

Supplementary Information for: Magnetic toroidal dipole response in individual all-dielectric nanodisk clusters

Zhong-Jian Yang,^{*,†} Yan-Hui Deng,[†] Ying Yu,[‡] and Jun He^{*,†}

[†]Hunan Key Laboratory of Super Microstructure and Ultrafast Process, School of
Physics and Electronics, Central South University, Changsha 410083, China

[‡]State Key Laboratory of Optoelectronic Materials and Technologies, School of
Physics, Sun Yat-sen University, Guangzhou 510275, China

*Corresponding author: zjyang@csu.edu.cn; junhe@csu.edu.cn

1. The case for an individual Si nanodisk.

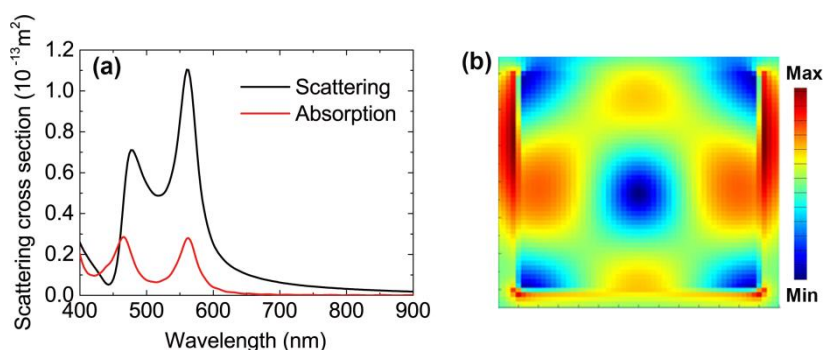


Figure S1. (a) The absorption and scattering spectra of an individual Si nanodisk. The diameter and height are both 120 nm. (b) Electric field enhancement on the $y = 0$ plane at $\lambda = 570$ nm. The excitation is similar to that of Figure 2 in the text.

2. Fitting the $|m+T^{(m)}|$ response spectrum by a Fano model.

An analytical two oscillator Fano interference model can be used to fit the response spectrum $Sca(\omega) = |s(\omega)|^2$ to get the original pure MD and TMD contributions to their coupling (S-D Liu et al, ACS Photonics 2018, 5, 1628-1639; T C Huang et al, J. Phys.

D: Appl. Phys. 2019, 52, 445102),

$$s(\omega) = a_r + \sum_j \frac{b_j \Gamma_j e^{i\phi_j}}{\omega - \omega_j + i\Gamma_j},$$

where a_r is the background amplitude, Γ_j , b_j , ϕ_j and ω_j are, respectively, the radiative damping, amplitude, phase and resonance energy of the two interfering oscillators ($j = 1, 2$). The fitting results are shown in Figure S2.

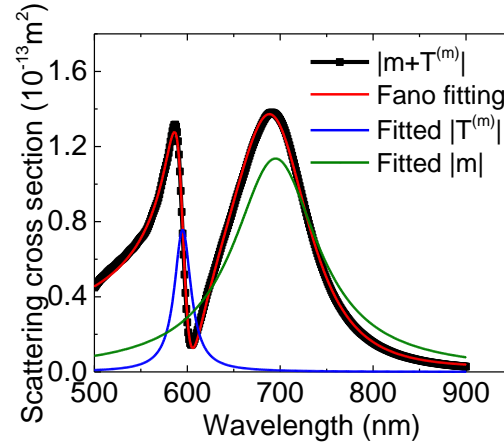


Figure S2. The numerical calculated scattering response of combined MD and MTD term ($|\mathbf{m}+\mathbf{T}^{(m)}|$, black line), and the fitting result with the Fano model (red line). The fitting parameters are $a_r = 0.3084$, $b_1 = 0.8709$, $\Gamma_1 = 0.0378$ eV, $\phi_1 = 3.624$ rad, $\omega_1 = 2.0847$ eV, $b_2 = 1.066$, $\Gamma_2 = 0.143$ eV, $\phi_2 = 2.636$ rad, $\omega_2 = 1.7847$ eV. The blue and green lines are the two oscillators used in the fitting.

3. Simulated directional scattering of an individual cluster with an oblique incidence.

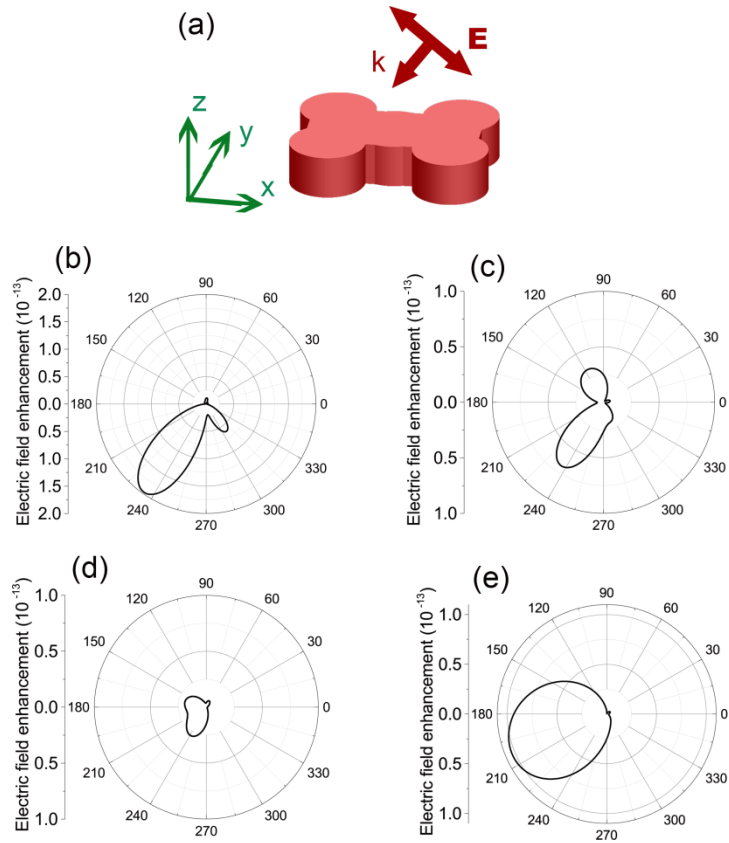


Figure S3. (a) Schematic of a Si nanodisk cluster with a plane wave excitation. It is the same as that in Figure 4(d). (b-e) Electric Far-field intensity distributions on the x - z plane (1 m radius from the structure) with different wavelengths. The wavelengths are $\lambda = 555$ nm (b), 600 nm (c), 645 nm (d), and 720 nm (e).

4. The case for a cluster with seven disks.

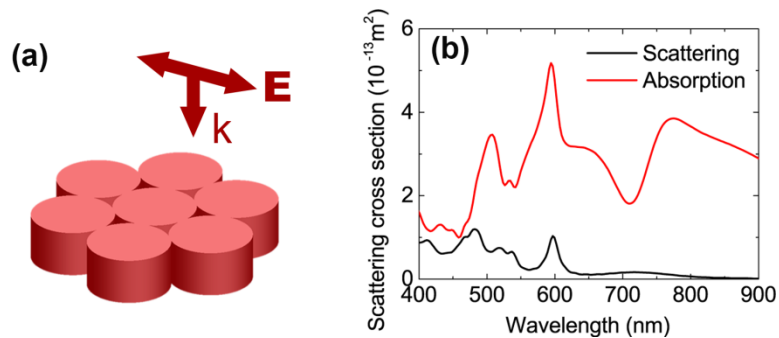


Figure S4. (a) Schematic of a Si nanodisk cluster with a plane wave excitation. The disks are touched with each other. (b) The absorption and scattering spectra of the cluster, where the size of each disk is the same as that in Figure 2 in the text.