«Saint Petersburg OPEN 2020»

BOOK of ABSTRACTS

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Crystal growth and structural properties of nanostructures

Electric, Magnetic and Microwave Devices

dV/dt testing of high voltage 4H-SiC Schottky diodes with different types of melal-polymeric packages

D A Knyginin, S B Rybalka, E A Kulchenkov, A A Demidov, N A Zhemoedov, A Yu Drakin
Bryansk State Technical University, Bryansk, 50 let Oktyabrya 7, 241035, Russia

Abstract. The *dV*/*dt* values for 4H-SiC Schottky type diodes with different type packages have been determined experimentally. It is determined that obtained *dV*/*dt* values for 4H-SiC Schottky type diodes in small-sized metal-polymeric packages (SOT, QFN) are varying in interval of 670÷990 V/ns.

Introduction

At present the SiC-based high-voltage Schottky type diodes are based on absolutely new generation of power semiconductors, posses the maximal values of breakdown voltage and minimal leakage currents [1]. Earlier, in our previous studies were investigated 4H-SiC Schottky type diodes in respect of their stability to rate of reverse voltage rise *dV/dt* [2]. In particular, it was established that in 4H-SiC Schottky diodes packaged in standard large-sized package of TO (Transistor Outline) type demonstrate the value of $dV/dt \approx 150 \div 200$ V/ns [2]. It is known that the diode package is one of the main elements that determines the characteristics of the diode [3]. Moreover, at present power electronic industry comes down to use of small-sized type of metal-polymeric package such as SOT (Small Outline Transistor), QFN (Quad Flat No-leads) and others [1,3]. However, effect of packaging type on *dV/dt* characteristics of 4H-SiC Schottky diodes to present are almost not studied, therefore the goal of this work is to study *dV/dt* characteristics for Schottky diodes in different types of packages.

2. Materials and methods

The used experimental measuring test makes it possible to test on *dV/dt* characteristics of a SiC Schottky type diodes which was described in detail earlier [2]. The main parameters of tester of *dV/dt* value in interval from 100 V/ns up to 1000 V/ns at amplitude of pulse of reverse voltage applied through a testing diode $V_A = 0.05 \div 0.9$ kV. Analyses of oscillograms has been carried out with used Tektronix MDO3102 oscillograph (bandwidth 1 GHz, refresh rate 5×10^9 s^{-1}).

3. Results and discussion

To prevent experimental errors, the equipment was initially calibrated with a control signal from the equipment by applied amplitude of pulse of reverse voltage (maximal amplitude of 0.7 kV) without diode which is shown in Fig. 1 (curve *1*). Then, were tested the following 4H-SiC type Schottky diodes: diode C3D06060F (CREE/Wolfspeed, US) in large-sized TO package type (TO-220-F2); diode 5DS402A (AO «GRUPPA KREMNY EL», Bryansk, Russia) in small-sized SOT package type (SOT-89); diode C3D1P7060Q (CREE/Wolfspeed, US) in small-sized QFN package type (PowerQFN). All obtained *dV/dt* test results for diodes are shown in Table 1.

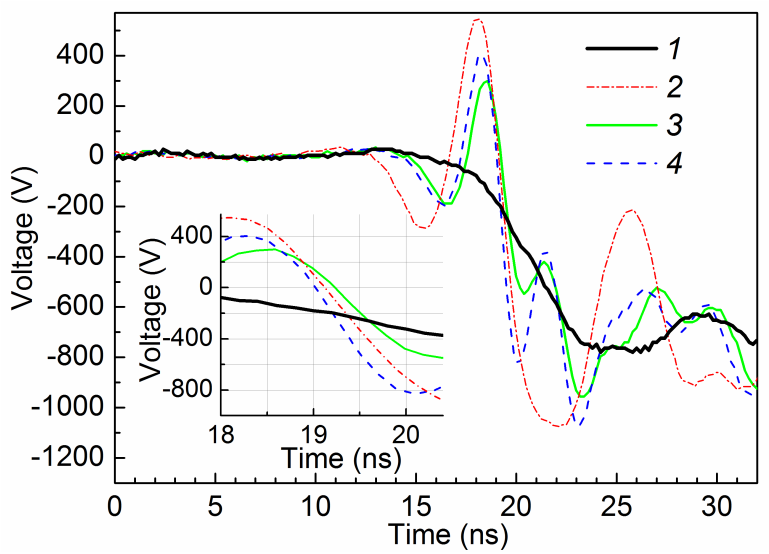

Figure 1. The reverse voltage waveform for diodes (pulse amplitude of 0.7 kV): *1* – without diode, *2* – C3D06060F (Cree), *3* – 5DS402A9 («GRUPPA KREMNY EL»), *4* – C3D1P7060Q (Cree).

The obtained *dV/dt* value for diode C3D06060F (curve *2* in Fig. 1) in large-sized TO package is equal of 880 V/ns. The testing results for diode 5DS402A (curve *3* in Fig. 1) in small-sized SOT package type is equal of 670 V/ns and for C3D1P7060Q (curve *4*) in small-sized QFN package is 990 V/ns.

Table 1. *dV/dt* results for testing of 4H-SiC Schottky diodes with different packages type.

No.	Package type	Diode's type	Package dimensions (mm)	*dV/dt* (V/ns)
1	TO-220-F2	C3D06060F	10.3×16.07	880
2	SOT-89	5DS402A	4.6×2.6	670
3	QFN 3.3	C3D1P7060Q	3.3×3.3	990

4. Conclusions.

The obtained results indicated that the package's size miniaturization not lead to *dV/dt* characteristics degradation and *dV/dt* values for small-sized metal-polymeric packages type (SOT, QFN) not only are comparable with large-sized TO package type, but in case of QFN package type the *dV/dt* results are greater than in case of the large-sized TO package.

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References

[1] Baliga B J 2019 *Wide Bandgap Semiconductor Power Devices: Materials, Physics, Design, and Applications* (Cambridge: Woodhead Publishing–Elsevier)
[2] Sedykh S V, Rybalka S B, Drakin A Yu, Demidov A A, Kulchenkov E A 2019 *J. Phys.: Conf. Ser.* **1410** 012195
[3] Lu D, Wong C P 2017 *Materials for advanced packaging* (Cham: Springer International Publishing)