Supplementary information

The specific substrates corresponding to Fig. 1 consist in a transparent dielectric layer (refractive index n) deposited (or grown) on a Si substrate. The layer thickness t is adapted to tune one of the anti-reflectance conditions to the LSPR of the metallic particles:

$$t = (m + \frac{1}{2})\frac{\lambda}{2n} \qquad \text{with} \qquad \lambda = \lambda_{LSPR} \tag{1}$$

where λ is the electromagnetic wavelength in vacuum and m the destructive interference order. Three embedding media (air, SiO_2 or TiO_2) have been considered in Fig. 1a. The extinction efficiency C_{ext} of an Ag metallic sphere ($D = 3\,\mathrm{nm}$) embedded in a transparent medium (dielectric function ε_m) is essentially due to absorption and one gets[1]:

$$C_{ext} \approx C_{abs} = 12\pi\frac{D}{\lambda}\varepsilon_m^{3/2}\frac{\varepsilon''(\lambda)}{[\varepsilon'(\lambda) + 2\varepsilon_m]^2 + [\varepsilon''(\lambda)]^2} \tag{2}$$

where $\varepsilon = \varepsilon' + i\varepsilon''$ is the complex dielectric function of the metal. The relaxation of the plasmon (wavelength λ_p in the bulk) due to finite size effect has been accounted for by adding a supplementary term at the imaginary part ε'' of the bulk dielectric function[2]:

$$\varepsilon''_s = \frac{\lambda^3}{2\pi c \lambda_p^2}\Gamma_s \qquad \text{with} \qquad \Gamma_s = \frac{1}{\tau_s} = 2g_s\frac{v_F}{D} \tag{3}$$

In the expression of the damping parameter Γ_s, v_F is the Fermi velocity and g_s a coefficient that allows to define an effective mean free path for electron collisions. In Fig. 1a, which is here only schematic, we have adopted the most common value, $g_s = 1$.

The expected reflectance spectra of the corresponding bilayers are reported in Fig. 1b. In each case, the dielectric thickness has been chosen in order to realize a $3\lambda/4$ antireflective system ($m = 1$ in Eq. (1)) at the SPPR wavelength λ_{LSPR} of the embedded Ag-NCs. The modelling of the reflectance has been performed by considering the propagation of incident and successive reflected electromagnetic waves in the stratified medium using a matrix formulation[3,4]. One observes in Fig. 1b that the higher the refractive index of the embedding matrix, the higher the quality factor defined as $Q = \lambda_{LSPR}/\Delta\lambda$ (where $\Delta\lambda$ is the FWHM). Moreover, this enhancement of the dielectric confinement is accompanied by a red shift of the LSPR, following the sequence : air ($n = 1$), SiO_2 (1.46) and TiO_2 (2.57).

Bibliography

[1] S. A. Maier, *Plasmonics: Fundamentals and Applications*, Springer, 2007.

[2] C. F. Bohren and D. R. Huffman, *Absorption and scattering of light by small particles*, 1983.

[3] R. Carles, C. Farcau, C. Bonafos, G. Benassayag, M. Bayle, P. Benzo, J. Groenen and A. Zwick, *ACS Nano*, 2011, **5**, 8774–82.

[4] M. Bayle, P. Benzo, N. Combe, C. Gatel, C. Bonafos, G. Benassayag and R. Carles, *Physical Review B*, 2014, **89**, 195402.