May 4th, 11:00 AM - 1:00 PM

Surface Plasmon Characterization in Ag Nanotriangles for Evaluation of Fano Resonance Conditions

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Methodology

- Ag nanotriangles with sharp tip and ~ 1 µm side length is produced by combining a growth and a seed solution With AgNO3. [1]
- Growth solution: Acetonitrile, L- ascorbic acid, Trisodium citrate dihydrate (TSC), H_20 .
- Seed solution: TSC, $AgNO_3$, H_2O_2, $NaBH_4$, H_2O.
- Ag triangles are deposited on Indium Tin Oxide (ITO) waveguide using dip coating method.
- SEM and PEEM images of the deposited Ag nanoparticles are taken for analysis.

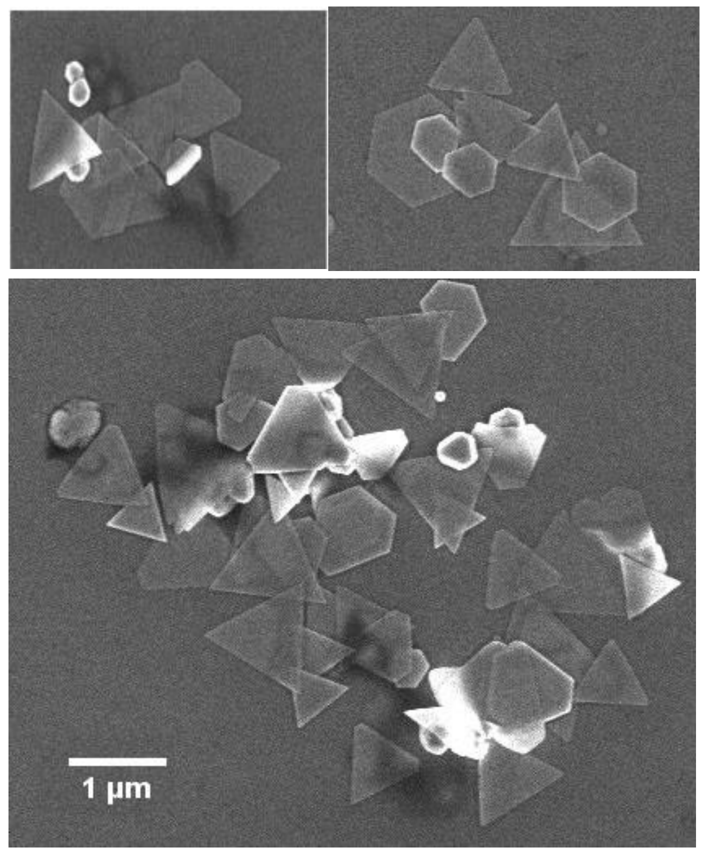

Fig 2: Ag nano particle solution.

Fig 1: SEM image of Ag nanoparticles deposited on a waveguide sample of ITO over glass through dip coating.

Introduction

- Localized Surface plasmon resonance (LSPR) is a collective oscillation of electrons and light localized at the metallic nanostructure.
- The properties of the LSPR and the resonance conditions are highly dependent on the confining materials and geometry of the confining nano structure.
- The sensitivity of the surface plasmon resonance to the property of the confining materials made SPR sensors a central tool for biosensing.
- The frequency resolution of SPR sensors is typically limited by the broad resonance of the SPR mode.
- The resolution can be enhanced through the Fano resonance which yields a sharp resonance peak through the coupling between a narrow and a broad resonance.
- In this work, the surface plasmons were excited in a triangular silver nano plate deposited on a planar waveguide consisting of an ITO layer on a glass substrate by the incident femtosecond laser beam.
- The surface plasmons are imaged using photoemission electron microscopy (PEEM) for LSPR analysis.
- Calculation using Finite Element Analysis (FEA) to determine the conditions for Fano resonance through the coupling excited LSPR within the Ag nanotriangle and the planar waveguide mode is currently in progress

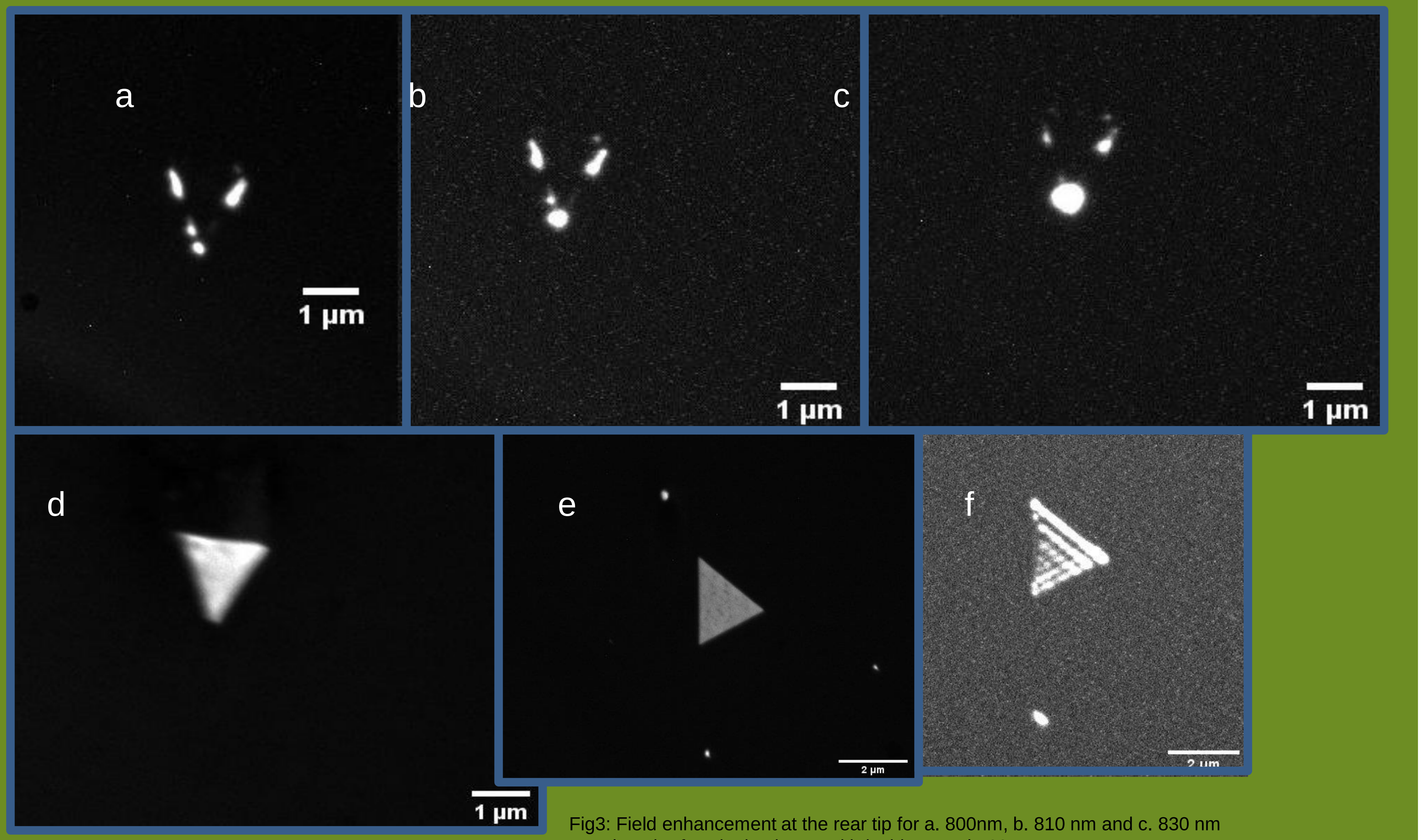

Fig3: Field enhancement at the rear tip for a. 800nm, b. 810 nm and c. 830 nm wavelength of excitation beam with incident angle 60°.
d,e. Ag nanotriangles at 244 nm incident laser beam
f. Interference between SPP and 800 nm TM polarized beam.

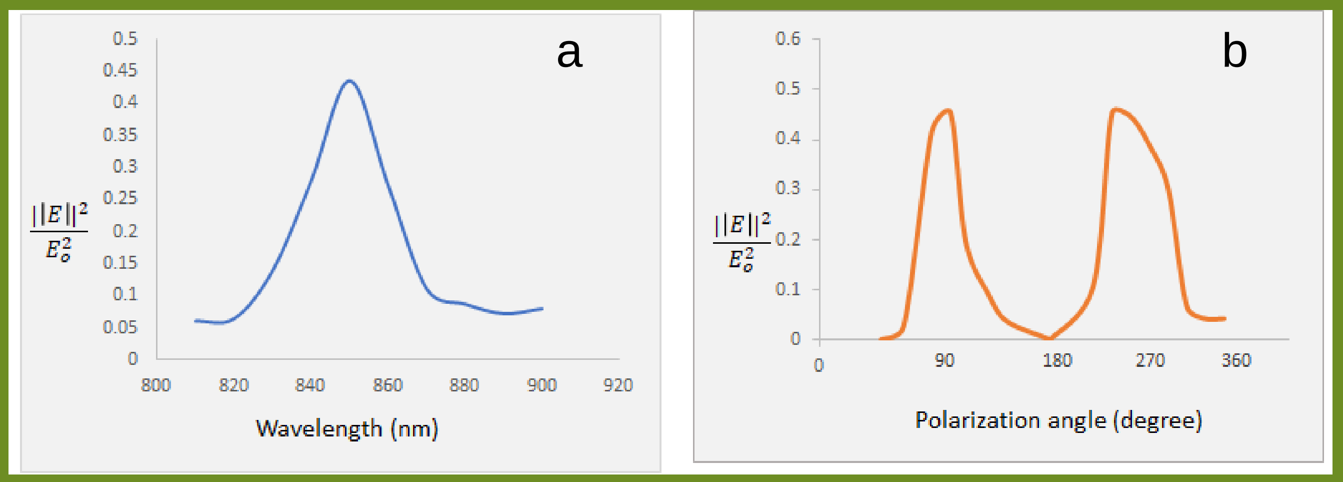

Fig 4:
a. Rear tip field enhancement Vs excitation wavelength at 60° angle of incidence.
b. Rear tip field enhancement Vs polarization angle for 845nm excitation wavelength.

Fano resonance

- A dielectric layer is placed between Ag and ITO waveguide as a coupling layer in the simulation model.
- By adjusting the refractive index, thickness of this layer the resonance condition for the plasmon mode and the waveguide mode will be calculated.

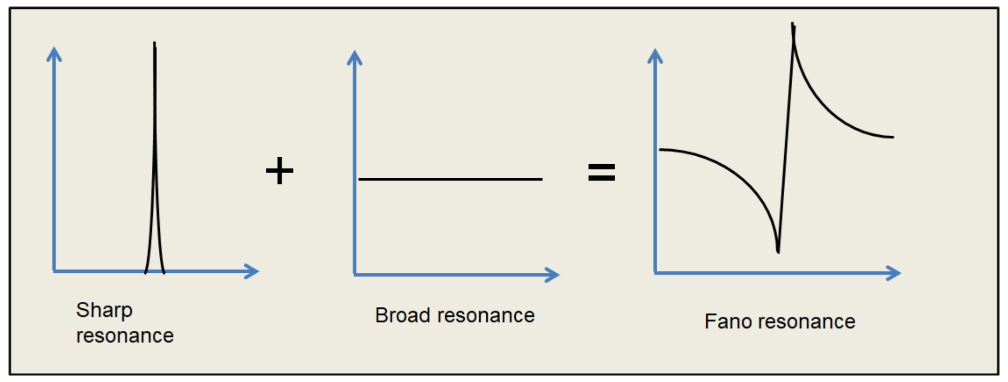

Fig 5: A sharp resonance for the waveguide mode coupled to a broad resonance of the plasmon mode can lead to Fano resonance.

References:

Liu, X., Li, L., Yang, Y., Yin, Y., & Gao, C. (2014). One-step growth of triangular silver nanoplates with predictable sizes on a large scale. *Nanoscale*, *6*(9), 4513.

Scheffler, C. M., Word, R. C., & Könenkamp, R. (2020). Controlling electric field and photoemission at the tips of triangular gold antennas. *Plasmonics*, *16*(2), 371–377.

Kasani, S., Curtin, K., & Wu, N. (2019). A review of 2D and 3D plasmonic nanostructure array patterns: Fabrication, Light Management and sensing applications. *Nanophotonics*, *8*(12), 2065–2089.

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