Supporting Information:

Nanofabrication of plasmonic circuits containing single photon sources

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1. Optical Set-up

The optical set-up used for characterization of the nitrogen vacancy (NV) centers as well as the NV-center dielectric loaded surface plasmon polaritons waveguide (DLSPPW) coupled system is presented in Fig. S1.

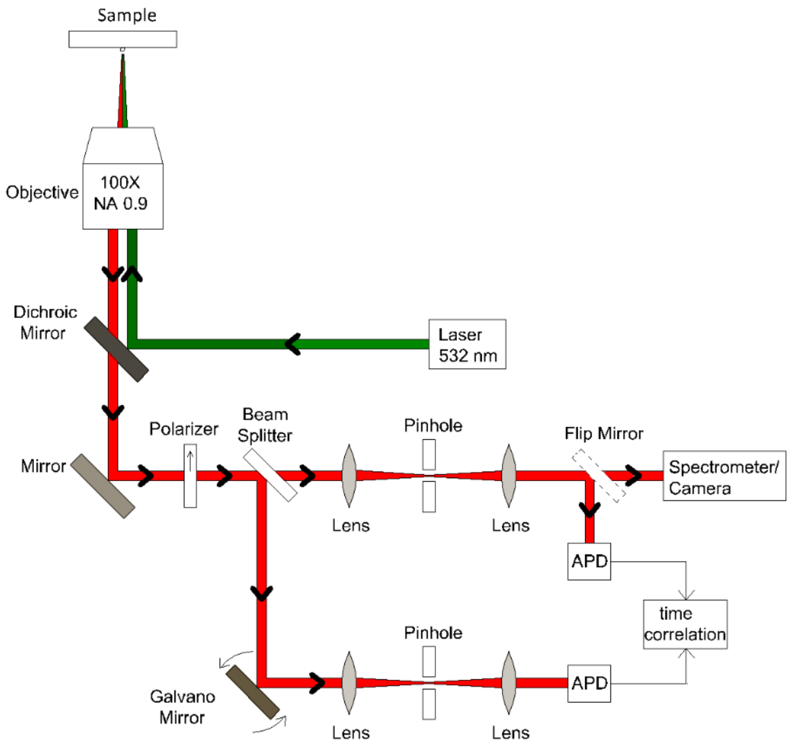

Figure S1. Schematic of experimental setup. Green line indicates excitation path from pump laser (532 nm) onto the sample, which is focused by a 100× (NA 0.90) objective. The fluorescence light, indicated by red line, is collected by the same objective, and passed through a dichroic mirror, polarizer and then beam splitter. When illuminated by a continuous wave laser, the emission from a single quantum emitter is split into two channels through the beam-splitter and then detected by two identical avalanche photodiodes (APDs) where we record time delay across the APDs to generate an intensity autocorrelation signal $g^{(2)}(t) \;= < I(t')I(t'-t) >$. Lifetime measurements are performed using pulsed excitation with pulse width/period of ~50 ps/400 ns. Postfabrication measurements are performed to show coupling of the emitter to the DLSPP waveguide where the nanodiamond is excited and a fluorescence image of the focal plane is taken either by a charge-coupled device (CCD) camera or a galvanometric mirror scan. Fluorescence spectrum of ND-waveguide system is taken by a grating spectrometer.

2. Excitation of DLSPP mode with a single NV-center

In Fig. S2 and S3, we present two NV-DLSPPW coupled systems. In Fig. S2, we present an NV^- center coupled to a DLSPPW waveguide and in Fig. S3, a NV^0 center coupled to a DLSPPW waveguide is presented.

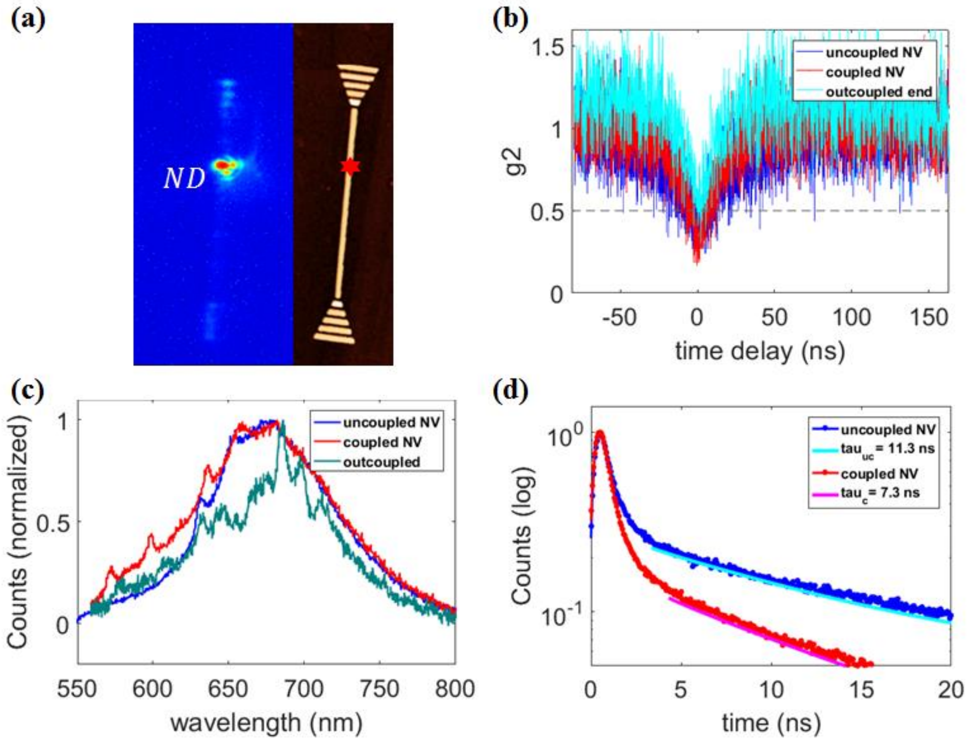

Figure S2. DLSPP waveguide coupled to a nanodiamond containing single nitrogen NV-center. (a) A charge-coupled device (CCD) camera image of the whole structure where the nanodiamond is excited and a fluorescence image of the focal plane is taken (left), and an atomic force microscope (AFM) image of the fabricated waveguide (right), are presented. The position of NV-center is indicated with a "star". Emission from the gratings at the ends of the waveguide, when nanodiamond is excited, confirms the coupling of NV-center to the waveguide mode. (b) Autocorrelation for the NV-center before (blue) and after (red) coupling to the waveguide, and cross correlation between the outcoupled grating end and NV-center (light green). (c) Spectrum taken from uncoupled NV (blue), coupled NV (red), and outcoupled light through the grating end (dark green) are presented. (d) Lifetime of the NV-center before (blue) and after (red) coupling.

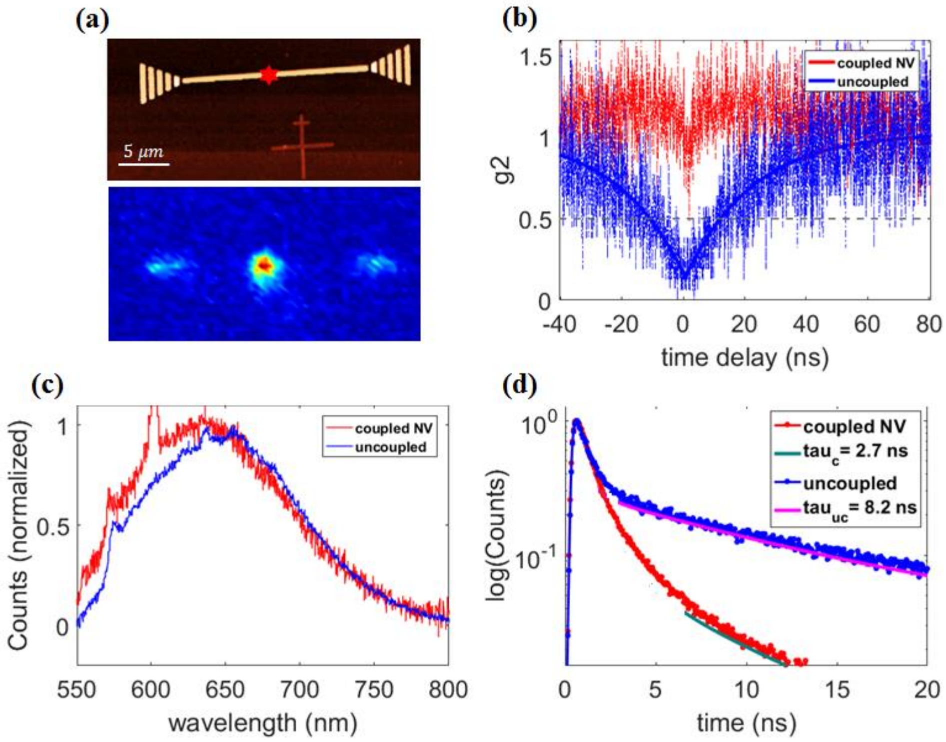

Figure S3. (a) An atomic force microscope (AFM) image of the fabricated waveguide (top), and a galvanometric mirror scan image (bottom), where the nanodiamond is excited and a fluorescence image of the focal plane is taken, is presented. Emission from the gratings at the ends of the waveguide, when nanodiamond is excited, confirms the coupling of NV-center to the waveguide mode. (b) Autocorrelation, (c) Spectrum, and (d) Lifetime of the NV-center before (blue lines) and after waveguide fabrication (red lines).

3. Routing of single plasmons in a DLSPPW based circuitry

When two DLSPPW waveguides are placed in the vicinity to each other, their individual modes cease to exist and two modes called antisymmetric and symmetric modes are supported, as presented in Fig. S4. The effective mode indices of the two modes are different and as the two modes propagate, the modes acquire a phase relative to the other mode. This results in a distribution of energy in the waveguides as a function of propagation distance, which can be used for routing of plasmon polaritons, in case of DLSPP, from one DLSPPW to other as explained in Fig. S4. The coupling length L_c is given by, $L_c = \lambda/2(\mathrm{n}_{eff}^{+} - \mathrm{n}_{eff}^{-})$, where n_{eff}^{+} and n_{eff}^{-} are the effective mode indices of symmetric and antisymmetric modes, respectively, and λ is the vacuum wavelength.

In Fig. S5, we present a system where emission from an NV-center is coupled to a DLSPPW and routed to another DLSPPW.

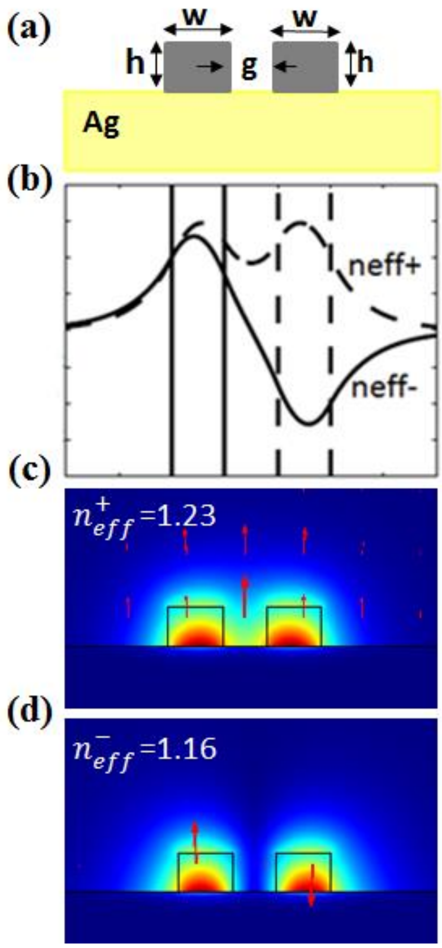

Figure S4. Simulation results of DLSPP-based directional coupler structure consists of two rectangular DLSSP waveguides of height h=180 nm, width w=250 nm, refractive index n_d=1.41, the separation gap at the parallel section is g=200 nm (a). The length of the parallel section (coupling length) to be L_c=5.3 μm in order to impart a π phase shift, at λ=700 nm, between the symmetric (n^+_{eff}) and anti-symmetric (n^-_{eff}) DLSPP modes (b) supported by the structure using $L_c = \lambda/2(\mathrm{n}^+_{eff} - \mathrm{n}^-_{eff})$. (c) Symmetric (d) Antisymmetric modes. Surface shows electric field norm (V/m) profile and red arrows indicate E-field

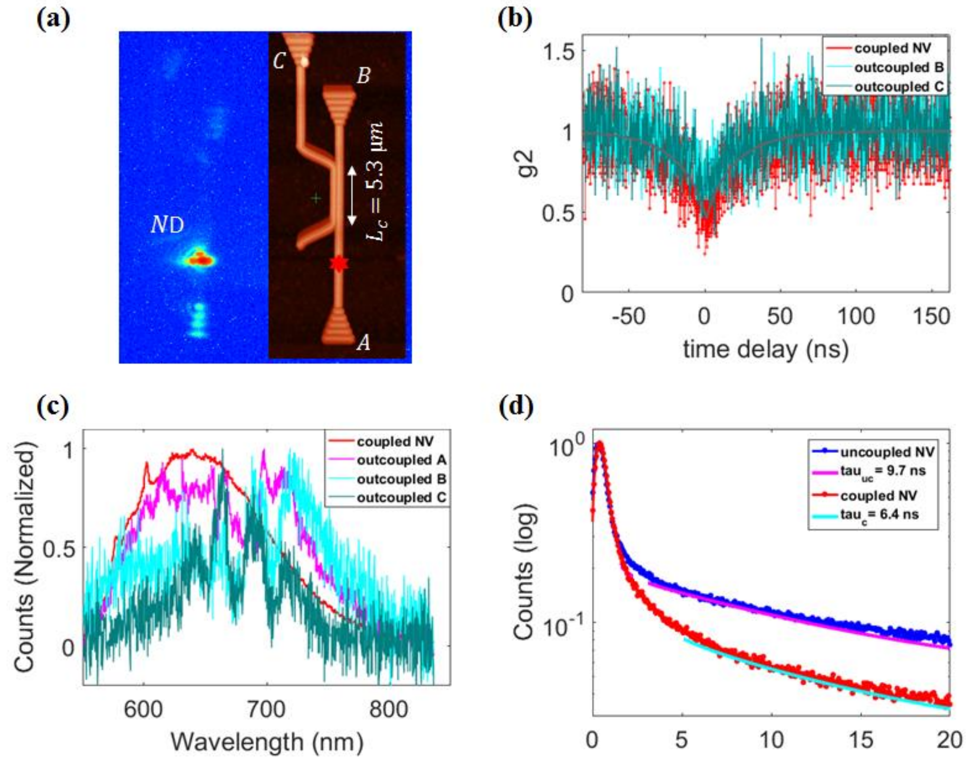

Figure S5. DLSPP-based DC coupled to a single NV-center in nanodiamond. (a) Charge-coupled device (CCD) camera image of the whole structure when the scanning laser beam is outcoupled through the grating ends (bottom), AFM image of the fabricated DC (top). (b) Autocorrelation from the coupled NV (red) and cross correlation taken between the coupled NV and outcoupled ends B (light green) and C (dark green). (c) Spectrum taken from the coupled NV (red), outcoupled ends B (light green) and C (dark green). The resonance wavelengths observed in the spectrum of the ends (B and C) are in good agreement with the ones corresponding to the coupling length, $L_c = 5.3\ \mu m$, that are calculated to be 725 nm (m=18), 687 nm (m=19), 653 nm (m=20), and 622 nm (m=21). (d) Lifetime taken before (blue) and after (red) coupling to the DC.