Reverse-Recovery in Diamond PIN diodes

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Today, the development of high performances diamond power devices is increasingly being an important technological challenge for several research groups. Indeed, According to its outstanding electrical and thermal properties, diamond is the ultimate semiconductor for high power applications. Among the diamond-based power devices, PIN diode is one of the most advanced and promising. Moreover, despite the significant progress to reduce their serial resistance as well as to increase their breakdown voltage[1,2], the charge-carrier transport mechanism in diamond PIN diode is not yet understood and worse, their dynamic features (turn-on and turn-off) still remain unexplored.

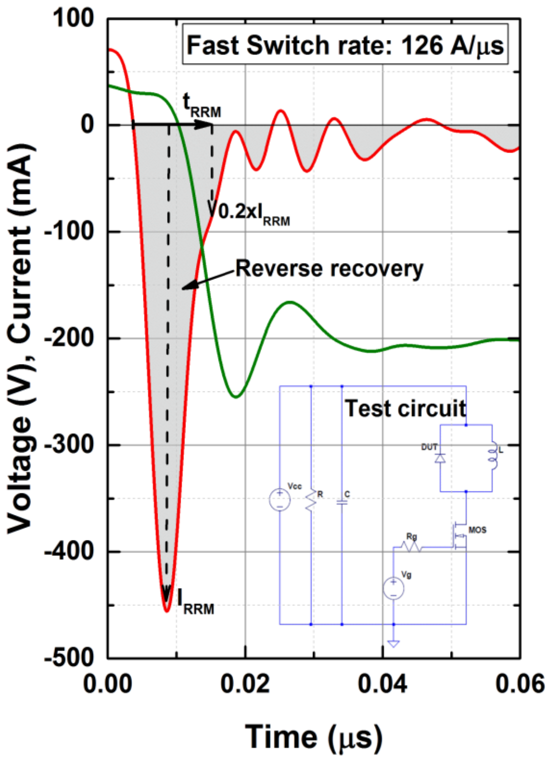

FIG. 1: Turn-off characteristics of 200 µm diameter diamond PIN diode

This work aimed at investigating the dynamic features of diamond PIN diodes. A particular emphasis was placed on the turn-off in order to highlight the reverse recovery, and thus demonstrate the bipolar behavior of diamond PIN diodes.

Figure 1 shows the room temperature (RT) turn-off characteristics of a 200 µm diameter pseudo-vertical diamond PIN diode, which was measured using a double-pulse clamped inductive rig (confer Fig. 1). The diamond diode was characterized by a 1 µm thick phosphorus-doped layer ([P] = 10^{20} cm^{-3}), an 8 µm thick intrinsic layer ([P], [B] < 10^{15} cm^{-3}), and a 3 µm thick boron-doped layer ([B] = $2x10^{20}$ cm^{-3}). A reverse recovery phenomenon was observed as shown on Figure 1. As in case of Silicon technologies[3], the reverse recovery time (t_{RR}) and the current overshoot I_{RRM} dependent of the mosfet switching rate. Thus, at fast mosfet switching rate (126 A/µs), a t_{RR} of 10 ns and a reverse current overshoot (I_{RRM}) of 450 mA was measured (confer Fig.1), whereas at low mosfet switching rate (5.25 A/µs), the t_{RR} was about 100 ns and the I_{RRM} was about 50 mA. The I_{RRM} and t_{RR} dependence of the mosfet switching rate, diode on-current level, the reverse voltage, and the temperature will be discussed.

Reference:

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