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Quantum Sensing and Imaging of van der Waals Ferromagnet using Nitrogen- Vacancy Centers in Diamond

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The nitrogen-vacancy (NV) centres in diamonds are solid-state quantum emitters exhibiting unique spin and optical properties at room temperature. They are sensitive to magnetic fields, temperature, pressure, and other physical quantities, making them valuable as probes for sensing all of these physical quantities. In our work, we use NVs to form a magnetic microscope, with a high spatial resolution (˜250 nm) limited by the diffraction limit and sensitivity of <1 μT/sqrt(Hz). This
configuration is sometimes referred to as a Quantum Diamond Microscope (QDM) (1).
We use the QDM to reveal and understand the fundamental processes of magnetic domain pattern formation and their variation with temperature and external bias field, as well as characterizing the
Curie temperature (Tc) of recently discovered van der Waals (vdW) magnetic materials, namely Iron Germanium Telluride (Fe_5GeTe_2). We exfoliate these vdW materials down to a few nanometres. We observe that depending upon the thickness, their fundamental properties such as Tc, magnetization, domain pattern, etc. change.
We focus on measuring the Tc and imaging the domain structure of FGT flakes through out-of-plane magnetization. (Fig. 1). Our results (2) indicate structural features affecting magnetic orientation in these flakes, as well as a decrease in Tc as we are making the transition from bulk to 2D, which further decreases as the thickness of these 2D flakes decreases.

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References:

(1) Levine, Edlyn V., Turner, Matthew J., Kehayias, Pauli, Hart, Connor A., Langellier, Nicholas, Trubko, Raisa, Glenn, David R., Fu, Roger R. and Walsworth, Ronald L. "Principles and techniques of the quantum diamond microscope" Nanophotonics, vol. 8, no. 11, 2019, pp. 1945-
1973.

(2) Bindu, Bindu et. Al, in preparation.

Keyword-1

Quantum Sensing

Keyword-2

NV Centers in Diamond

Keyword-3

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