ABSTRACT

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Novel plasmonic materials and nanodevices for integrated quantum photonics
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Light-matter interaction is the foundation for numerous important quantum optical phenomena, which may be harnessed to build practical devices with higher efficiency and unprecedented functionality. Nanoscale engineering is seen as a fruitful avenue to significantly strengthen light-matter interaction and also make quantum optical systems ultra-compact, scalable, and energy efficient. This research focuses on color centers in diamond that share quantum properties with single atoms. These systems promise a path for the realization of practical quantum devices such as nanoscale sensors, single-photon sources, and quantum memories. In particular, we explored an intriguing methodology of utilizing nanophotonic structures, such as hyperbolic metamaterials, nanoantennae, and plasmonic waveguides, to improve the color centers performance. We observed enhancement in the color center's spontaneous emission rate, emission directionality, and cooperativity over a broad optical frequency range. Additionally, we studied the effect of plasmonic environments on the spin-readout sensitivity of color centers. The use of CMOS-compatible epitaxially grown plasmonic materials in the design of these nanophotonic structures promises a new level of performance for a variety of integrated room-temperature quantum devices based on diamond color centers.