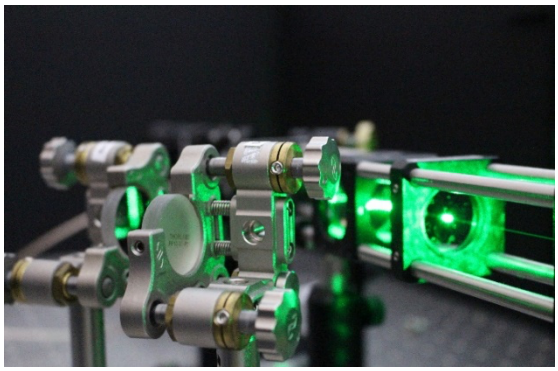
ENGINEERED DIAMOND TECHNOLOGIES PROSPERITY PARTNERSHIP

Controlling spin qubits in diamond: towards building a quantum computer

Supervisor:	Gavin Morley (Warwick Physics)
Second supervisor:	Ben Green (Warwick Physics)
Funding:	Fully funded PhD studentship (48 months)
Start date:	September/October 2022
Application deadline:	Ongoing

If a quantum computer could be built with enough qubits, it would be able to solve problems that are intractable with the classical computers we have now. A leading design for this is to build nodes with five or more interacting qubits, and then link them up. Nitrogen vacancy centres (NVC) in diamond have been used to demonstrate this linking by entangling their electron spins optically. The nuclear spins coupled to NVC can have long coherence times of over 10 seconds.

This project will make use of our laser-written NVC and the laser-written electrical wires we can create around them [1, 2] as well as new diamond material with very low strain made by our industrial collaborators Element Six. The laser writing is done by the group of our academic collaborator Patrick Salter in Oxford University. We will create arrays of these qubits inside diamond membranes, and use laser-written wires to control the NVC. The use of membranes is needed to fit the diamonds into optical cavities which will boost the optical entanglement. The low diamond strain will greatly reduce the need to electrically tune the optical emission of the NVC. We will work to improve the yield of NVC in these diamonds but by using optical entanglement we benefit from not needing to have high yields, unlike in quantum computer designs that rely on nearest-neighbour coupling. The student will learn to use our cleanrooms for fabricating diamond devices including plasma etching to thin down membranes. The student will also use and further develop our equipment for coherent quantum control of single NVC spins.



The research will be carried out in both the Physics and Engineering Departments at Warwick in close collaboration with industrial partner Element Six. This project is supported by the recently funded UKRI/EPSRC Engineered Diamond Technologies Prosperity Partnership grant – which aims to advance and solidify the UK's world-leading role in diamond technologies to develop solutions where no other material is capable – and the Warwick Centre for Doctoral Training in Diamond Science and Technology. The project will exploit the world-leading diamond synthesis capabilities of Element Six and Warwick's pioneering expertise in defect and material characterisation, and micro/nanofabrication of devices based on diamond. The student will join the Prosperity Partnership team (which consists of 5 academic research groups spread across Warwick Chemistry, Physics and Engineering) and benefit from interactions well as over 40 researchers in the wider diamond community at Warwick as well as at other academic institutions.

Applicants must have (or expect to obtain) at least the equivalent of a UK first or upper second-class degree in Physics (or related subjects). The studentship will commence in October 2022 (although an earlier start is possible based on your availability) and will provide a maintenance grant and tuition fees at the standard UK rate, currently set at £15,609 for the 2022/23 academic year. Funding may be available on a competitive basis to exceptional students of any citizenship. Applications are welcome to those able to support themselves or with funding already arranged. Such applications will go through the same level of academic assessment.

For more details please contact Gavin Morley (gavin.morley@warwick.ac.uk) and DST.Admin@warwick.ac.uk and provide a CV. Further information about the research of Dr. Morley can be found at https://go.warwick.ac.uk/gavinmorley.

[1] Y-C Chen *et al*, Nature Photonics **11**, 77 (2017).
[2] CJ Stephen *et al*, Physical Review Applied 12, 064005 (2019)