EPSRC DTP funded PhD Studentship

Project Title: 2D-heterostructure devices for nanoscale quantum Sensing

Primary Supervisor details: Dr Isaac Luxmoore

Additional Supervisory team details:
Prof David Wright

Department: Physics and Astronomy

Location: Physics Department, Streatham Campus

PhD Programme: PhD Physics

Project Description:

Precision measurement underpins science and technology, and novel sensors that push the fundamental limits of accuracy and precision are required for applications ranging from nano-electronics to medical imaging. Colour centre defects in the two-dimensional semiconductor hexagonal boron nitride (hBN) have atom-like electronic transitions that can be probed with optical and microwave techniques [1,2], and thanks to a spatial extension on the scale of the atomic lattice, they can provide an exquisite probe of their local environment. This project will develop an integrated microwave and photonic platform to control and investigate spin based sensors in 2D materials [3]. Nanophotonic computational design will be used to optimise the optical interface and the hBN sensing element will be integrated with other 2D materials to develop electrical spin-initialisation and/or readout. The ultimate aim is to build a new generation of sensors with the highest possible sensitivity and spatial resolution, and to apply nuclear magnetic resonance techniques for single-cell analysis, surface chemistry and point-of-care medical analysis.
The project will include a collaboration with the Quantum Materials Team at the National Physical Laboratory (NPL), who will provide access to their precision measurement facilities, including a low-temperature 4-probe scanning tunnelling microscope, which will aid the calibration and qualification of the quantum sensors developed in this project. NPL will also provide access to their Post Graduate Institute for Measurement Science, which will provide additional, industrially relevant training, from world leaders in measurement science.

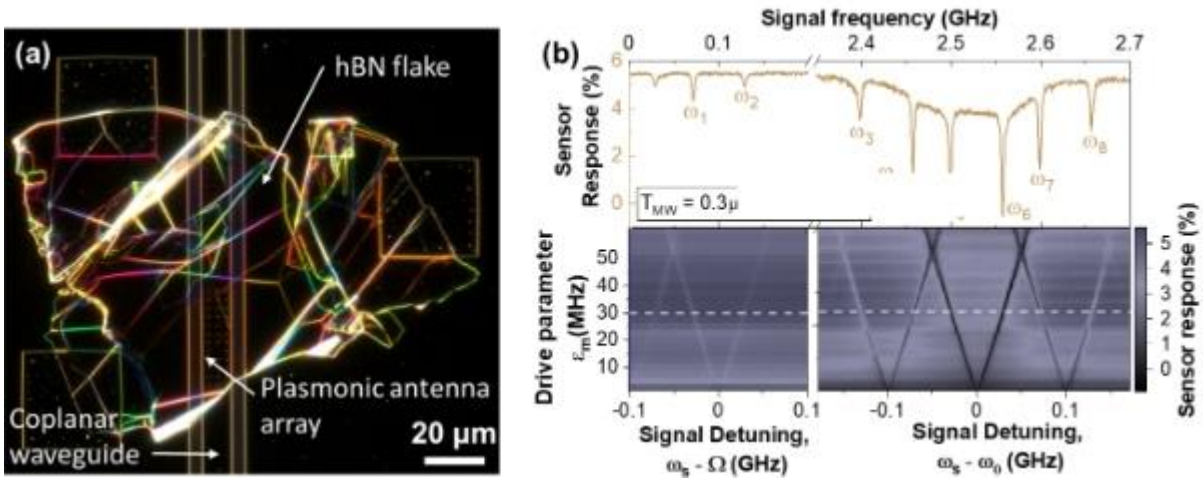

Figure 1. (a) Dark-field optical microscope image of a hexagonal boron nitride (hBN) flake on a microwave coplanar waveguide [1]. The hBN flake hosts spin defects which act as nanoscale magnetic field sensors. (b) Using optical and microwave excitation techniques [2], the spin defects can be used to sense AC-magnetic fields [3].

References:

[1] S. Baber et al., Nano Lett. 22, 461 (2022).
[2] A. J. Ramsay et al., Nature Communications 14, 461 (2023).
[3] C. J. Patrickson et al., npj Quantum Information 10, 5 (2024).

Project specific enquiries:

If you have project specific enquiry please contact the lead supervisor named above.