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Boron-doped superlattices and Bragg reflectors in diamond

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Introduction The diamond delta-doping contributed to our growth expertise of metallic diamond boron-doped layers ($p^+ > 5\ 10^{20}$ at.cm^{-3}) and nominally undoped ($p^- < 5\ 10^{17}$ at.cm^{-3}) by Microwave Plasma-assisted CVD (MPCVD) [1]. The film thickness and doping control of such layers were based on the difference of their refractive indexes by spectroscopic ellipsometry [2]. In this study, the periodic variation of these refractive indexes arranged in a multilayer stack will be used to build Bragg reflectors (BR). Further, the BR wavelength will be finely tuned to the emission of NV or SiV color centers.

Experiment Homoepitaxial diamond films so-called superlattices (SL) were obtained by periodically overgrowing p^+ with p^- layers on diamond (100)-oriented substrates without turning off the plasma. Optical spectra were monitored in real time during MPCVD diamond growth to improve the BR efficiency. SL periods and the abruptness of p^+/p^- interfaces were confirmed by X-ray diffraction (XRD) experiments.

Results Fig. 1 displays a transmittance dip in the 550–750 nm range of a p^+/p^- diamond SL composed of 20 periods. This bore proof that the periodicity and interfaces abruptness of the p^+/p^- stack had a sufficient quality to confer BR properties. Thicknesses measured by ellipsometry were ~17 nm and ~118 nm for p^+ and p^- layers, respectively. Fig. 2 shows the corresponding XRD curve of the (004) reflection measured in a high resolution diffractometer. The substrate (S) and five orders of satellite peaks (±1… ±5) are revealed. The simulation of these satellites peaks provided a p^+/p^- period of ~133 nm, in good agreement with the ellipsometry fit.

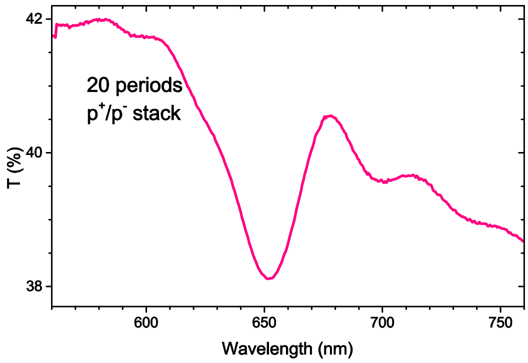

Figure 1 A 3% transmittance dip through a boron-doped superlattice grown on a Ib-type diamond substrate.

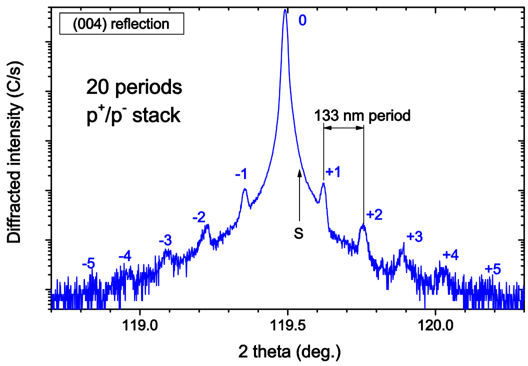

Figure 2 Experimental (004) XRD intensity curve for a 20 p^+/p^- periods superlattice structure, whose period were ~133 nm. S and (±1… ±5) indicate the position of substrate peak and the order of satellites peaks, respectively.

[1] A. Fiori et al, Appl. Phys. Express **6**, 045801 (2013).
[2] J. Bousquet et al, Appl. Phys. Lett. **104**, 021905 (2014).