Vanadium Doped Silicon Carbide Simulation for High Voltage Operation

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TECHNICAL ABSTRACT

6H-Silicon Carbide(6H-SiC) compensated by Vanadium is investigated as a candidate material for use in photoconductive semiconductor switches (PCSSs) operating in the linear mode and high hold-off application[1]. The PCSS investigated in this paper (Fig. 1.a) is designed for fast rise time and low (sub nanosecond) jitter in its on-state mode. Analysis of the optical properties of Va-compensated SiC and of switch conduction is presented and performance of switch with two different forms of electrode is discussed. The electrical parameters of the PCSS with curved electrodes are compared with the one having rectangular electrode.

As shown in fig. 1.b the schematic of the circuit used to simulate the optical pulse response of the PCSS includes a load resistor 50Ω and a capacitor 1.5uF. Simulations were carried out at 360V voltage source. The PCSS is stimulated by illuminating Nd:YAG uniform laser pulse with square shape and wave length 1064nm. Results of this simulation show that the current capability in the circuit having PCSS with rectangular electrodes is smaller than the one with a PCSS with curved electrodes. This is shown in fig 2.3. a,b.

The cutline in figue 2 is positioned at the boundary between electrode and PCSS substrate. It is observed that the current density in the PCSS especially in the mentioned points varies drastically at cathode. To illustrate this behavior we can mention to photogeneration and recombination rate deep in the device. If we consider electrodes along the y axis, In figure 3 according to the electrode shape, the cutline is at y=10 μm away from the surface of the switch. The current density in the second design has significantly decreased. Change in electrode geometry and permeability difference between electrode and bulk material of PCSS particulary in conjunction points leads to these results.

In conclusion, by adjusting the shape of the electrodes and higher current density can be achieved. Simulations also show that the electric field at the contacts increases abruptly especially on the cathode side which may lead to reliability problems. Using high doped region near electrodes and larger areas for the switch may help alleviate this problem[2].

REFERENCES:

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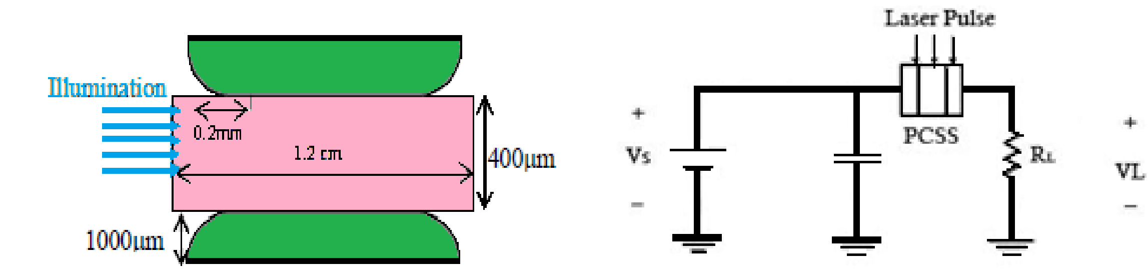
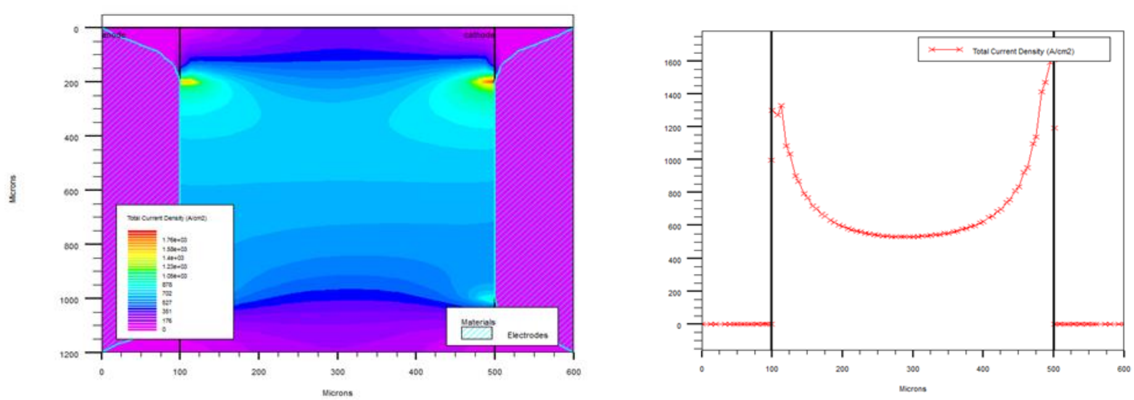


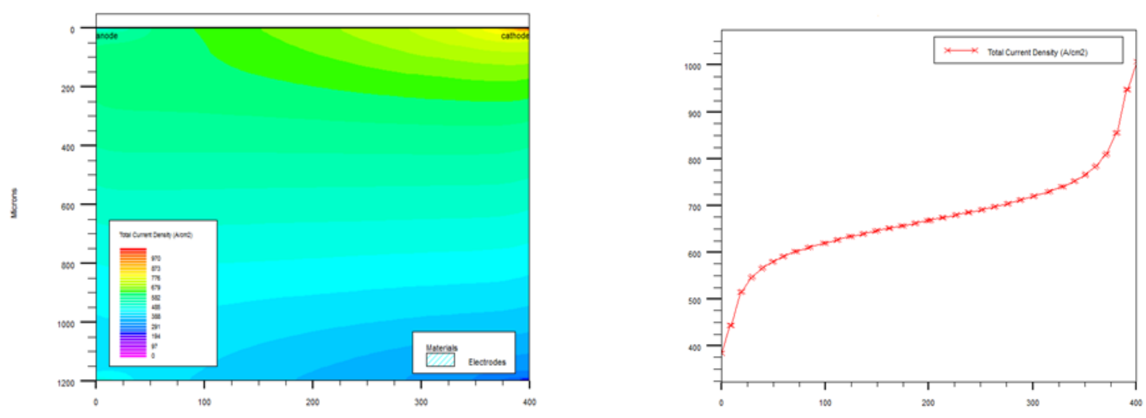
(a) (b)

Figure 1. (a) PCSS geometry (b) Schematic of the circuit used to simulate the optical pulse response of the PCSS



(a) (b)

Fig 2. (a)The contour of PCSS current with curved electrodes (b) Current density cutline through y=200 µm



(a) (b)

Fig. 3. (a)The contour of PCSS current with linear electrodes (b) Current density cutline through y=10 µm