Diamond-doped Optical Fibres for Remote Magnetometry Applications

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The ability to persistently monitor weak magnetic fields is a key objective in long-term surveillance. One approach to meeting this goal is the development of optical fibre-based magnetometers capable of remote operation. Diamond containing the negatively-charged nitrogen vacancy colour centre (NV) is emerging as an important system for the sensing of various physical parameters including magnetic field and temperature. Many existing diamond NV magnetometers require complex microscopes to monitor the fluorescence signal, which can restrict NV to laboratory settings. Here I will discuss the fabrication and characterization of an intrinsically magneto-sensitive optical fibre with potential applications as a high-efficiency remote magnetic sensing platform [1]. The fibre was fabricated using lead-silicate glass by the rod-in-tube technique. The glass rod was coated with NV centre-enriched ~1 μm diameter diamond particles and subsequently inserted into the glass outer tube. This rod-in-tube assembly was drawn down to fibre, with the diamond particles distributed at the fused interface between rod and tube, as determined by fluorescence spectroscopy. The hybrid fibre allows for optical interrogation of NV-spin states via bound modes in a highly-stable waveguide structure [2]. Magnetic field sensing in the diamond:fibre system can be performed in three different configurations, conventional confocal, side excitation and longitudinal collection (along the fibre), and excitation and collection of the fluorescence performed along the length of the fibre. Our results open the possibility of robust, field-deployable fibre optical magnetometry for a broad range of quantum sensing applications.

[1] D. Bai, M. H. Huynh, D. A. Simpson, P. Reineck, S. Afshar V., A. D. Greentree, S. Foster, H. Ebendorff-Heidepriem, and B. C. Gibson, Fluorescent diamond microparticle doped glass fiber for magnetic field sensing, *APL Materials* 8, 081102 (2020).

[2] S. Li, D. Bai, M. Capelli, Q. Sun, S. Afshar V., D. A. Simpson, S. Foster, H. Ebendorff-Heidepriem, B. C. Gibson, and A. D. Greentree, Preferential coupling of diamond NV centres in step-index fibres, *Optics Express*, Vol. 29, Issue 10, pp. 14425-14437 (2021)

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