Role of the oxygen interlayer on electrical properties of WC/*p*-diamond Schottky diodes

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Introduction High temperature operation (T > 300 °C) of diamond Schottky-barrier diodes (SBDs) is recently struggling. Hence, SBDs composed of tungsten carbide (WC) deposited on O-terminated diamond showed strong mechanical strength, and rectification abilities even at T > 325 °C [1]. Further, post-annealing of WC/*p*-diamond SBDs at 600 K demonstrated ideal features, and stable behaviours [2]. In this study, we examined the rule of the oxygen at the WC/diamond interface on SBDs electrical properties.

Experiment SBDs structures were composed of a conductive diamond substrate capped with a semi-insulating epitaxial layer. The VUV-light/ozone treatment has been employed to oxidize the surface of epitaxial layers, over which WC has been deposited by conventional sputtering. Afterward, SBDs have been stabilised by vacuum post-annealing at 600 K. Schottky barrier height (ϕ_B) and diode ideality factor (n) provided leading indications on the WC/*p*-diamond interface quality during annealing. In addition, a few SBDs have been nano-characterised by TEM, similarly to diamond MOS structures [3], in order to look at the WC/*p*-diamond interface chemical composition.

Results & discussion As shown on Fig. 1, the analysis of the chemical composition of SBDs cross-sections has revealed the presence of a nm-thick oxygen layer in between WC and diamond. Moreover, it pointed out several pores in the oxygen interlayer, those occurrence matched with defective SBDs electrical properties. Such porosity of the oxygen interlayer visible on TEM might indicate a chemical corruption at the WC/*p*-diamond interface. In addition, it might be at the origin of variations in ϕ_B values, measured on current-voltage characteristics. These variations of ϕ_B were affected by the annealing time, which supposed a sensitivity to WC/*p*-diamond interface chemistry.

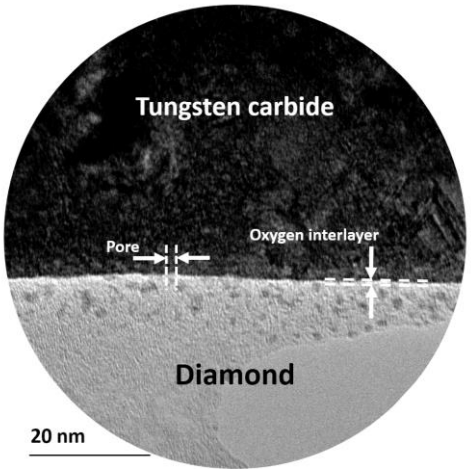

Figure 1: TEM image of a defective WC/O-term *p*-diamond SBDs annealed at 600 K for 90 minutes observed in transversal cross-section. This image shows several pores in the oxygen interlayer.

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[3] J. C. Pinero, D. Araujo, A. Traore, *et al.*, Phys. Status Solidi A **211**, 2367 (2014).