

Hydrogenated Black Diamond FET with high voltage breakdown of 1.8kV

M.Syamsul N.S.B¹, Y.Kitabayashi¹, D.Matsumura¹, T.Saito¹, H.Kawarada¹

1. Graduate School of Advanced Science and Engineering, Waseda University, Tokyo, Japan

Email: naysriq@asagi.waseda.jp

Less attention and further studies involved on black polycrystalline diamond since the early year of 2000 even though promising characteristics were demonstrated by William et al. and his team shows that the carrier concentration and mobility values similar to both white polycrystalline diamond and single crystal material. [1].

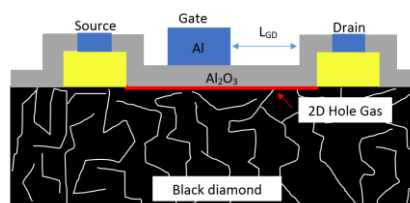


Fig. 1: Cross section of C-H Black diamond FET

Highest breakdown voltage is recently discovered in 2014 by Hitoshi Umezawa et al. and his team is 1530V with gate-drain length, L_{GD} of 30 μm [2]. In this paper, C-H black diamond were fabricated by the implementation of a wide gate-drain length up to 20 μm device structure with C-H bonded channel to achieve high breakdown voltages as shown in Figure 1. Au/Ti source and drain contacts were deposited followed with annealing in H_2 forming TiC layer underneath [3]. Exposure of H_2 plasma was then performed and followed with device isolation by exposing to Oxygen plasma. Finally, Al_2O_3 was deposited as a gate insulator and the passivation layer for a C-H bonded surface channel and a metal gate electrode Aluminum was deposited. With room temperature I-V measurements, this device exhibits perfect device characteristics, pinch-off and saturation region I_{DS} - V_{DS} with maximum current density of 1.1mA/mm higher than any clean boron doped polycrystalline diamond shown in Figure 2. In Figure 3, the maximum breakdown voltage ($V_{B_{max}}$) is 1802V at a gate-drain distance (L_{GD}) of 18 μm . Thus, C-H Black diamond currently is the highest value of $V_{B_{max}}$ reported for a diamond FET so far better than any single crystalline and clean polycrystalline diamond device satisfying $V_{B_{max}}/L_{GD} = 100\text{V}/\mu\text{m}$ (1MV/cm).

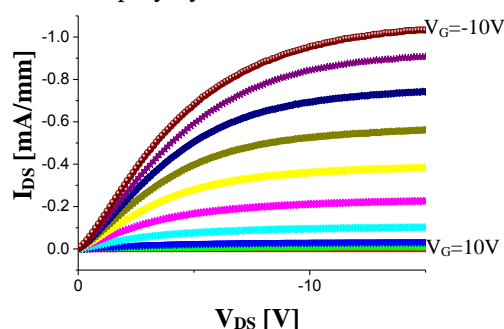


Fig. 2: I_{DS} - V_{DS} of characteristics of a C-H black diamond

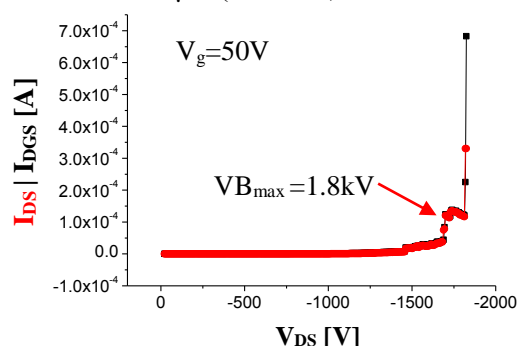


Fig. 3: Breakdown characteristics of a C-H black diamond

References

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