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On-chip plasmonic cavity-enhanced spontaneous emission rate at the zero-phonon line

Hamidreza Siampour,* **Shailesh Kumar, and Sergey I. Bozhevolnyi**

Centre for Nano Optics, University of Southern Denmark, Campusvej 55, DK-5230 Odense M, Denmark

**E-mail: hasa@mci.sdu.dk*

Highly confined surface plasmon polariton (SPP) modes can be utilized to enhance light-matter interaction at the single emitter level of quantum optical systems [1-4]. Dielectric-loaded SPP waveguides (DLSPPWs) confine SPPs laterally with relatively low propagation loss, enabling to benefit both from a large Purcell factor and from a large radiative efficiency (low quenching rates) [1, 2]. In this work, we present a DLSPPW-based Bragg cavity resonator to direct emission from a single diamond nitrogen vacancy (NV) center into the zero-phonon line (Fig. 1). A quality factor of ~70 for the cavity and an up to 42-fold spontaneous emission rate enhancement at the zero-phonon line (a ~7-fold resonance enhancement in addition to a ~6-fold broadband enhancement) is achieved, revealing the potential of our approach for on-chip realization of quantum-optical networks.

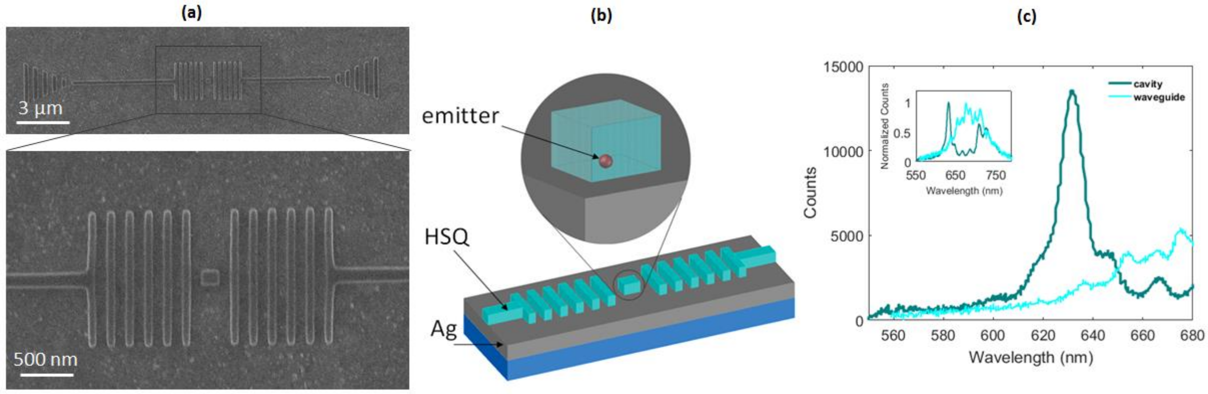

Fig. 1 (a) Scanning electron micrograph of the waveguide-integrated plasmonic cavity. (b) Schematic of a nanodiamond coupled to a cavity. The cavity resonator consists of two distributed Bragg mirrors that are built at opposite sides of the incorporated NV emitter using electron-beam lithography of hydrogen silsesquioxane (HSQ) resist deposited on silver-coated silicon substrates. (c) Plasmon-coupled emission from single NV-center recorded in the out-of-cavity (dark green line) compared to the fluorescence spectrum coupled to a straight DLSPP waveguide (no Bragg gratings, cyan line).

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