–Electronic Supplementary Information –

Plasmonic elliptical nanoholes for chiroptical analysis and enantioselective optical trapping

Zhan-Hong Lin,[1] Jiwei Zhang[1,2] and Jer-Shing Huang[1,3,4,5,*]

[1]*Leibniz Institute of Photonic Technology, Albert-Einstein Straße 9, 07745 Jena, Germany*

[2] *MOE Key Laboratory of Material Physics and Chemistry under Extraordinary Conditions, and Shaanxi Key Laboratory of Optical Information Technology, School of Physical Science and Technology, Northwestern Polytechnical University, Xi'an 710129, China*

[3]*Abbe Center of Photonics, Friedrich-Schiller University Jena, Jena, Germany*

[4]*Research Center for Applied Sciences, Academia Sinica, 128 Sec. 2, Academia Road, Nankang District, 11529 Taipei, Taiwan*

[5]*Department of Electrophysics, National Chiao Tung University, 1001 University Road, 30010 Hsinchu, Taiwan*

e-mail address: jer-shing.huang@leibniz-ipht.de

S.1 Transmission Intensity of Gold Film

Here, we investigated the influence of the gold film thickness on the transmission intensity. As shown in Figure S1, when the thickness of the gold film is larger than 100 nm, the direct transmission intensity is less than 0.1%. This means gold films with thickness larger than 100 nm show negligible transmission intensity and the observable signal can be considered as only coming from the nanoholes. This would greatly reduce the background and improve the signal-to-noise ratio.

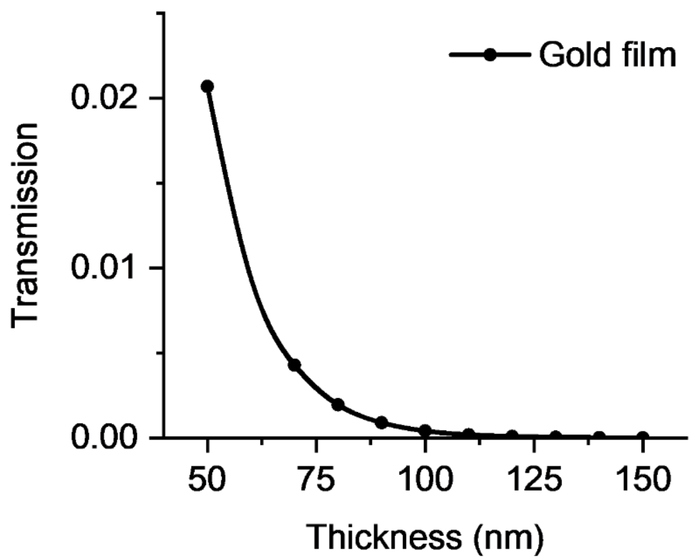

Figure S1. Direct transmission of light through the gold film as a function of the film thickness.

S.2 Circularly Polarized Field Generation on the Nanohole by Linearly Polarized Excitation at θ = 45°

The simulated $\hat{I}$ and D_{CPL} under the linear excitation polarized at $\theta = 45°$ as functions of R_x and R_y have shown that the maximum near-field $\hat{I}$ and the D_{CPL} cannot be simultaneously obtained. While small radii support large $\hat{I}$, high D_{CPL} requires large radii, as indicated by the arrows in Figure S2a and b. The above problem stems from the fact that the elliptical nanohole cannot provide equal enhancement for the electric field components along the x- and y-axis. Consequently, the electric field components in x and y direction are not the same and the electric field inside the nanohole is elliptically polarized. To address this issue, the in-plane polarization of the linearly polarized illumination was optimized for every individual elliptical nanohole, as described in the main text.

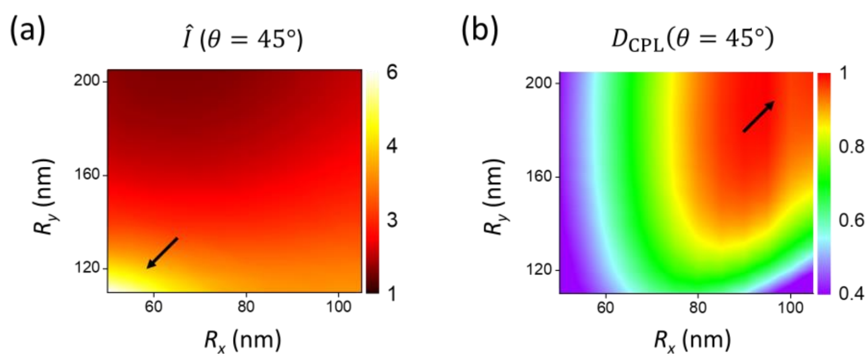

Figure S2. (a) Near-field intensity enhancement $\hat{I}$ and (b) D_{CPL} of the field on the elliptical nanohole verse R_x and R_y under a 45° polarized excitation.

S.3 Electric Field Components and Phase Shift on the Nanohole by Linearly Polarized Excitation

A simple way to understand how the elliptical hole can generate circularly polarized field upon linearly polarized illumination is to consider the elliptical nanohole as a nano-quarter-wave plate, which provides equal field enhancement in two orthogonal field components and a phase shift of 90 degrees between them. This offers the possibility to obtain a circularly polarized near field in the elliptical nanohole. As shown in Figure S3, by adjusting the radii of the major and minor axes of the elliptical nanohole, the electric field and the phase shift with respect to the incident light can be controlled. Figure S3 (a) and (b) shows that, with the optimal ellipticity, the induced electric field components in the *x* and *y* directions are similar. Figure S3 (c) shows that the phase difference between E_x and E_y is around 90 degrees. This results in a circularly polarized near field.

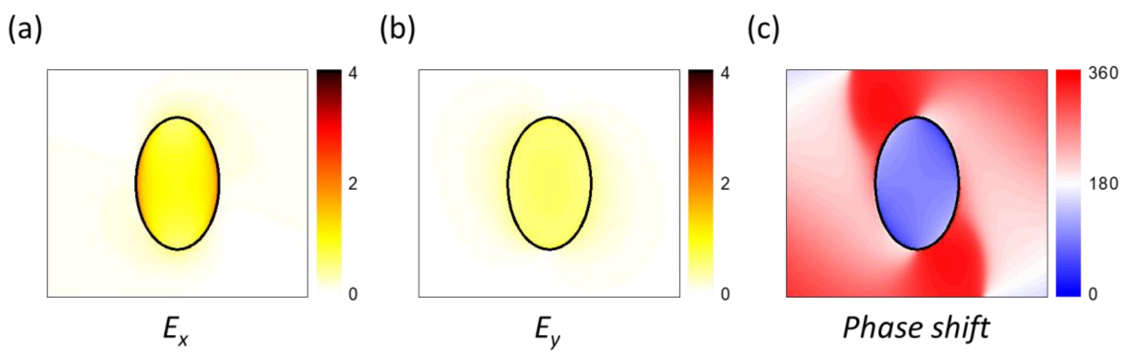

Figure S3. Distributions of (a) E_x, (b) E_y and (c) the phase shift between E_x and E_y recorded 1-nm above the top surface of a nanohole with the optimal ellipticity ($R_x = 80$ nm and $R_y = 145$ nm). The in-plane angle of the linear polarization is $\theta = 58.53°$.

S.4 Transmission Spectra of the Optimal Elliptical Nanohole

Figure S4 shows the influence of the gold film thickness on the transmission spectrum of the elliptical nanohole. A small peak at 955 nm is observed for the film thickness of 100 nm. Increasing the thickness of the gold film from 100 to 150 nm leads to a slight blue shift of the peak position and a significant decrease in the overall transmission.

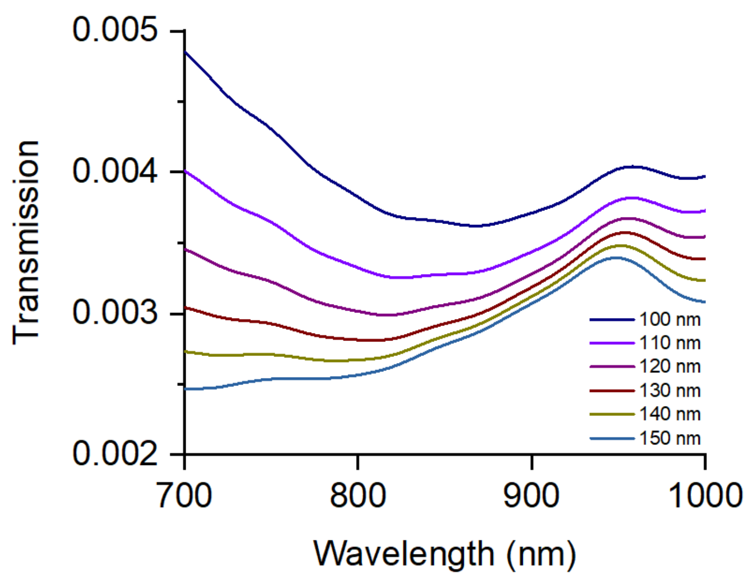

Figure S4. Transmission spectrum of the optimal elliptical nanohole with respect to the thickness of the gold film.