Quantum Nanophotonics with Diamond

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Individual color centers in diamond have recently emerged as a promising solid-state platform for quantum communication and quantum information processing systems, as well as sensitive nanoscale magnetometry with optical read-out. Performance of these systems can be significantly improved by engineering optical properties of color centers using nanophotonic approaches. In this talk I will describe a high-flux, room temperature, source of single photons based on an individual Nitrogen-Vacancy (NV) center embedded in a top-down nanofabricated, single crystal diamond nanowires\textsuperscript{1,2,3}, plasmonic nano-apertures\textsuperscript{4,5}, and diamond-based optical cavities\textsuperscript{6,7} and waveguides. Using the nanowire geometry, for example, an order of magnitude brighter single photon source is realized, with an order of magnitude lower pump power, compared to an NV center in a bulk diamond\textsuperscript{2}. By embedding diamond nanowires in metals\textsuperscript{5}, it is possible to further increase photon flux by increasing photon production rate via Purcell effect. To that end, we demonstrated Purcell factors of \textasciitilde6 in geometry that consists of diamond nanoposts embedded in silver\textsuperscript{6}. Finally, recently we demonstrated optical nanocavities and waveguides fabricated directly in thin diamond films\textsuperscript{7}. Single-photon emission of NV centers embedded in diamond ring resonators, featuring quality factors on the order of 10,000, has been demonstrated. These devices could enable strong coupling between photons and NV centers.