Fabrication of a NV center diamond probe by using focused ion beam for scanning magnetic field imaging

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Recently nitrogen vacancy center (NV center) in diamond crystal has been attracting much attention in scientific community for utilizing it as a single spin sensor, since single spin existing in a combination of a carbon defect and nitrogen in diamond has been demonstrated to be detectable through optically detected magnetic resonance (ODMR) [1]. One possible NV center-based scanning probe for magnetic imaging is that with nanodiamonds hosting NV center glued to atomic force microscopy tip apex. However, small size nanodiamond is difficult to manipulate and attach on to such a sub-micron-sized diamond cantilevers in a scanning-probe platform.

In this work, we fabricate the nanosized scanning diamond NV center probe by using focused ion beam (FIB). Initially the μ-diamond of size ~30-40 μm hosting NV center was attached using the conductive silver paste to a tungsten wire which connected to the tuning fork as shown in Fig. 1(a). Next, the microdiamond is processed via FIB by using donut-shaped template to avoid damage of NV center by Ga ion source [2]. The FIB fabricated NV diamond probe having a tip apex diameter of about ~500 nm is shown in Fig. 1(b). The fabricated NV center diamond probe is then characterized for its optical and spin properties, such as photoluminescence (Fig. 1(c)), electron spin resonance (ESR) (Fig. 1(d)) and spin life time (T1) measurement (Fig. 1(f)). The effect of the Ga ion (used in the FIB) on the NV in diamond is investigated via structural characterization and T1 measurement. Finally, fabricated NV center diamond probe can be used as the magnetic field sensor (Fig. 1(e)) by integrating it with a quartz tuning-fork based AFM system and a confocal microscopy.

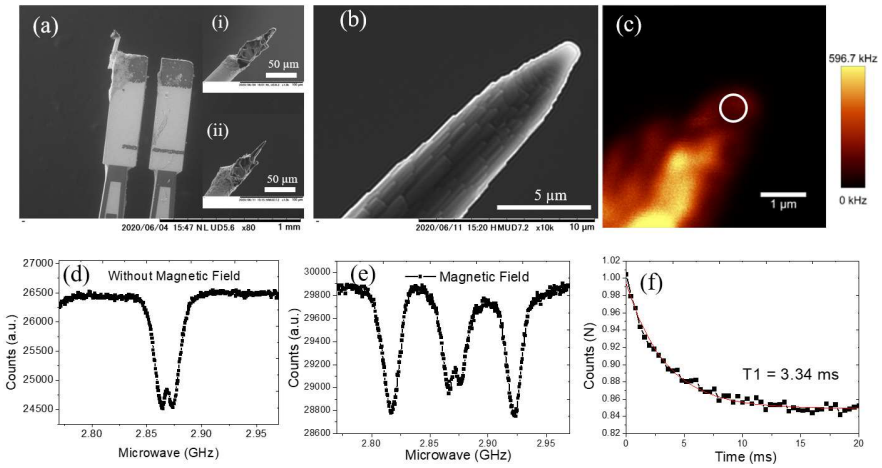

Fig.1. SEM image of (a) μ-diamond attached to the end of tungsten wire on the tuning fork (inset (i) side view of the μ-diamond (ii) FIB fabricated diamond probe), (b) zoomed image, (c) PL image from the fabricated probe, (d) ESR spectra obtained from the tip, (e) under magnetic field, (f) T1 measurement on the probe (white circle in (c)).

References

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