Variations of Plasmon Coupling between Two Identical Au Nanospheres with Their Separation and Sizes Studied within a Hibridization Scheme

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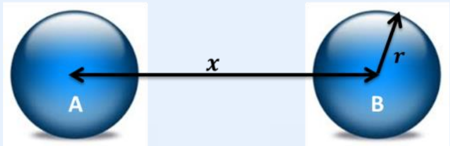
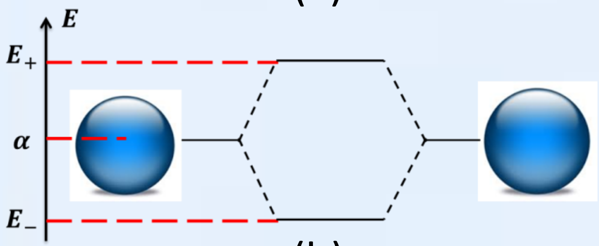
Introduction

The plasmon coupling effect is studied using a simple scheme adapted from the quantum orbital hybridization model.



(a)



(b)

Figure 1. (a) Scheme of two identical metal nanospheres where x and r are separation and radius of spheres. (b) Plasmon hybridization model of (a)

Basic Formulation

Mimicking quantum mechanics formulation of linear combination of the two plasmon modes.

$$E_{\pm} = \frac{\alpha \pm \beta(x,r)}{1 \pm S(x,r)}$$

where

- α = LSPR energy of each uncoupled plasmon,
- β = the coupling parameter,
- S = the orbital overlap = 0

Results

The best fit with the set of coefficients (α_i, b_i, c_i) given in Table 1 is obtained by the following expression

$$E_{-}^{i}(x) = \alpha_i \frac{b_i}{x^2} e^{\frac{c_i}{x}}$$

Table 1. Coefficients of bonding energy scheme for various radii

i	r_i (nm)	α_i	b_i	c_i
1	12	2.308	51.92	-11.97
2	16	2.296	150	2.05
3	20	2.281	329.6	15.66

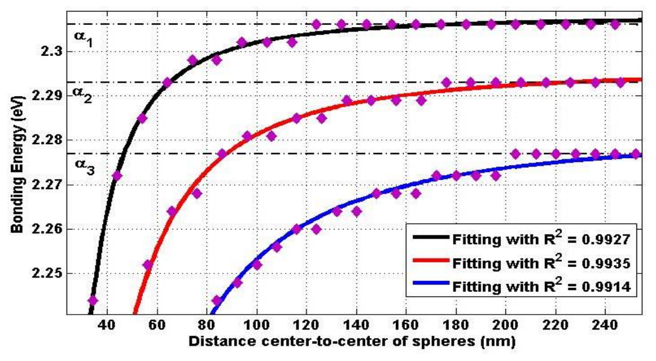


Figure 2. Variation of bonding energy for increasing center-to-center separation for various radii of the Au nanospheres.

Conclusion

Hybridization scheme developed in this study shows that the interparticle coupling depends on the separation and the size of particles.

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