Electronic Supplementary Material (ESI) for Nanoscale.

Supporting information for Cathodoluminescence nanoscopy of open single-crystal aluminum plasmonic nanocavities

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I. REFLECTION OF SURFACE PLASMON POLARITONS BY THE ALUMINUM WALL

Surface plasmon polaritons (SPPs) are reflected by the aluminum wall with the height of $h = 136$ nm. Two-dimension simulation is carried out, where an electric dipole polarized along x-axis is used to excite SPPs at the interface between aluminum and vacuum. The SPP wave is reflected by the aluminum wall. The reflectivity and reflection phase can be obtained by comparing the fields with and without the reflector, as shown in Fig. S1.

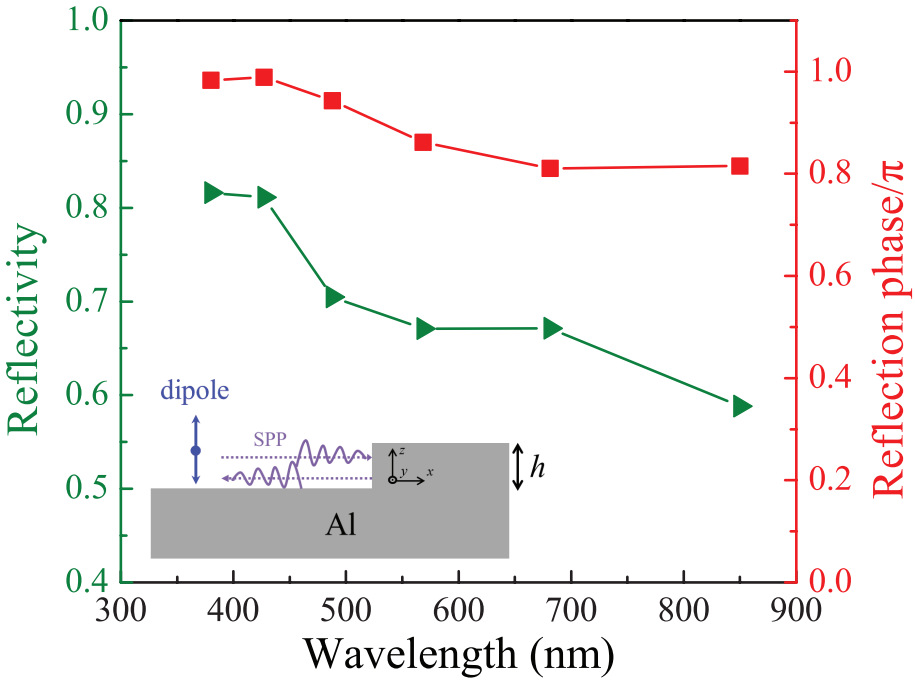

FIG. S1: Simulated reflectivity and refection phase shift of the out-of-plane component of SPPs for the cavity reflectors. The height of the reflector is 136 nm.

II. THE NORMAL MODES IN A TRIANGLE UNDER PERFECT ELECTRIC CONSTRUCTOR BOUNDARIES

The optical modes in an equilateral triangle cavity can be obtained analytically as long as the fields are efficiently reflected by the facets. For the TM mode, the electric field $E_z(x, y)$

can be written as [1]

$$E_z(x,y) = A\{e^{ik_1 x}\sin k_2(y+\frac{a}{2\sqrt{3}}) + Be^{-ik_1[(x+a)/2-\sqrt{3}y/2]}\sin k_2(\frac{\sqrt{3}}{2}x+\frac{y}{2}-\frac{a}{2\sqrt{3}}) \\ +Ce^{-ik_1[(x-a)/2+\sqrt{3}y/2]}\sin k_2(\frac{\sqrt{3}}{2}x-\frac{y}{2}+\frac{a}{2\sqrt{3}})\} \quad (1)$$

where we have

$$k_1 = \pm\frac{2m\pi}{3a}, m = 1,2,3... \\ k_2 = \frac{2n\pi}{\sqrt{3}a}, n = 1,2,3... \quad (2) \\ B = (-1)^{n+1}, C = (-1)^n$$

As a result, the z component of field distribution for the first five modes are calculated and shown in Fig. S2. The field distribution are compared with the mode pattern obtained by cathodoluminescence mapping in the main text Fig. 2. Therefore, the mode index (m,n) can be determined.

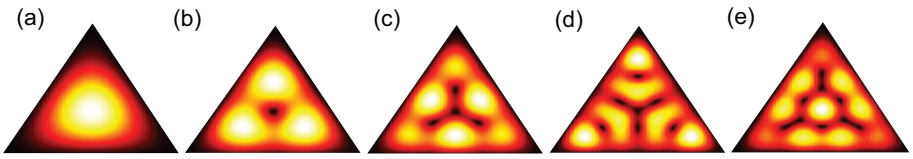

FIG. S2: The lowest five optical mode distribution $E_z(x,y)$ in a triangle cavity. The side length of the cavity is 1083 nm.

[1] Chang, H. C.; Kioseoglou, G.; Lee, E. H.; Haetty, J.; Na, M. H.; Xuan, Y.; Luo, H.; Petrou, A.; Cartwright, A. N. *Phys. Rev. A* **2000**, *62*, 013816.