SEMINAR

Department of Functional Materials

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Solid building, meeting room 1.32

Na Slovance 1999/2, Prague 8

Institute of Physics of the Czech Academy of Sciences

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Delta phosphorus doped diamond

Like ZnO and GaN semiconductors, the control of diamond’s doping for electronics is asymmetric. The p-type doping of diamond by substituting boron for carbon is fairly easy and now technologically mature. In contrast, the n-type conductivity of diamond is still difficult to realize and remains an issue for the fabrication of diamond-based bipolar devices (Fig.1).

Phosphorus is the donor impurity in diamond that gives the highest n-type conductivities. It was shown recently that it contributes to enhance the coherence lifetimes of the famous N-V quantum mitters1. This breakthrough was reached thanks to progress made in chemical vapor deposition (CVD) for electronics purpose. Indeed, diamond quality has been improved over time with even the possibility to reduce unwanted defects as nuclear spins from the 13C isotope together with the control of a low phosphorus doping range (< 1x1017 at/cm3)2.

From years, my team and I grow n-type phosphorus doped layers in a microwave plasma CVD reactor (MPCVD). Recently, a gas line dedicated to 12C isotopically enriched methane was introduced. We are used to control the phosphorus doping from ultra-lightly (n- like) up to heavily (n+ like) phosphorus doped (100) diamond homoepilayers (~1015-1019 at/cm3).

In this work, we develop growth engineering to ensure sharp interface between epilayers (Fig.2). We also evidence a strong reduction of the 13C/12C ratio by growing phosphorus-doped homoepilayers with 12C isotopically enriched methane gas. The control of sharp interfaces together with mastering 12C enriched epilayers allow use to grow delta phosphorus doped diamond. By using secondary ion mass spectrometry (SIMS), I will show how 12C isotopically enriched methane gas help to understand diamond growth

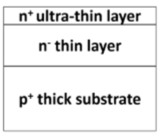

Figure 1 - Example of a stacking structure needed for bipolar devices

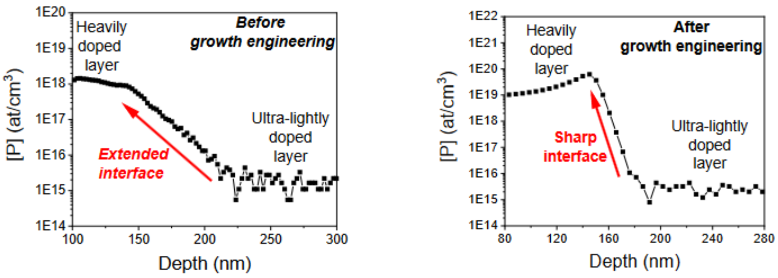

Figure 2 – SIMS profiles showing interface improvement before and after growth engineering

References

1. E.D. Herbschleb, *et al. Nature Communications* **10** (2019), 3766.
2. A. Watanabe, *et al. Carbon* **178** (2021) 294.