Magnetic Field Sensing with Silicon Vacancy in 4H-SiC under Ambient Conditions

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1. Introduction Silicon carbide (SiC) has emerged as a host of deep-center defects which can be utilized in room-temperature wafer-scale quantum technologies [1]. Similar to the nitrogen vacancy (NV) center in diamond, silicon vacancy (V_{Si}) related defect in SiC preserving addressable spins through optically detected magnetic resonance (ODMR) can be a potential candidate for magnetic sensing applications. In this study, we used a 532 nm green laser which is commonly used in optical excitation of NV center to excite V_{Si} in 4H-SiC for measuring the external magnetic field at room temperature.

2. Experiments A 4H-SiC sample irradiated with 2 MeV electrons at a fluence of 10^{18} cm^{-2} was used in our experiments. A 532 nm green laser beam expanded by a beam expander was focused onto the sample via an oil objective (NA=1.42). The fluorescence was collected through the same oil objective and transmitted through a beam splitter and a 834 nm long pass filter to an avalanche photodetector. In ODMR experiments, the RF signal was generated by a signal generator and amplified by a high power amplifier. The amplified RF signal was guided to a 30 µm diameter copper wire spanned across the surface of the 4H-SiC sample.

3. Results Figure 1 shows the ODMR spectra of V_{Si} with and without applying the external magnetic field. At zero magnetic field, we observed the single peak at 70 MHz, corresponding to zero field splitting of V_{Si} in the ground state [1]. When an external magnetic field is applied parallel to the c-axis of 4H-SiC crystal, the single peak is split into two peaks by the Zeeman effect. Figure 2 shows the evolution of the peak positions of V_{Si} in external magnetic fields. As shown here, the magnetic field dependent ODMR is in agreement with the theoretical results.

In conclusion, we proved that the magnetic field dependent ODMR of V_{Si} under 532 nm excitation agrees well with theoretical calculations.

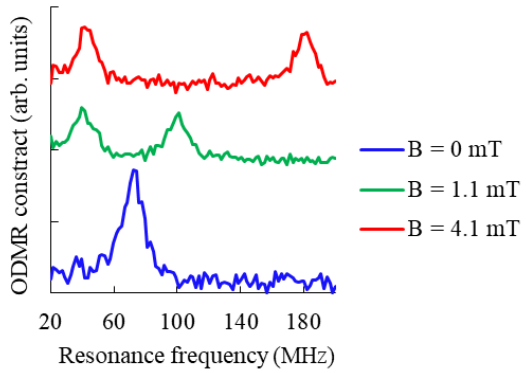

Fig 1. ODMR spectra of V_{Si} in 4H-SiC

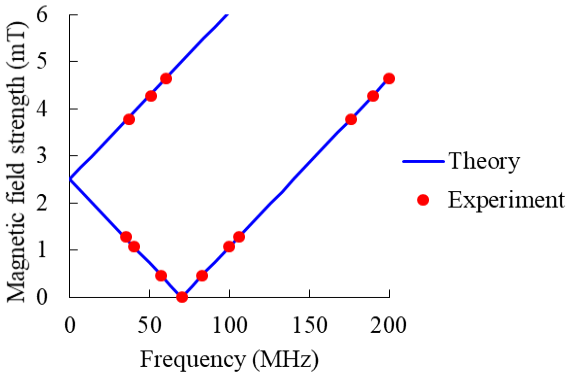

Fig 2. ODMR of V_{Si} as a function of magnetic field

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Reference [1] M. Niethammer et al., Physical Review Applied 6, (2016) 034001.