Generation of Enhanced LSPR Field in Periodically Varying Height Metal Nano-pillars

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Introduction

- Localized surface plasmon resonance (LSPR) is a well known light-matter interaction phenomenon where an incident light beam on a metal nanoparticle produces collective and coherent oscillations of the charged particle of the metal.
- LSPR field study is important for different fields of applications including chemical and biological sensors in particular, surface-enhanced Raman scattering (SERS) based sensing investigations.
- LSPR field coupling conditions dependence on nanoparticles' shape, size and surrounding medium is discussed here.

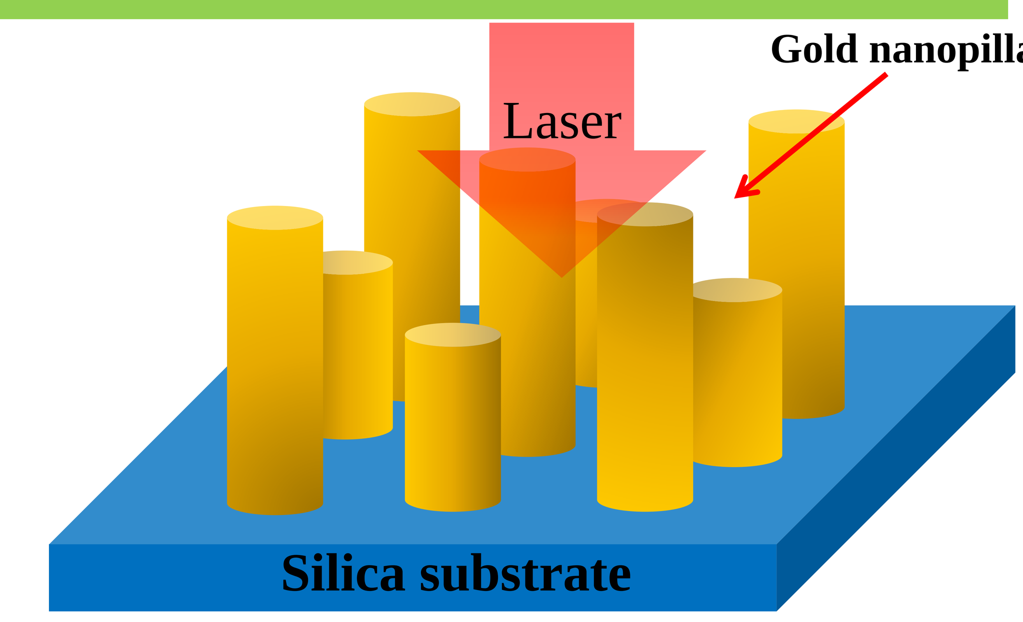

Figure 1. Schematic diagram of the proposed structure

Computational Analysis

In order to investigate the characteristics of the designed structure, finite element method (FEM) modeling using a commercially available software package COMSOL Multiphysics (wave optic module) was utilized to map the LSPR field distribution around the pillars. The result of the 3D simulation of the electric field distribution between two adjacent metal nanopillar for uniform height metal nanopillar and periodically varying height metal nanopillar within the array is shown in figure 2(a & b).

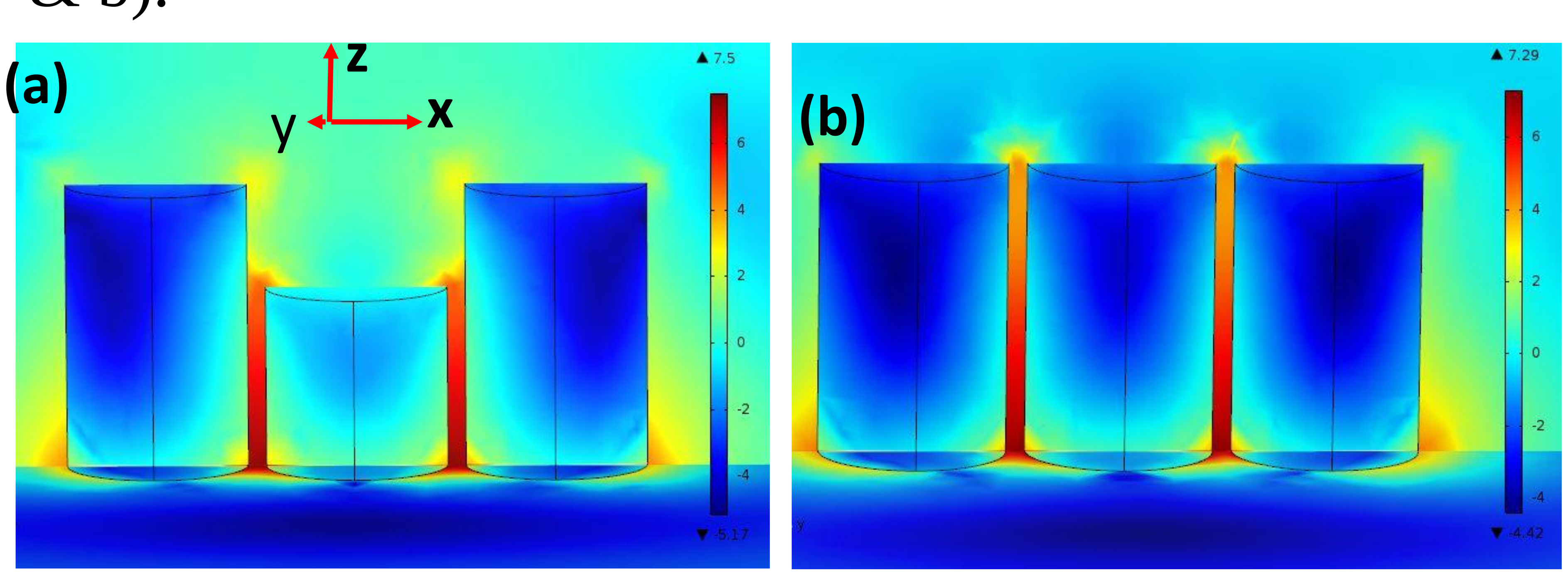

Figure 2. 3D FEM simulation of the LSPR field distribution around metal nanoillars

To approximate the conditions in our measurement apparatus, the metal nanopillar arrays in the simulation were excited with a normally (propagating in the −z direction) incident plane polarized (along x direction) wave at λ = 785 nm. The simulation was approximate considering gold nanopillars(AuNP). Only three AuNPs were modelled with symmetric boundary conditions on the sidewalls of the simulation boundary, in order to reduce the computational load.

Results

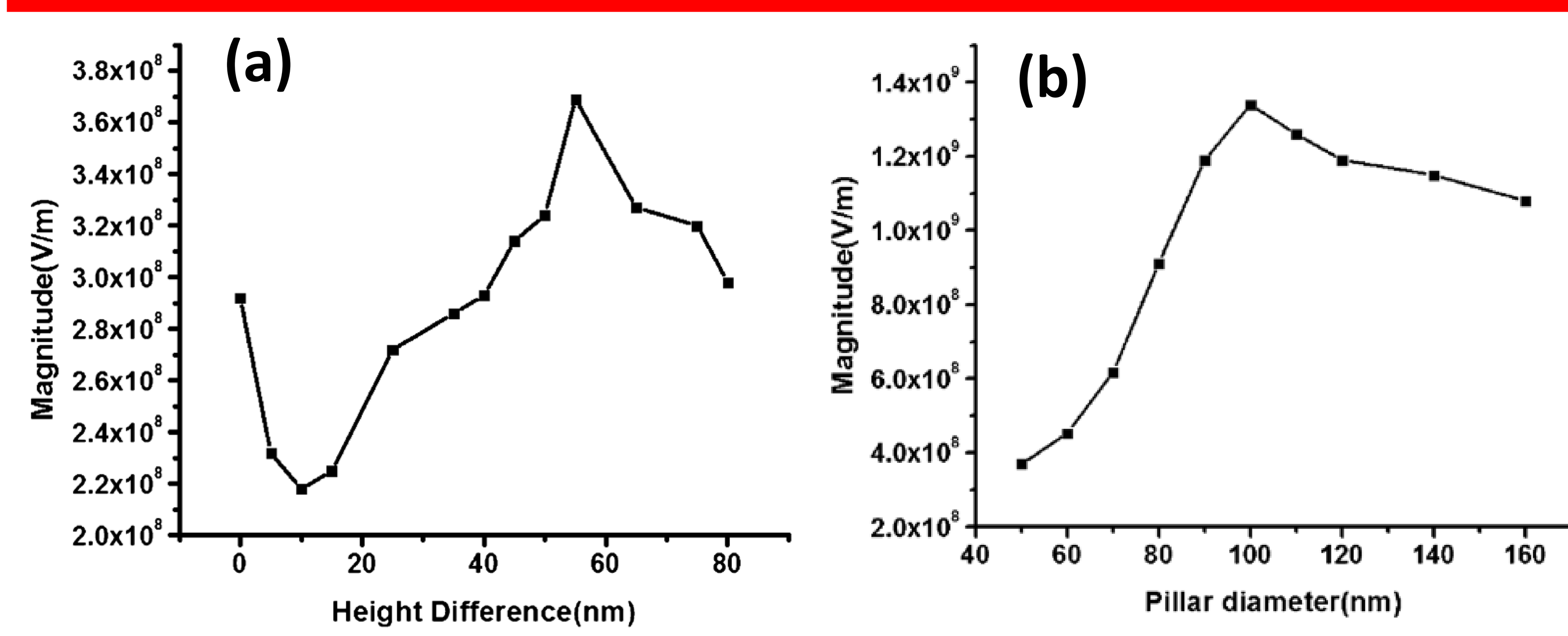

Figure 3. Generated LSPR field magnitude for different (a) pillar height difference (b) pillar diameter

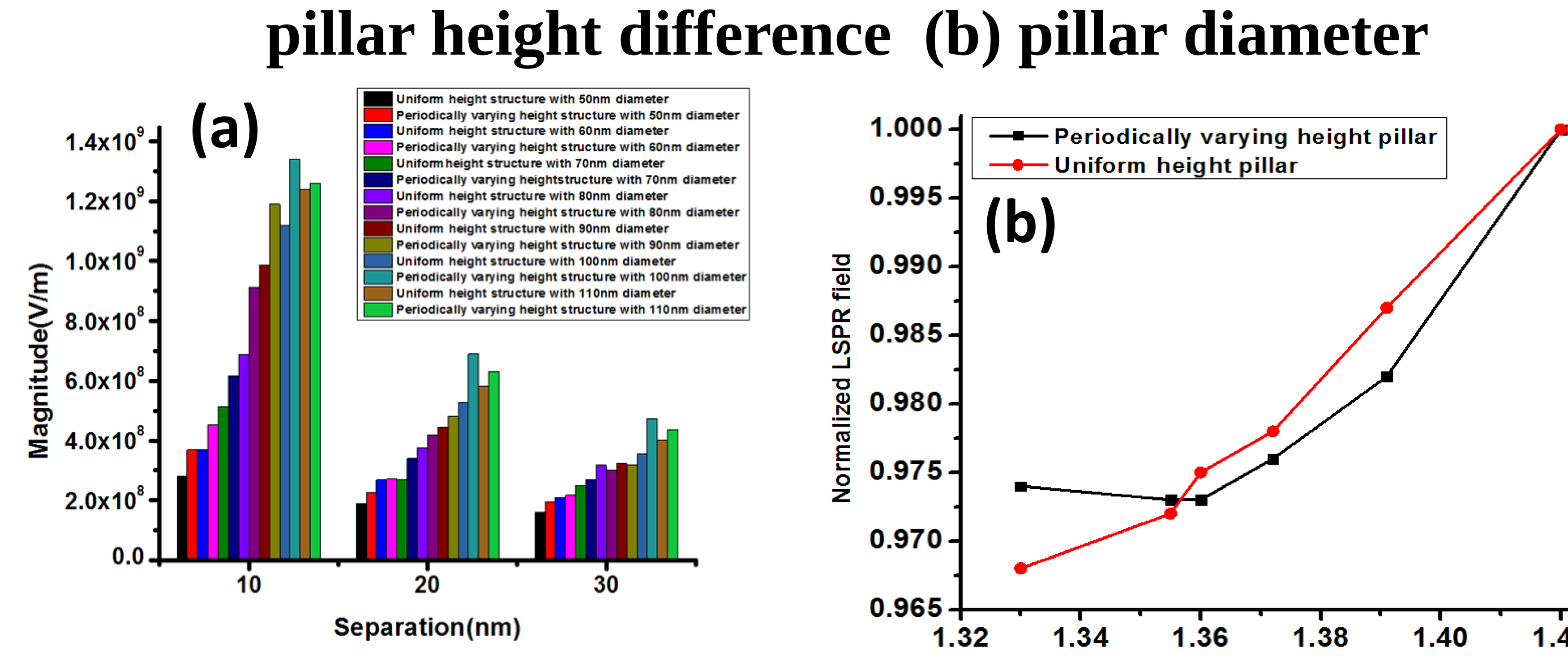

Figure 4. Comparison of (a) LSPR field condition and (b) refractive index of surrounding medium, between uniform and periodically varying height metal nanopillar

Conclusions

- Periodically varying height metal nanopillar provides enhanced LSPR field conditions than uniformly structured metal nanopillar.
- The refractive index sensing for periodically varying height metal nanopillar was found to be irregular while for an uniformed patterned metal nanopillar yields better refractive index sensing response.

References

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