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Fabrication Strategies for Practical Diamond Based Quantum Information Processing Devices

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Optically emitting defect centres in diamond display a range of unique quantum properties that offer exciting possibilities for the construction of quantum devices which employ optical single-spin read-out. Indeed diamond is an ideal material for use in the fabrication of (i) single photon sources for quantum communications, (ii) optical fibre-based single spin read out systems, (iii) photonic platforms for the investigation of quantum entanglement in solid state systems and (iv) optical regenerators and non-linear quantum gates. The toolkit of available fabrication strategies which are used to engineer devices taking advantage of these unique properties will be presented. Our most recent results include demonstrations of (i) optical fibre based single photon sources based on Nickel and Nitrogen optical centres, (ii) waveguiding of light in structures hewn from single crystal diamond, (iii) Electrical Stark shift of the frequency of single optical emitters, (iv) coupling between the spins between single NV and N atoms in devices engineered by ion implantation, and (v) electromagnetically induced transparency in single NV centres. These crucial demonstrations establish the feasibility of a defect tolerant architecture for the fabrication of a few ($\sim$10-50) qubit diamond based quantum information processor. We will present one such possible architecture and explain the specific role for ion beam processing in the creation of qubits and the engineering of diamond photonic devices.