18p-D6-14

WC/*p*-diamond Schottky Diode Behaviour at High Temperature

NIMS, °Alexandre Fiori, Tokuyuki Teraji, Yasuo Koide

E-mail: FIORI.Alexandre@nims.go.jp

Introduction Diamond-based Schottky-barrier diode (SBD) is promising to realize high-performance and robust rectifiers. Gold deposited on *p*-diamond has revealed Schottky-barrier height (SBH) inhomogeneities, *i.e.* lowering pads.[1] It was attributed to a corrupted diamond termination. In addition, gold has a weak adhesion on diamond. Thus, carbon-based conductors, like tungsten carbide (WC), will be preferred to build tough electrode. But, previous works indicated a thermal alteration of the WC/*p*-diamond interface,[2] with possible inhomogeneities. This work aims to understand the heat response of WC/*p*-diamond SBD, by means of the systematic and statistical characterisations of current-voltage measurements in a wild temperature range.

Experiment A lateral diode structure (*p*-diamond on insulator Ib-type diamond (100) substrate) was employed. Diamond *p*-type epilayers were 1–2 µm in thickness and B-doped with ~10^{15} at·cm^{-3}. Annealed Ti/Au ohmic and 1:1 stoichiometric WC Schottky contacts were deposited, as described elsewhere.[3] Current density-voltage (*J-V*) characteristics were recorded under vacuum (<10^{-5} Pa) on a temperature-controlled stage. Quartz tube furnace was employed to anneal samples under vacuum at high temperatures. Diodes were step-by-step heated up to follow the evolution of their electrical properties.

Discussion Fig. 1 displays J_F-*V* forward characteristics of a typical lateral WC/*p*-diamond SBD, measured at 300 K, after formation and after been annealed to 600 K, 700 K and 800 K. While diodes were first heated up in the range of 500–600 K, SBHs were risen and ideality factors were improved. On the graph, the linear semi-logarithmic part of J_F-*V* curves became sharper than the initial “as deposited” state. While diodes were heated up a second time in the same temperature range, SBD properties were not modified. This suggested a modification at the interface between WC and *p*-diamond. Such diodes exhibited a reproducible high blocking efficiency, confirmed up to 500 V, with an average leak current lower than 5×10^{-8} A·cm^{-2}, at 300 K. The current transport measurement was studied from 80 to 600 K. While the temperature exceeded 650 K, SBHs were gradually reduced and ideality factors were degraded, as illustrated on Fig. 1, for 700 K and 800 K. In consequence, leakage currents in reverse operation were found larger and rectification properties were getting worse.

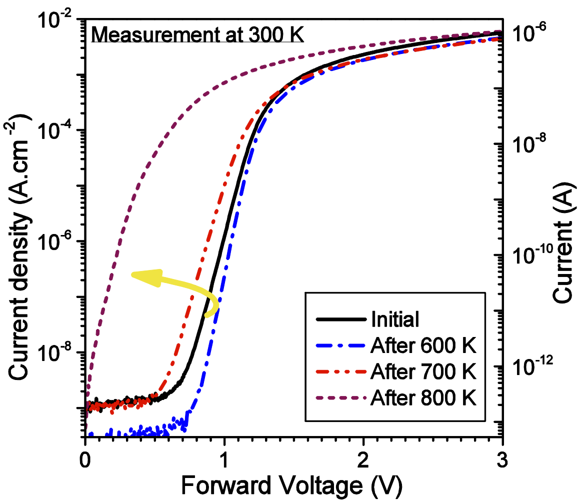

Fig. 1 Forward J_F–*V* characteristics of a typical WC/*p*-diamond (100) SBD. Measurements at 300 K after diode formation and after annealing at 600 K, 700 K and 800 K. Arrow indicates the shift in the curve when annealing temperature increase.

Conclusion WC/*p*-diamond SBD interface was stabilized by a 500–600 K vacuum annealing. Diodes exhibited high performances and similar properties on the whole sample for a working temperature below 650 K.

---

[1] T. Teraji, Y. Garino, Y. Koide, and T. Ito, J. Appl. Phys. **105**, 126109 (2009).
[2] M. Liao, J. Alvarez, and Y. Koide, Jpn. J. Appl. Phys. **44**, 7832 (2005).
[3] T. Teraji, M. Liao, and Y. Koide, J. Appl. Phys. **111**, 104503 (2012).

© 2014 年　応用物理学会