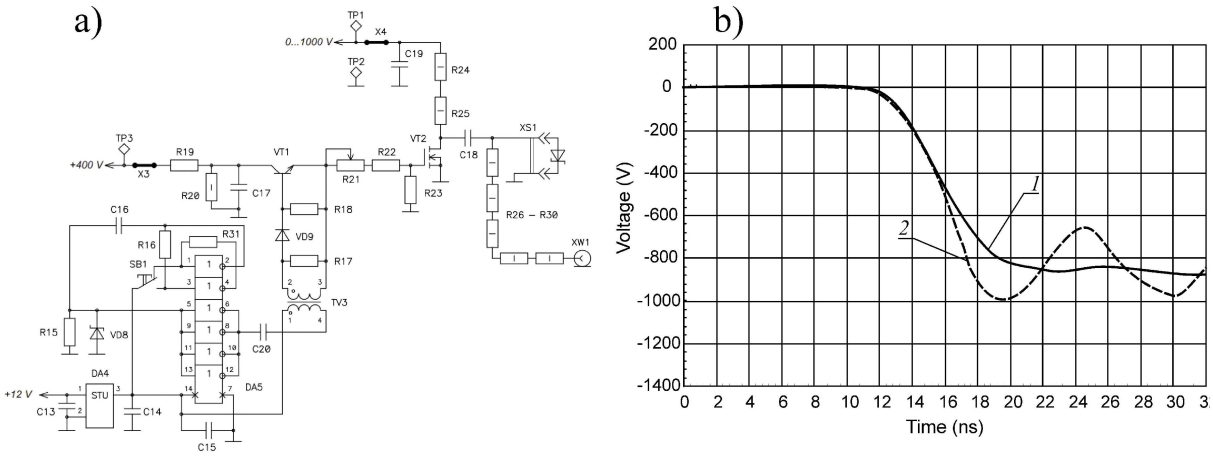

Figure 1. a) Tester circuit used to measure dV/dt value across a Schottky diode; b) Reverse voltage waveform for diodes (*1* – 5DS402A9 (Kremny), *2* – C4D10120 (Wolfspeed)) with impulse amplitude V_A=900 V.

4. Conclusions.

Finally, on the basis of the experimental measuring it is shown that at the maximal impulse of reverse voltage applied across the diode V_A=900 V the dV/dt values for domestic 5DS402A9 Kremny («Gruppa Kremny El », Bryansk, Russia) commercial diode (148 V/ns) are comparable with others commercial diodes. Therefore, it is determined that domestic SiC commercial diode possess the dV/dt values that more then typical for these type devices (80-120 V/ns) and therefore can stably work without failures(after 10,000 cycles of impulse). It is shown that value of dV/dt can be increase by using of diode's module (consist of four diodes of the 5DS402A9 type) where the dV/dt=184 V/ns.

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