Confining light on the tiny metal surface: Theory and Application

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Successful finding of plasmonic property in metal in nanostructure leading to conferment of electric field on the surface has been exploited in an extensive range of applications. These applications include energy harvesting, catalysis, bio-sensing, imaging, and photonics [1]. Especially, surface plasmon from the metal nanoparticles (NPs) finds their origin with the collective oscillation of electron clouds. In addition, suitable excitation leads to resonance with this collective oscillation in such plasmonic NPs to amplify the incident electromagnetic field to many folds in their near-field. In this elite group of plasmonic nanostructures, Ag takes a special position because of its high scattering cross section and having a resonance in the visible region. One key aspect of plasmonic coupling amplification strongly depends on the non-isotropic shape of NPs, which can confine the light to act as a "hot spot." However, practical implication of such shape depends on the theoretical understanding of the confinement on the metallic surface. In that direction here we have reported the Mie-resonance scattering from Ag NPs using MATAB calculation. Importantly, this study is further expanded for the visualization of hot spot for complex structure like nanonets using finite differential time domain (FDTD) calculation. Finally, all these theoretical studies have been utilized for the understanding of appearance of high Raman signal of dye molecule present on the plasmonic surface due to surface enhanced Raman spectroscopy (SERS) [2].

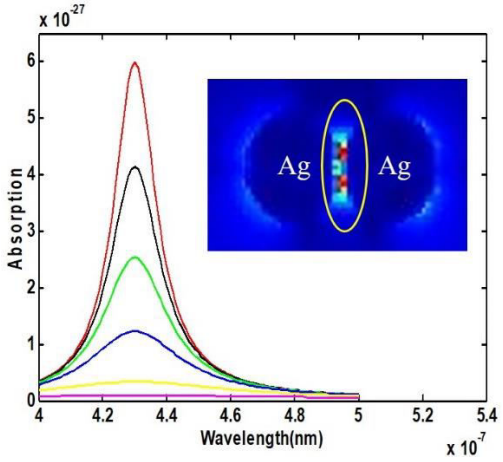

Figure 1: Mie resonance scattering obtained from MATLAB calculation (inset) representing hot-spot from FDTD calculation

References

1. B K Sahu, A Dwivedi, K K Pal, R Pandian, S Dhara and A Das, Optimized Au NRs for efficient SERS and SERRS performances with molecular and longitudinal surface plasmon resonance Appl. Surf. Sci. 537, 147615 (2021)
2. B K Sahu, A Pal, T S Reshma and A Das 2022 Single-molecule detection-enabled plasmonic Ag nanogap for unmasking vibrational properties in 0D SnO2 ACS Appl. Nano Mater. 5,12413–22 (2022)