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Supplementary Information

Long-distance transmission of broadband near infrared light guided by semi-disordered 2D array of metal nanoparticles

Hyounguk Kim,[a,b,†] Kinam Jung,[c,†] Seon Ju Yeo,[a] Wonseok Chang,[a] Jeong Je Kim,[a] Kwanil Lee,[a] Young Dong Kim,[b,d] Il Ki Han*[a,b] and S. Joon Kwon*[a]

[a] *Nanophotonics Research Centre, Korea Institute of Science and Technology, Seoul 02792, Republic of Korea.*
[b] *KHU-KIST Department of Converging Science and Technology, Kyung Hee University, Seoul 02447, Republic of Korea.*
[c] *Department of Mechanical Engineering, Hannam University, Daejeon 34430, Republic of Korea.*
[d] *Department of Physics, Kyung Hee University, Dongdaemoon-Gu, Seoul 02447, Korea*

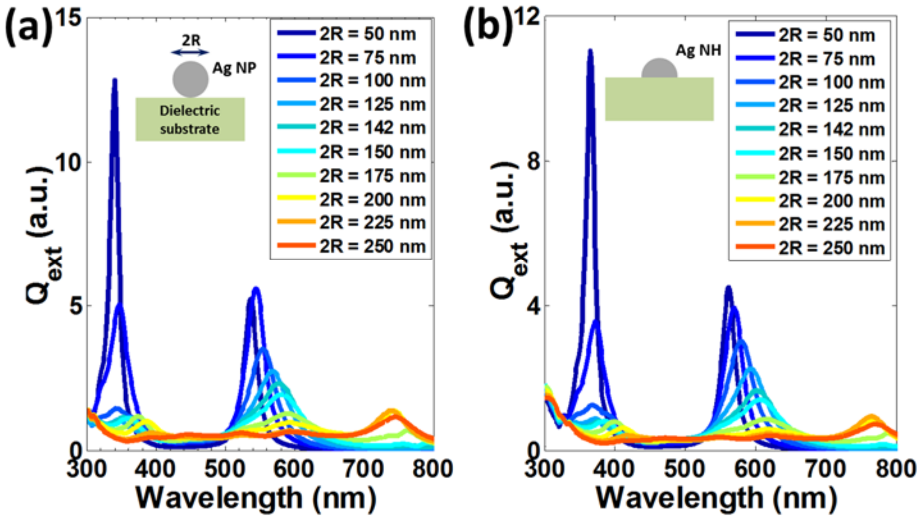

Figure S1. Calculated extinction spectra of a single Ag nanosphere (a) and nano-hemisphere (b) on Si substrate in UV-visible range. Discrete dipole approximation (DDA) method was used for the calculation of extinction spectra.

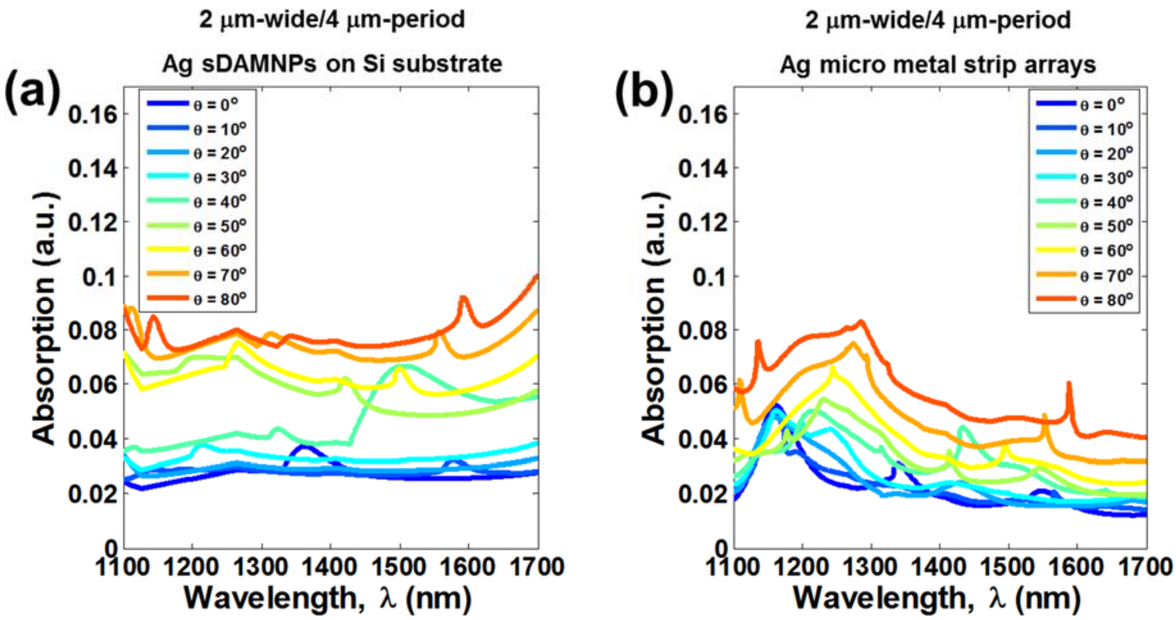

Figure S2. Calculated absorption spectra of the sDAMNPs on Si substrate (a) and 1D periodic Ag metal strip arrays. RCWA was used the calculation of absorption spectra.

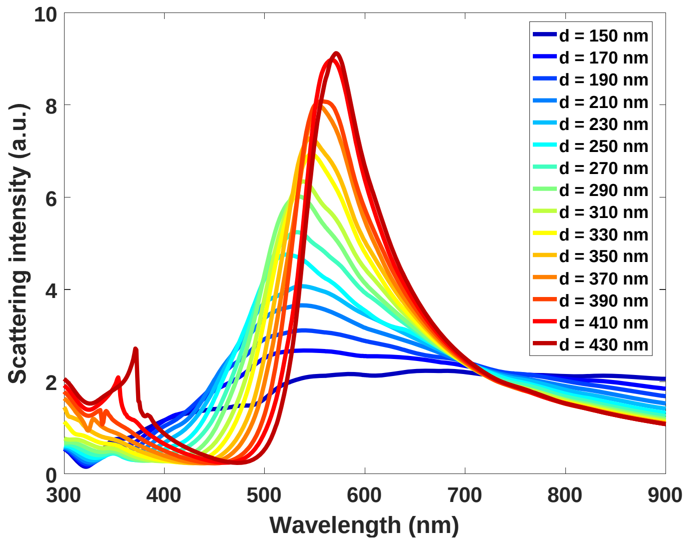

Figure S3. Scattering intensity of UV-visible light from the sDAMNPs with different inter-distances (gap denoted by d) among the Ag NPs.

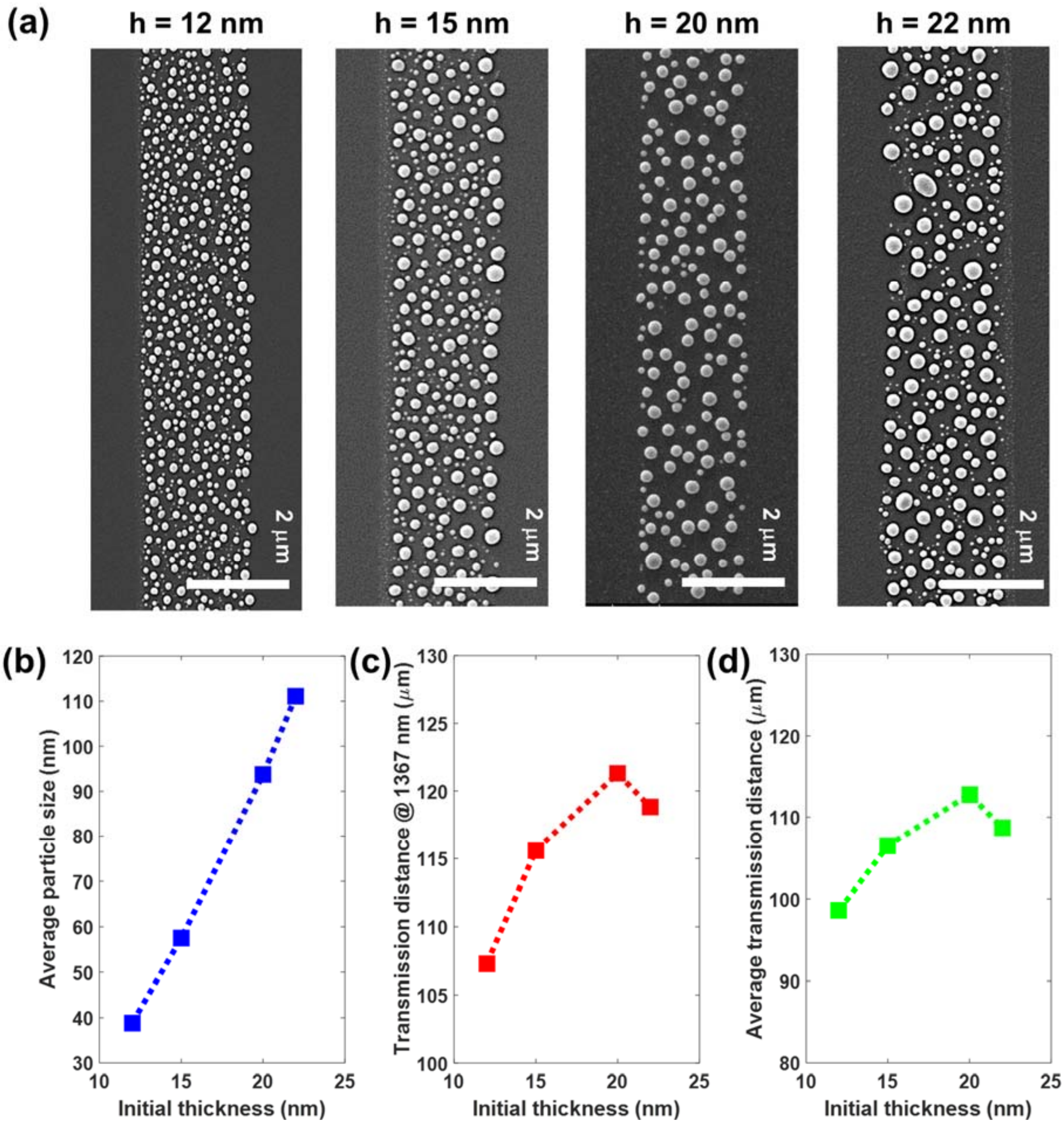

Figure S4. (a) Plane view SEM images of Ag NPs formed by Ag thin micro strips with different initial thicknesses (10 nm < h < 30 nm). (b) Average Ag NPs size (i.e., average radius R) as a function of h, (c) propagation (transmission) distance of NIR guided by sDCW at the wavelength of 1367 nm as a function of h, and (d) average transmission distance of NIR guided by sDCW in the range of 1200-1600 nm as a function of h.

2D self-consistent scattering field (2D SCSF) calculation

Each of the Ag NPs was assumed to a simple dipole with isotropic polarizability $\alpha(\omega)$ at radial frequency ω. The total E-field in the system can be expressed as $\mathbf{E}(\mathbf{r},\omega)=\mathbf{E_{inc}}(\mathbf{r},\omega)-\omega^2\sum_{i=1}^{N}\boldsymbol{\alpha}_\mathbf{i}(\omega)\mathbf{G}(\mathbf{r},\mathbf{r_i},\omega)\cdot\mathbf{E}(\mathbf{r_i},\omega)$, where $\mathbf{G}(\mathbf{r},\mathbf{r_i},\omega)$ is a Green's function dyadic, which describes the propagation of E-field from the position of the i th particle ($\mathbf{r_i}$) to the point of observation ($\mathbf{r}$). $\mathbf{E_{inc}}(\mathbf{r},\omega)$ is the incident E-field, which was modeled as a Gaussian beam $E_{inc}(\mathbf{r})=\exp\left(-\left(z^2+y^2\right)/w^2\right)\exp\left(i\left(k_0 n_{eff}x-\omega t\right)\right)$, where w is the beam waist, k_0 is the wavenumber of the incident E-field in vacuum, and n_{eff} is the effective refractive index for the system. $\boldsymbol{\alpha}_\mathbf{i}(\omega)$ is the isotropic polarizability of the i th particle which can be written as $\boldsymbol{\alpha}_\mathrm{i}(\omega)=\left[\mathbf{I}-\frac{1}{8}\left(\frac{\varepsilon_d(\omega)-1}{\varepsilon_d(\omega)+1}\right)\left(\frac{\varepsilon_d(\omega)-1}{\varepsilon_d(\omega)+2}\right)\left(\hat{z}\hat{z}+\hat{y}\hat{y}+2\hat{x}\hat{x}\right)\right]^{-1}\cdot\boldsymbol{\alpha}_\mathbf{i}^{(0)}(\omega)$. In the expression of $\boldsymbol{\alpha}_\mathbf{i}(\omega)$, $\varepsilon_d(\omega)$ is the dielectric constant of the dispersion medium, $\left[\hat{x}\ \hat{y}\ \hat{z}\right]$ is the unit vector of the Cartesian coordinate, and $\mathbf{I}$ is a 3×3 unit matrix. The non-perturbed polarizability $\boldsymbol{\alpha}_\mathbf{i}^{(0)}(\omega)$ of the i th particle can be written as $\boldsymbol{\alpha}_\mathbf{i}^{(0)}(\omega)=4\pi\varepsilon_0\mathbf{U}R_j^{\,3}\left(\frac{\varepsilon_{p,i}(\omega)-1}{\varepsilon_{p,i}(\omega)+2}\right)$ with the unit tensor $\mathbf{U}$, the radius of the i th particle R_j, and the dielectric constant $\varepsilon_{p,i}(\omega)$ of the i th particle. In this relationship, $\mathbf{E}(\mathbf{r_i},\omega)$ is the self-consistent E-field at $\mathbf{r_i}$. The set of linear equations on $\mathbf{E}(\mathbf{r_i},\omega)$ can be numerically solved to calculate the E-field at designated coordinates.