Remote magnetometry with fluorescent microdiamonds incorporated in optical fibres

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Nitrogen-vacancy (NV) centres in diamond are well-known high-sensitivity, room temperature magnetometers. While NV-based magnetic field sensing techniques are addressed optically,[1] most applications require complex confocal microscopes bounds in high-level laboratories. However, recent studies have investigated a hybrid combination of diamond crystals and optical fibres as a unique magnetic field sensing structure.[2]

In our work, we have incorporated diamond particles with 1 µm diameter at an interface within an optical fibre during the fibre fabrication process.[3] Figures 1(a) and 1(b) show the newly-created diamond-doped fibre (sensitive to magnetic fields) characterised by fluorescence microscopy. We achieved an average density of more than 20 particles/mm along the fibre. Afterwards, we studied the emission properties of the embedded microdiamonds and their magnetic field sensitivity. Figure 1(c) shows an example measurement that reached a preliminary sensitivity of 10 µT/√Hz. Finally, we spliced our fabricated fibres to conventional fibres to achieve longer distances between the diamond sensors and the detection system.

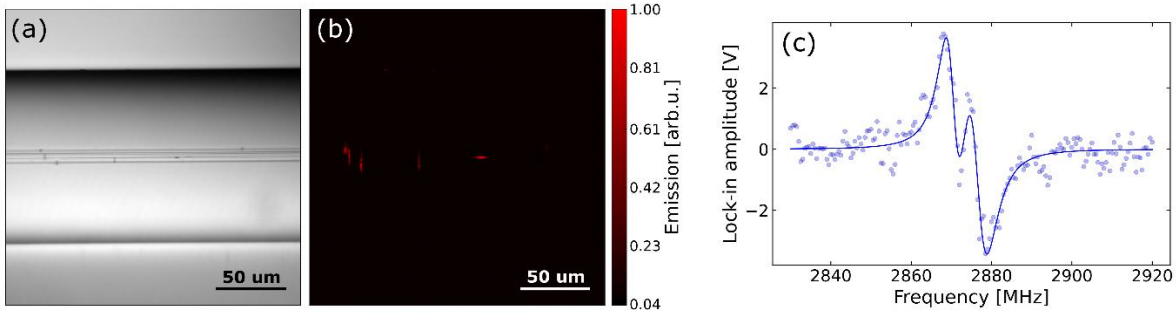

Figure 1 (a) Transmission micrograph of the created diamond-doped fibre. The embedded microdiamonds cause scattering visible as small dots around the centre of the fibre. (b) Fluorescence confocal image in the 655-755 nm window. The red spots correspond to NV fluorescence. (c) Example of an optically detected magnetic resonance (ODMR) measurement on a single microdiamond embedded in the fibre.

The incorporation of diamond particles within the optical fibre made the system more robust and resilient compared to alternative approaches where diamond materials are coupled externally to fibres. Our study opens the potential for the deployment of hybrid diamond-fibre sensing tools outside the research laboratories.

[1] D. Budker et al., *Nat. Phys.* **3**, 227-234 (2007).

[2] S. Li et al., *Optics Express*, **29**(10), 14425 (2021).

[3] D. Bai, et al., *APL Materials* **8**, 081102 (2020).