Weak magnetic field NV diamond sensor

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We report on our recent efforts aimed at creating a compact magnetic field sensor for biological applications based on a bulk NV diamond. As a rule, sensors used in biology and medicine should be ultra-sensitive to low-frequency (ranging from DC to hundreds of Hz) variations of weak (0 to 1 G) magnetic fields; in addition, an ideal magnetic sensor designed for invasive study should not create a strong microwave (MW) field around it. At the moment there is no way to satisfy all these requirements in one setup, but we have taken some steps in all these directions. To increase the sensitivity of DC sensor, we proposed to simultaneously excite hyperfine NV triplets with three harmonics of an amplitude-modulated MW field; to eliminate the "blind zones" arising in a weak field due to the overlap of the ODMR spectral lines [1], we proposed the use of modulating magnetic fields oriented along certain crystallographic directions, such as <110>, <101>, <011>, etc. We also suggested methods of ODMR excitation with resonant MW + radiofield (RF) [2]. Using single-frequency RF excitation in the megahertz range [3], we observed various types of magnetic-dependent response, such as ultra-narrow (~ 7 kHz HWHM) optically detectable nuclear resonances. Most recently, we investigated the response of NV fluorescence level to non-resonant RF excitation (Fig. 1) and found strong dependence on the magnetic field value at zero and weak fields (0 to 1 G), which allows us to hope to create a low-field magnetometer that does not use the MW fields.

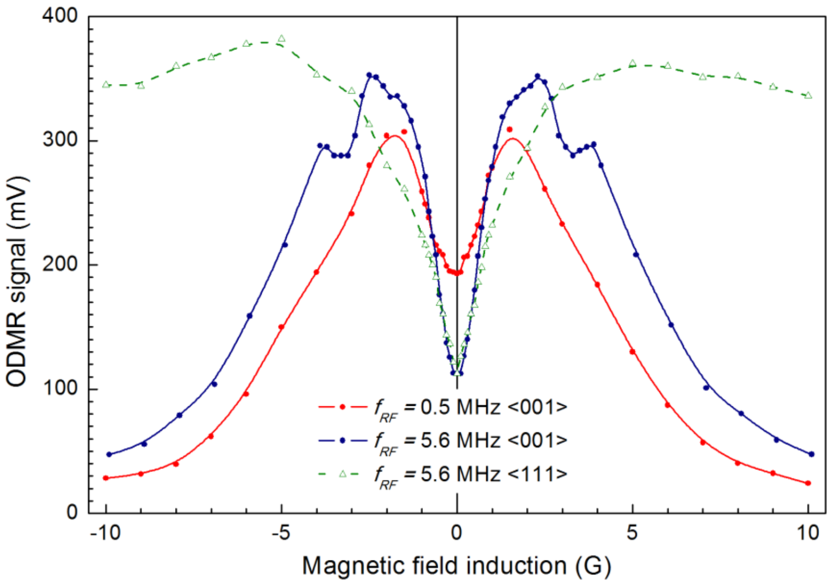

Figure 1. ODMR signal dependency on the magnetic field induction at single-frequency RF excitation applied in <001> and <111> directions. Low-frequency amplitude modulation of RF field and synchronous detection were used in order to subtract the fluorescence background.

[1] A.K. Dmitriev, A.K. Vershovskii, Concept of a microscale vector magnetic field sensor based on nitrogen-vacancy centers in diamond, JOSA B., **33**, 3, B1-B4 (2016).

[2] A.K. Dmitriev, A.K. Vershovskii, Multi-frequency ODMR of Nitrogen-Vacancy Color Centers in Diamond Crystals in zero magnetic fields. - Journal of Physics: Conference Series, **1135**, 1, 012051 (2018).

[3] A.K. Dmitriev, A.K. Vershovskii, Ultra-Narrow Low-Field Nuclear Spin Resonance in NV Centers in a Bulk Diamond Crystal, Appl. Magn. Reson., **50**, 4, 599 (2019).