Optical Detected Magnetic Resonance of Nitrogen-Vacancy Centers Generated by Ion-Implantation in Vertical Diamond Schottky Diode

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NV centers in diamond are investigated for quantum applications owing to their outstanding properties such as a long spin coherence time even at room temperature [1]. Nitrogen ion-implantation is one of the best methods for generating NV centers in diamond devices [2]. However, ion-implantation induces crystal defects in addition to NV centers [3]. Recently, we reported the existence of nitrogen-related deep defects levels in vertical diamond Schottky diodes (VDSD) with nitrogen ion-implanted layer by transient photocapacitance spectroscopy (1.2 and 2.2 eV below conduction band edge) [3] .Thus far, the effect of such defects on NV centers features are still unclear. In this paper, NV centers generated by ion-implantation in VDSD are investigated by photoluminescence (PL) and optical detected magnetic resonance (ODMR).

VDSDs with nitrogen-ion implanted layer have been fabricated. The detailed fabrication process is reported in ref [3]. Nitrogen ion was then implanted in the epitaxial layer with an energy of 80 keV (dose of 10^{12} ions cm^{-2}, implantation depth: 100 nm). Ti (30 nm)/Pt (30 nm)/Au (100 nm) metallic stack was deposited at the bottom of sample and annealed at 420°C to form ohmic contact 10-nm-thick Mo electrodes (300 μm in diameter) were fabricated at the top side of the sample to form Schottky contact. PL and OMDR were performed by using a homemade confocal microscope system.

The PL and ODMR measurements were carried on NV centers located below the semi-transparent Mo electrode. PL and ODMR measurements were taken at different applied reverse voltage (Vr) across VDSDs. Fig.1 (a) shows the achieved PL spectrums. At 0 V, both NV^0 and NV^- ZPL (at 575 nm and 637 nm respectively) were observed in the PL spectrum. The intensity of NV^0 ZPL was higher than that of NV^-. For applied reverse voltage (Vr) > 0 V, the intensity of NV^- ZPL and phonon sideband increased with Vr whereas the intensity of NV^0 ZPL decreased. The decreased in the intensity of NV^0 ZPL was ascribed to the ionization of NV^0 into NV^- under high Vr due to the band bending in the space charge region [4]. Fig.1 (b) shows the ODMR spectrums measured for Vr ranging from 0 – 40 V. The achieved ODMR spectrums exhibited resonance dips. It has been found that the resonance dip split for Vr ≥ 10 V. Such dips splitting induced by increasing Vr was ascribed to the Stark effect [5]. The dips splitting was related to an increase in electric field within the Schottky diode. In summary, we performed ODMR on nitrogen ion implanted Schottky diode and we observed ODMR splitting due to effect of electric field produces inside space charge region. Ion implantation can introduce defects in diamond due to high energy ion bombardment into diamond lattice, we can use OMDR technic to measure the disturbance cause by these defects and determining the electric field strength.

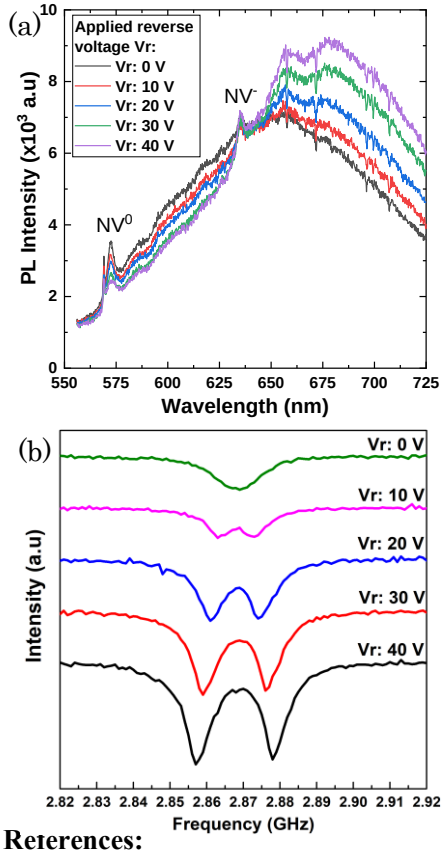

Figure 1 show VDSD optical characterization. (a) NV center spectrum at different applied bias. (b) ODMR spectrum at different applied bias.

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