Supporting Information

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Enhanced Light Emission by Magnetic and Electric Resonances in Dielectric Metasurfaces

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1. FABRICATION OF SILICON NANOPARTICLE ARRAYS

The Si nanoparticle arrays were fabricated using electron-beam lithography and selective dry etching. Polycrystalline Si thin films (thickness of 90 nm) were grown on a synthetic silica glass substrate by low-pressure chemical vapor deposition using SiH₄ gas as a source of Si. A resist (NEB22A2, Sumitomo) was cast on the Si film and exposed to electron-beam lithography, followed by development to make nanoparticle arrays of resist on the Si film. The Si film was vertically etched using a Bosch process with SF₆ and C₄H₈ gases, and the resist residue was etched away by oxygen dry etching. We show the SEM images of the arrays used for the photoluminescence measurement in Figure S1.
Figure S1. SEM images of the Si nanoparticles arrays with $a = 430$ nm and (left panel) $d = 105$ nm and (right panel) 134 nm.
2. SIMULATED EXTINCTION SPECTRA

The extinction for TM and TE light at $\theta_{in} = 4^\circ$ simulated for the array with $d = 126$ nm and $a = 430$ nm by using the surface integral method is shown in Figure S2(a). The result reproduces the experimental extinction spectra in Fig. 1(c). For more detailed analysis on the origin of the features, we decompose the TE spectrum into the contributing electric dipole ($p_y$) and magnetic dipoles ($m_x$ and $m_z$). The sharp peak at $\lambda = 630$ nm is pure $m_x$, while the other three peaks are the mixtures of $p_y$ and $m_z$. Among the three, the contribution of $p_y$ is larger at $\lambda = 608$ and 654 nm because these features are associated with the ($\pm 1, 0$) diffraction orders that couple to $p_y$.

**Figure S2.** (a) Simulated extinction spectra around the Rayleigh anomaly at $\theta_{in} = 4^\circ$ for the Si nanoparticle array with $a = 430$ nm and $d = 126$ nm, embedded in a homogeneous medium with refractive index $n = 1.46$. The permittivity of Si is taken from ref. [57] with the imaginary part (Im($\varepsilon$)) increased by five times. (b) Analysis of the contributions of electric
and magnetic dipoles on the extinction by a multipolar decomposition of the scattering spectra for the TE light at $\theta_{in} = 4^\circ$.

The extinction simulated for the array with a smaller particle size ($d = 92$ nm) and $a = 430$ nm (Fig. S3) shows a very narrow (FWHM $\sim 0.07$ nm) and small extinction ($\sim 10\%$) associated to magnetic M-SLR, which is not resolved in the experiment (Fig. 5, bottom panel).

Figure S3. Simulated extinction spectra around the Rayleigh anomaly at $\theta_{in} = 0^\circ$ for the Si nanoparticle array with $a = 430$ nm and $d = 92$ nm, embedded in a homogeneous medium with refractive index $n = 1.46$. The permittivity of Si is taken from ref. [57] with the imaginary part (Im($\varepsilon$)) increased by five times. Note the small spectral range in the plot (10 nm).
3. EXTINCTION AND PL SPECTRA FOR THE ARRAY WITH SMALLER NANOPARTICLES

A notable correspondence between the extinction and PL enhancement is observed also for the arrays with a smaller particle size ($d = 105$ nm). Because of the narrow extinction resonance, the PL shows a very narrow and sharp peak due to the outcoupling. Given that the pump enhancement is negligible because of the mismatch between the Mie resonance and the excitation beam ($\lambda = 532$ nm), the PL enhancement due to outcoupling (~16 times) is larger for the array with a smaller particle size. This is due to the narrower resonance or higher $Q$-factor supported in this array.

Figure S4. (a) Experimental TE extinction and (b) PL enhancement as a function of $\theta_{in}$ and $\theta_{em}$, respectively, for the Si nanoparticle array with $a = 430$ nm and $d = 105$ nm embedded in a polymer layer containing 3 wt% of Lumogen F Red molecules. (c) Optical transmission (left axis) and PL intensity (right axis) normalized to the maximum of the reference at $\theta_{in} = \theta_{em} = 0^\circ$. The normalized PL spectrum of the reference is shown as a grey area. (d) Optical transmission (left axis) and PL intensity enhancement (right axis) at $\theta_{in} = \theta_{em} = 0^\circ$. 