Supplementary Information for

Surface roughness and substrate induced symmetry-breaking: influence on the plasmonic properties of aluminum nanostructure arrays

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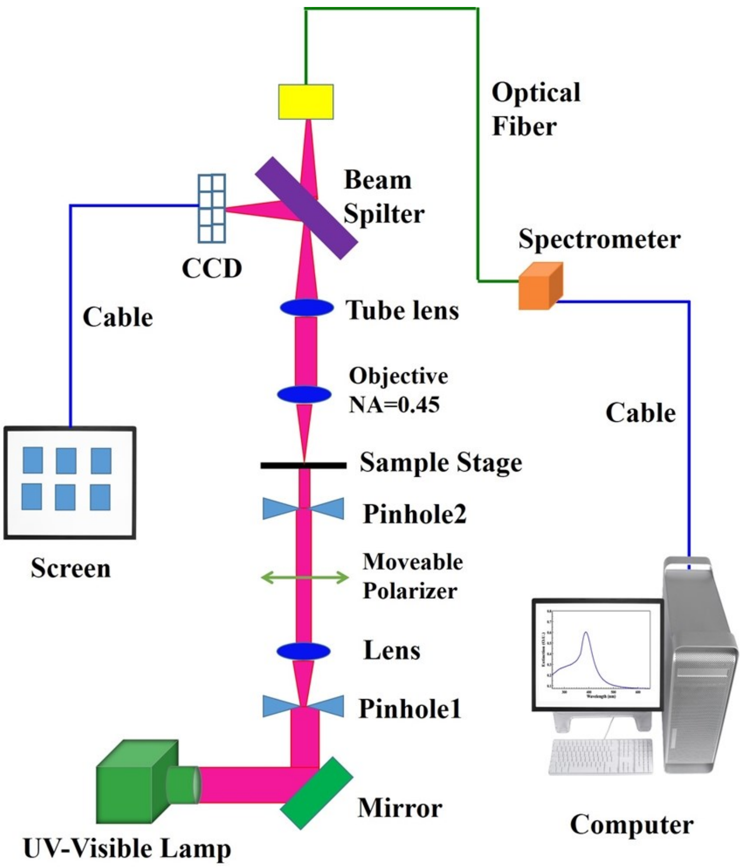

Fig. S1. Schematic image for homemade UV-visible extinction setup.

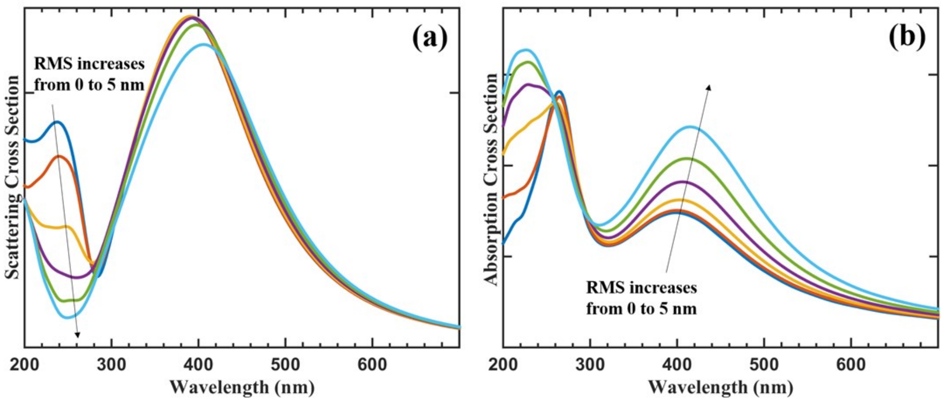

Fig. S2. Scattering (a) and absorption (b) cross section of a single Al nanodisk (diameter 100 nm) on the quartz substrate with increasing RMS value from 0 to 5 nm.

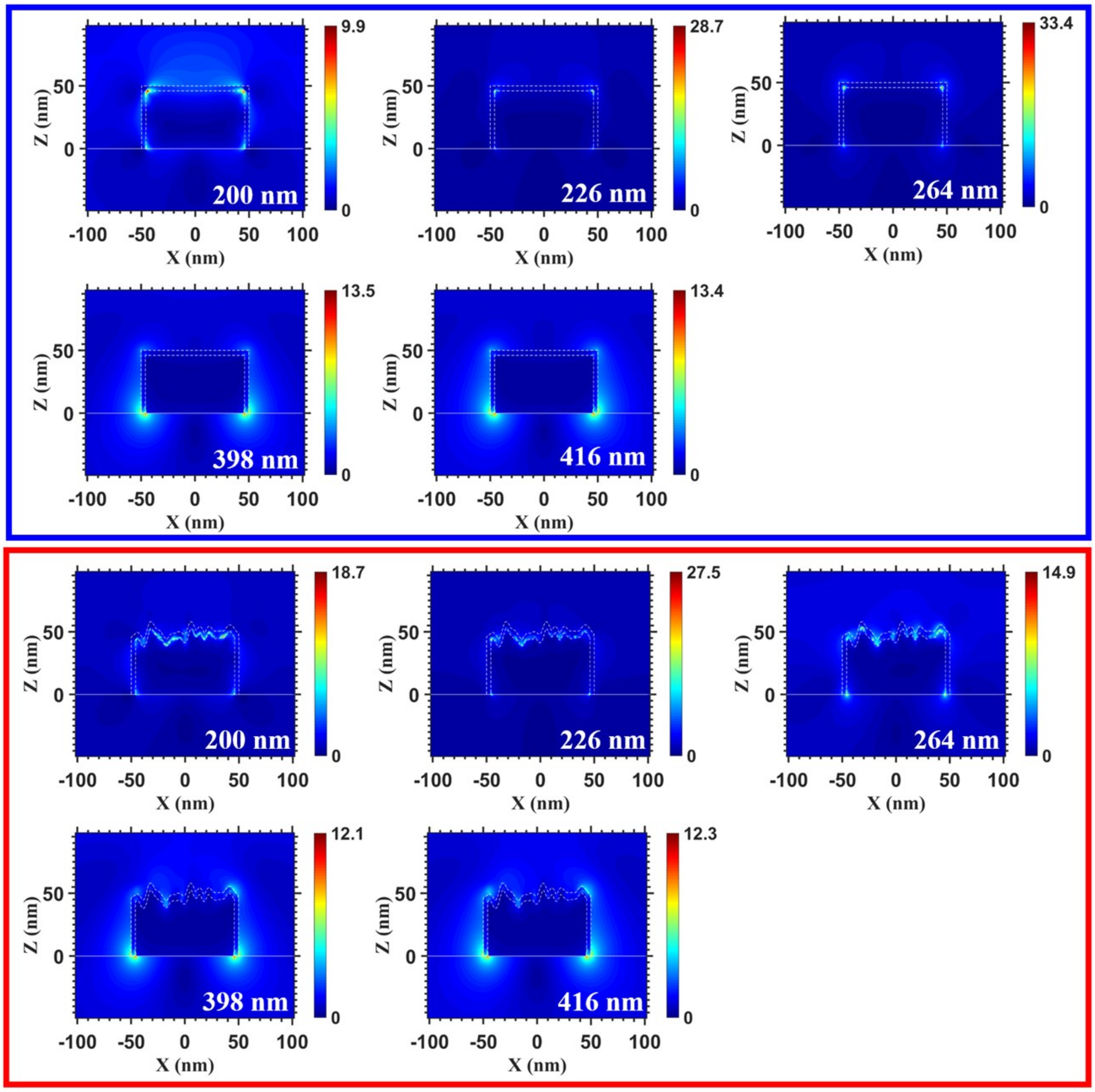

Fig. S3. Calculated E-field distribution at XZ plane of an isolated Al nanodisk of 100 nm diameter with top surface roughness RMS 0 nm (blue box) and 5 nm (red box) plotted at specific wavelengths. The polarization is along x direction. The white dashed lines sketch the Al nanodisk with the 4 nm oxide layer, and the area below Z = 0 nm stands for the quartz substrate.

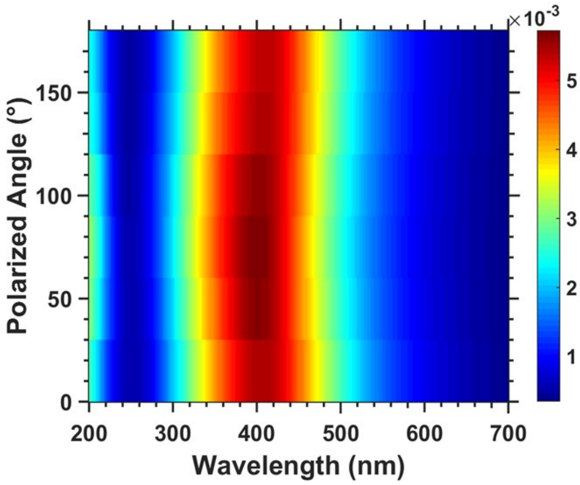

Fig. S4. Simulated scattering spectra of roughened single nanodisk (D = 100 nm, RMS = 5 nm) with polarized angle of optical source.

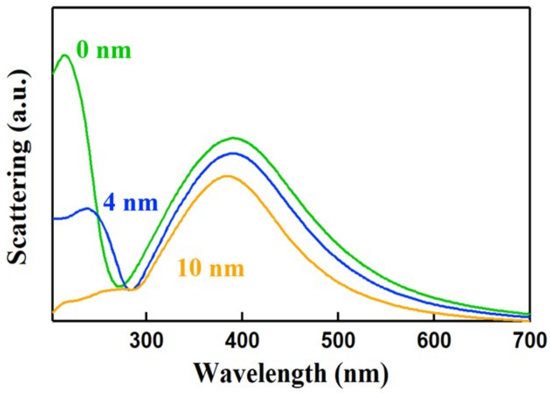

Fig. S5. Simulated scattering spectra of smooth Al nanodisk (D = 100 nm, height 50 nm) with increasing oxide layer of 0, 4, and 10 nm.

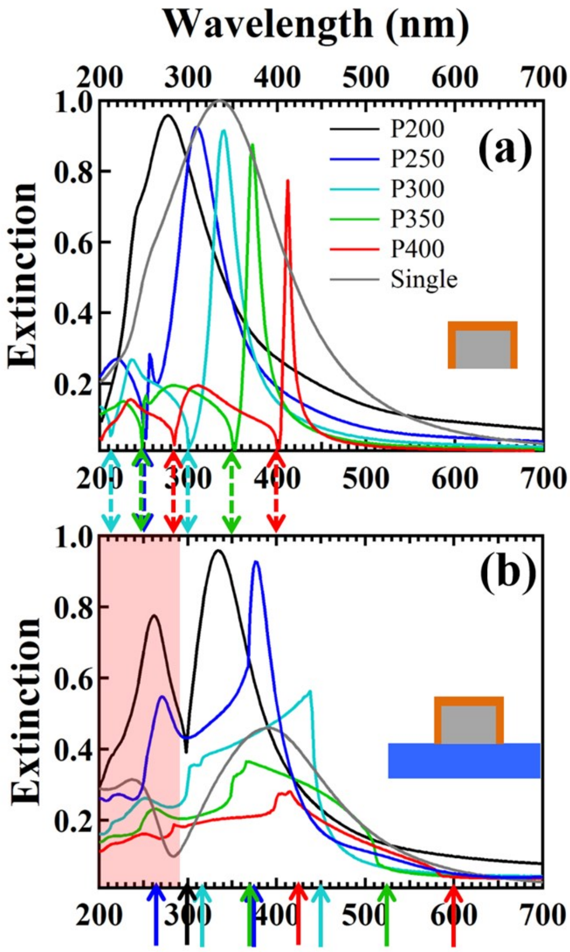

Fig. S6 Calculated extinction spectra of periodic smooth Al nanodisk (D = 100 nm, RMS 0 nm) arrays with different pitches (P) from 200 nm to 400 nm without (a) and with (b) the quartz substrate; the scattering spectra of an isolated Al nanodisk (gray lines), normalized to the maximum of the one without the quartz substrate, are also displayed to show the coupling effect. The arrows with dashed (solid) lines indicate the lattice modes from the air (quartz) side. The color of each arrow corresponds to the associated spectrum, and the shaded area corresponds to the mode Q due to the presence of the quartz substrate.

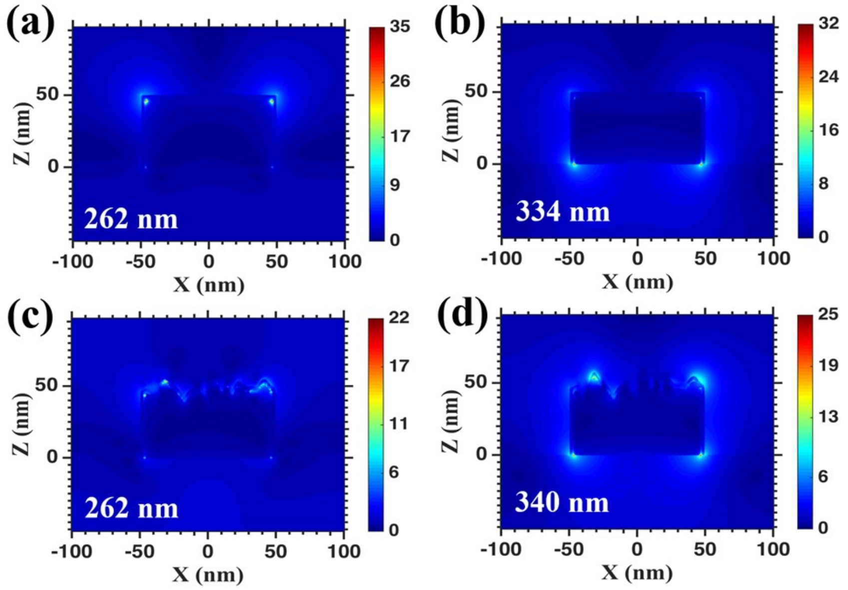

Fig. S7. Calculated E-field distribution in the XZ plane of Al nanodisk array (D = 100 nm and pitch 200 nm). Cross sections of E-field intensity with top surface roughness of RMS 0 nm (excited at 262 nm (a) and 334 nm (b)) and RMS 5 nm (excited at 262 nm (c) and 340 nm (d)). The polarization is along x direction, and the area below Z = 0 nm stands for the quartz substrate.

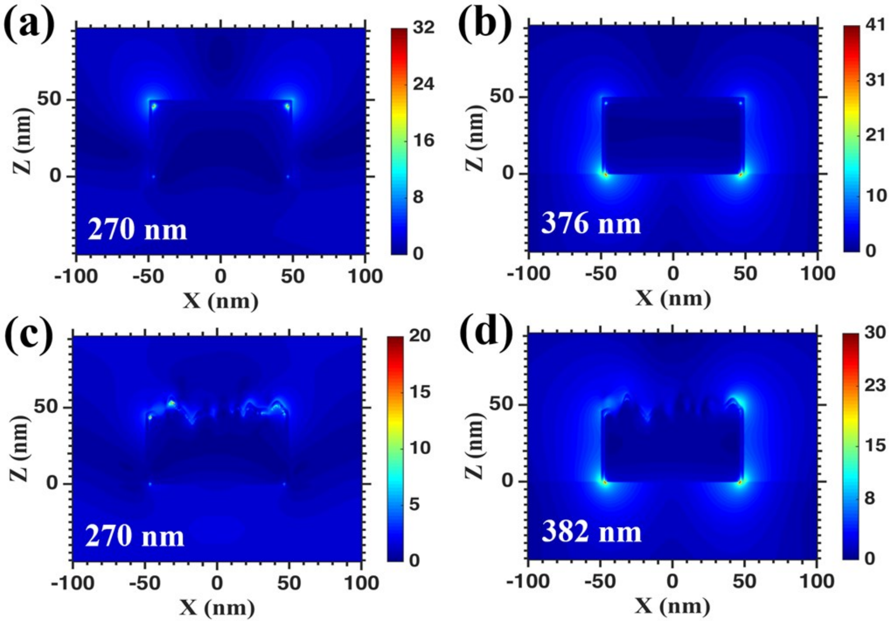

Fig. S8. Calculated E-field distribution in the XZ plane of Al nanodisk array (D = 100 nm and pitch 250 nm). Cross sections of E-field intensity with top surface roughness of RMS 0 nm (excited at 270 nm (a) and 376 nm (b)) and RMS 5 nm (excited at 270 nm (c) and 382 nm (d)). The polarization is along x direction, and the area below Z = 0 nm stands for the quartz substrate.

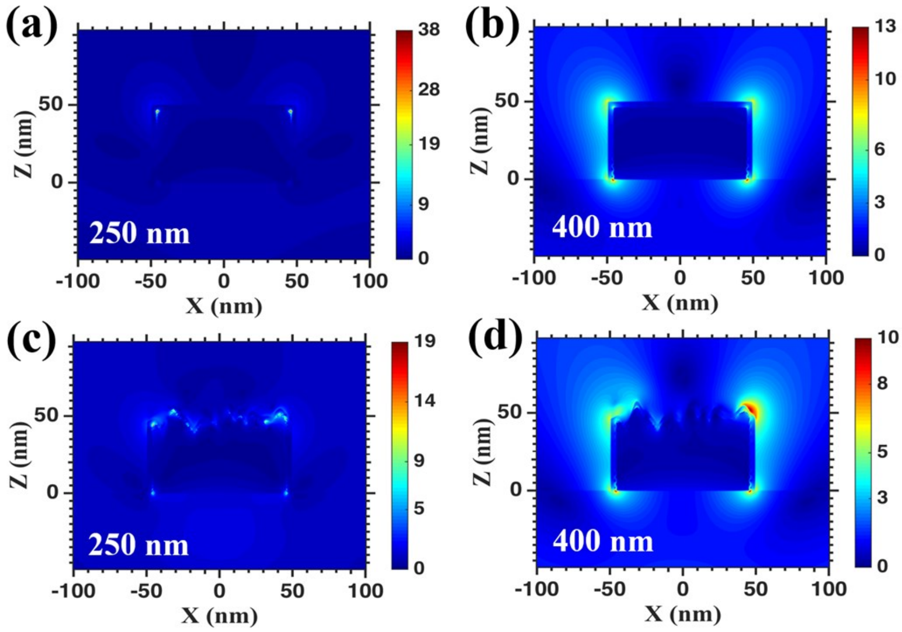

Fig. S9. Calculated E-field distribution in the XZ plane of Al nanodisk array (D = 100 nm and pitch 400 nm). Cross sections of E-field intensity with top surface roughness of RMS 0 nm (excited at 250 nm (a) and 400 nm (b)) and RMS 5 nm (excited at 250 nm (b) and 400 nm (d)). The polarization is along x direction, and the area below Z = 0 nm stands for the quartz substrate.