NWS11-2011-000093

Abstract for an Invited Paper
for the NWS11 Meeting of
the American Physical Society

Diamond Nanophotonics and Quantum Optics

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The diamond nitrogen-vacancy (NV) center is an optically active impurity whose "atom-like" properties make it a promising solid state qubit, in which well-defined optical transitions are used to control the quantum state of single NV electron and nuclear spins. These properties have led to impressive demonstrations of quantum information storage in single NV nuclear spins, entanglement between NV electron spins and single photons, and implementations of high resolution optical magnetometers using single NVs. A missing ingredient for implementing quantum information processing architectures with NVs is creating scalable coherent coupling between them. Nanophotonic circuits, in which waveguides function as a "quantum bus" between NVs embedded in optical microcavities, offer a chip-based solution to this hurdle. In my talk I will review recent advances in realizing nanophotonic devices in diamond based materials. I will present results demonstrating Purcell enhanced coupling between optical nanocavities and NVs in single crystal diamond, and will discuss opportunities and challenges which lay ahead for diamond quantum optics.