LSPR Tuning of Ag@SiO2 Core-Shell Nanosphere Trimer Configurations

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Electromagnetic illumination can excite the collective oscillations of free electrons around the nanoparticles which arises to an optical phenomenon called LSPR (localized surface plasmon resonance). This LSPR effect enhances and localizes the electromagnetic field in the near vicinity of nanoantenna. Metal nanoparticle clusters with core-shell structures are promising structures providing highly localized E-field within the core-shell crevices and at the junction between the nanoparticles called "hot-spots" and can detect a small amount of analyte in spectroscopic sensing techniques such as surface enhanced Raman spectroscopy (SERS)[1].

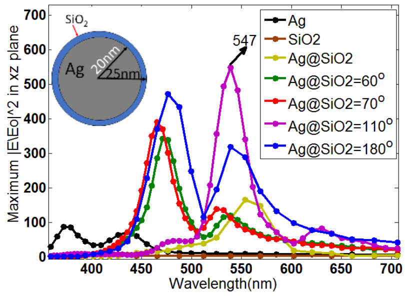

Fig.1 Electric field enhancement for Ag, SiO_2, Ag@SiO_2, Ag@SiO_2(60°), Ag@SiO_2(70°), Ag@SiO_2(110°) & Ag@SiO_2(180°)

In this work the evolution of LSPR properties of core-shell (Ag@SiO_2) nanosphere trimer of gap size, 2nm is analyzed as the symmetric configuration is transformed from linear to equilateral triangle by using FDTD simulation tool, MEEP. This is done by varying the vertex angle of the triangle, ϴ to180° (linear chain, $D_{\infty h}$), 60° (equilateral triangle, D_{3h}) and 60°< ϴ<180° (70° and 110°) for isosceles triangles, C_{2v}. The key factor in sensing based on LSPR is to excite the LSPR modes of trimer nanospheres to yield a high e-field enhancement[2]. Core-shell monomer yields higher enhancement than the pure Ag monomer. The LSPR peak of trimer core-shell with ϴ, 110° exhibits an enhancement value of 547 which is nearly 8 times greater than the silver nanosphere (Fig. 1). This is due to the arise of hot-spots in the nanogaps and the excitation of plasmonic modes of its kinked triangle(C_{2v}) configuration. The effect of the polarization dependence of trimer on E-field intensity has also been analyzed (Fig.2). The D_{3h} and C_{2v} configurations do not highly depend on the polarization where D_{3h} shows an enhancement value of 338 and 208 for parallel and perpendicular polarization, respectively, and same trend is observed in the case of C_{2v} as well. However, the E-field intensity of $D_{\infty h}$ configuration exhibits a strong polarization dependence. For parallel polarization the enhancement value is 470 and for the perpendicular polarization the value is decreased to 100. Thus the geometry and polarization dependence of the E-field intensity of trimer configurations are investigated and the highest E-field intensity of C_{2v}(110°) configuration is a good choice for building it as an array for the application such as SERS.

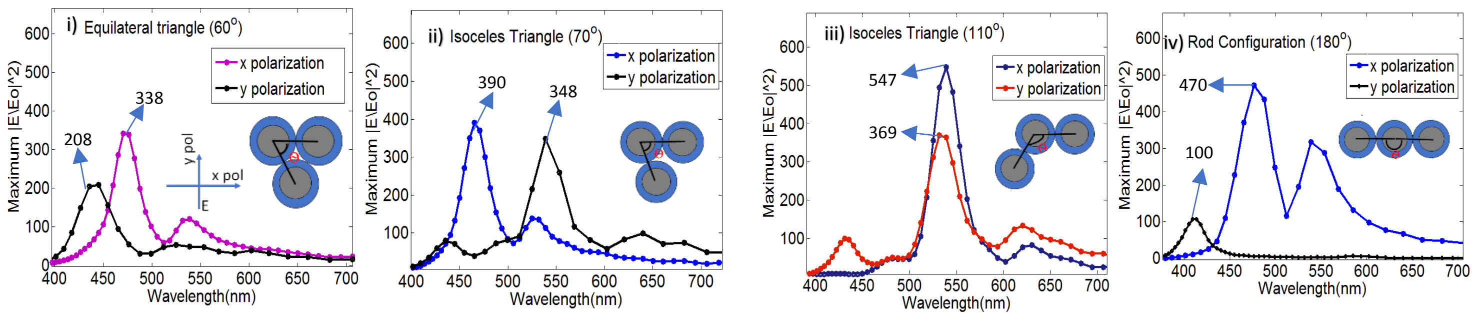

Fig. 2) i, ii. iii and iv, E-field enhancement of D_{3h}, C_{2v} and $D_{\infty h}$ respectively, with different polarization(x and y direction)

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