Electronic Supplementary Material (ESI) for RSC Advances.

Supplementary Information Ⅰ

In a MIM system, there are two metal-dielectric interfaces to generate SPRs at two sides of the metallic surfaces. With electric field and magnetic field continuity relations, the dispersion relation (DR) from Maxwell's equations with a finite length of propagating TM (trans-verse magnetic) modes is

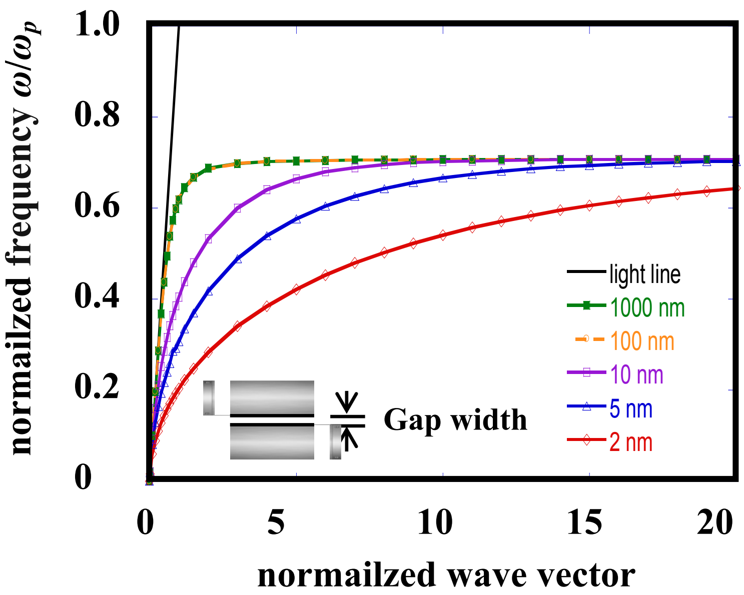
$$e^{k_i d}\left(1+\frac{\varepsilon_i}{k_i}\frac{k_m}{\varepsilon_m}\right)^2 - e^{-k_i d}\left(1-\frac{\varepsilon_i}{k_i}\frac{k_m}{\varepsilon_m}\right)^2 = 0 \qquad k_m = \sqrt{k^2-\frac{\omega^2}{c^2}\varepsilon_m} \qquad k_i = \sqrt{k^2-\frac{\omega^2}{c^2}\varepsilon_i}$$

where ε_i is the dielectric constant of insulator, ε_m is the dielectric constant of insulator, ω is the frequency of surface plasmon, k_i is the wave vector in dielectric layer , k_m is the wave vector in metal layer. Considering the Drude mode of sliver slabs and the energy loss from collisions (we used the constant $\Gamma = 0.68*10^{14}\ s^{-1}$), the solution of anti-symmetrical mode is

$$\varepsilon(\omega)\left(\frac{k_i}{k_m}\right) = -\tanh\left(\frac{1}{2}k_m d\right) \qquad \varepsilon(\omega) = \left(1-\frac{\omega_p^{\,2}}{\omega^2+\Gamma^2}\right)$$

$$\left(1-\frac{\omega_p^{\,2}}{\omega^2+\Gamma^2}\right)\left(\frac{\sqrt{k^2-\left(\frac{\omega}{c}\right)^2}}{\sqrt{k^2-\left(1-\frac{\omega_p^{\,2}}{\omega^2+\Gamma^2}\right)\left(\frac{\omega}{c}\right)^2}}\right) = -\tanh\left(\frac{1}{2}\sqrt{k^2-\left(1-\frac{\omega_p^{\,2}}{\omega^2+\Gamma^2}\right)\left(\frac{\omega}{c}\right)^2}\,d\right)$$

The corresponding normalized DR curves in silver/air/silver (MIM) configurations with five types of insulator thickness are obtained by equation (1) and plotted in the Figure. The curves based on the insulator thickness from 100 nm to 1000 nm overlap completely, denoting SPPs coupling is weak as the insulator thickness larger than 100 nm. However, when the thickness decreases to 10 nm, the coupled mode happens. The normalized surface plasma frequency



(ω/ω_p) decreases with the decrease in the insulator thickness, especially at insulator thickness 5 nm to 2 nm, indicating the SPR wavelength is strong affected by insulator thickness.