Electronic Supplementary Material (ESI) for Nanoscale.

Calculation of Transmission (T_m)

At the end of the interface, the boundary conditions of the electromagnetic fields permit the SP mode on the metal-dielectric interface to couple to the radiative modes into the free space in both $x < 0$ and $x > 0$ (the end of the interface is at x=0). Also, there is finite probability that the SP mode will be reflected into the SP mode itself. To calculate the transmission we use $x > 0$ as free space, employing the boundary conditions at the interface $x = 0$, to obtain the following set of equations:

$$\begin{aligned} &H_y^{(1'0)}(0,z,\omega) + r\bar{H}_y^{(1'0)}(0,z,\omega) + \textstyle\sum_m \mathcal{R}_m \bar{H}_y^{(1'm)}(0,z,\omega) \\ &= tH_y^{(2'0)}(0,z,\omega) + \textstyle\sum_m \mathcal{T}_m \bar{H}_y^{(2'm)}(0,z,\omega) \end{aligned} \tag{1}$$

$$\begin{aligned} &E_z^{(1'0)}(0,z,\omega) + r\bar{E}_z^{(1'0)}(0,z,\omega) + \textstyle\sum_m \mathcal{R}_m \bar{E}_z^{(1'm)}(0,z,\omega) \\ &= tE_z^{(2'0)}(0,z,\omega) + \textstyle\sum_m \mathcal{T}_m \bar{E}_z^{(2'm)}(0,z,\omega) \end{aligned} \tag{2}$$

where $1'$ and $2'$ indicate the regions $x<0$ and $x>0$, respectively. The coefficients r and t represent the amplitudes of reflected and transmitted surface plasmons, respectively, whereas $\mathcal{R}_m$ and $\mathcal{T}_m$ are the amplitudes of the mth reflected and transmitted radiative mode into free space, respectively. Following [**?**], we consider a geometry, where, the dielectric part is extended from $z = 0$ to $z = d$ ($d > 0$) and the metal part is extended from $z = -d$ to $z = 0$. To evaluate the unknown coefficients r, t, $\mathcal{R}_m$, and $\mathcal{T}_m$, the entire range $-d<z<d$ at $x = 0$ is divided into a number of segments of equal length. If the number of such segments is $n - 1$, the above set of boundary conditions will lead to $2n$ linear algebraic equations. A convergence is reached by increasing n. The transmissivities of the surface plasmons into the mth radiative mode in the free space at the end of the interface ($x = 0$) can thus be obtained, by solving the above set of algebraic equations, as

$$T_m = |\mathcal{T}_m|^2 \frac{\int_{-d}^{d} E_z^{(2'm)}(0,z,\omega) H_y^{(1'm)}(0,z,\omega)dz}{\int_{-d}^{d} E_z^{(1'0)}(0,z,\omega) H_y^{(1'0)}(0,z,\omega)dz} \tag{3}$$

After substituting the electric and magnetic field components, values, the integral can be obtained for infinite range along z. In our model, we have considered $d = 40$ μm, which is much larger than the decay length and therefore can be treated as infinity to reach the numerical convergence. The energy associated with the mode number is given by

$$k_m = \sqrt{\frac{\epsilon_1 \omega^2}{c^2} - \frac{m^2\pi^2}{d^2}} \tag{4}$$

The corresponding transmission coefficients T_m into the mth radiative mode have been evaluated using boundary conditions for discrete equally spaced points along the interface $x = 0$. In Fig. 1, we show the distribution of the transmitivity across a number of radiative modes. The lower values of m for which the T_m is dominant, contribute the most to the intensity. The transmission probability of photons across all possible modes is large (54%) and if we use polarization dependent detector then the probability of detection for one of the mode is $\sim 10^{-3}$.

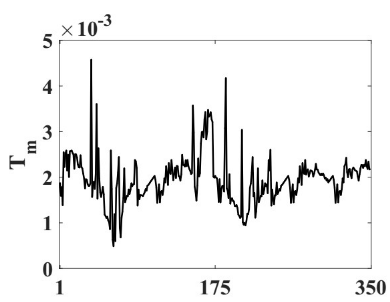

Figure 1: Transmission of the surface plasmons into radiative modes. $\epsilon_1 = -9.23 + 0.3\iota$ and $\epsilon_2 = 1, \lambda_0 = 490$ nm, $\lambda_{SP} = 0.94\lambda_0$. The total transmission into radiative modes is 54% of the SP mode across all possible modes.

Lumerical simulation for emission of photons at the end of the interface

As it has been discussed in the manuscript that the photons comes out in a particular direction. To validate this, We have checked our results with finite difference time domain (FDTD) simulations of propounded geometry (Fig. 1 in the Main Text) were carried out with 2 dielectric emitters embedded in a 100 nm thick dielectric layer (n = 1.4). The separation between the two emitters emitting 490 nm wavelength is varied from 2 to 5 nm. Emitters are placed at 10 nm from the surface of the dielectric layer and separated by 10 nm air from the surface of 400 nm thick silver film. We performed the simulations for in-plane dimensions taken to be 2 x2 μm^2, 3 x3 μm^2 and 5 x5 μm^2 with a grid size of 1 nm in x, y and z-directions and z-dimension taken to be 510 nm. The dimensions of the structure are shorter than the SP propagation length in all the cases considered. The far-field patterns calculated show that the two lobes radiated out from the edge of the interface are as predicted by the theoretical model presented here. FDTD simulation results using Lumerical software are shown in Fig. 2(b) in the Main Text. For highly uniform commercially available CdSe quantum dots emitting in the 650 nm wavelength range, gold film may be considered as it is more stable compared to silver which oxidizes.

References

[1] A. Maradudin *et al.*, *Progress in Surface Science* **33.3**, 171-257 (1990).