The study of plasmonic elliptical dimer nanoantennas with different geometry

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Abstract: - In this paper, the electrical property of a geometric optimization with elliptical shape dimer nanoantennas has been studied. Numerical calculations are based on the method of finite-difference time-domain (FDTD). Three types of elliptical shape dimer nanoantennas with different geometrical parameters were considered, namely, horizontal dimer, parallel dimer, and parallel-horizontal dimer. We have found that plasmonic nanoantennas with the horizontal dimer embedded into a 1D double-arm grating system provide strong electric field enhancement as compared with the others.

I. INTRODUCTION

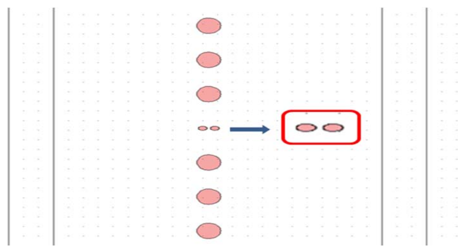
Recently, nanoantennas that couple optical waves into localized surface plasmons show their property for fluorescence enhancement [1-5]. These nanoantennas, including dipole antennas and bow-tie antennas can focus the incident light enegy and then realize a localized and enhanced field in a narrow gap. The strong field enhancement of dipole antennas has readily been shown by white light continuum generation [6]. The aim of this paper is to provide such a detailed analysis.

In this study, we discuss the property of the elliptical shape dimer nanoantennas with different geometry. And we will simulate their internal electric field enhancement at the different geometries of the elliptical shape dimer. And we compare these simulation results of three type geometries to find the optimum electrical field enhancement of the elliptical shape dimer nanoantenna. The proposed plasmonic structure would be a potential key component in the applications of optical nanosensors.

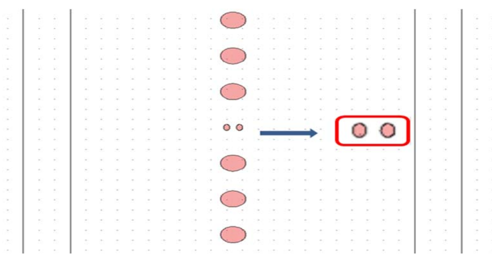
II. Simulation and Result

A plasmonic nanoantenna embedded into a 1D double-arm grating system the structure of the elliptical shape dimer nanoantenna with different geometrical parameters: (a) horizontal dimer, (b) parallel dimer, and (c) parallel-horizontal dimer is shown in Fig. 1. The electrical properties and operation were verified by FDTD numerical simulation. In order to obtain the design rule for achieving optimal electric field intensity enhancement at a chosen frequency, we investigated the effect of the number of the grating period N on the focal point intensity first. As shown in Figs. 2 (a)-(c), by increasing the number of grating periods, the electric field intensity with different geometry dimers can be enhanced as a function of the wavelength for different number of grating periods. We find that the maximum electric field intensity enhancement when N=11 in horizontal dimer antenna, and N=5 in parallel dimer antenna, and N=4 in parallel-horizontal dimer antenna, respectively. The optimization number of grating periods compare for different geometry dimer nanoantenna is shown in Fig. 3.

The numerical results show that the electric field intensity enhancement of the horizontal dimer nanoantenna is better than the others. So, we will use this geometry structure to design the plasmonic nanoantenna in the applications of optical nanosensors.



(a) With horizontal dimer



(b) With parallel dimer

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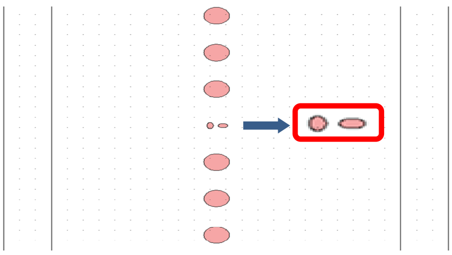
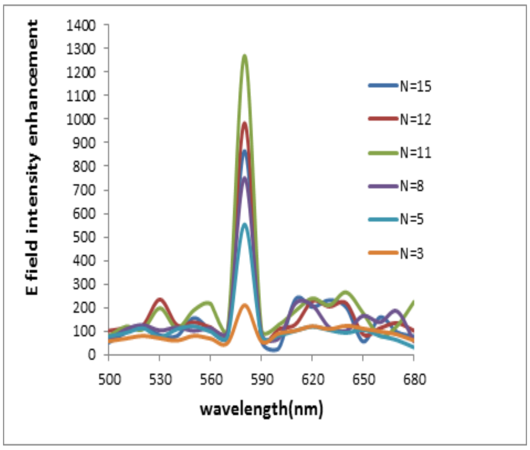
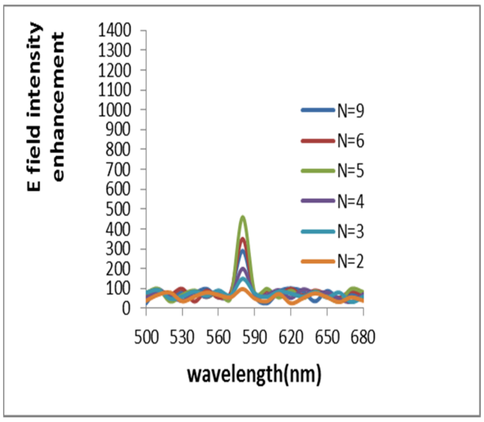


(c) With parallel-horizontal dimer

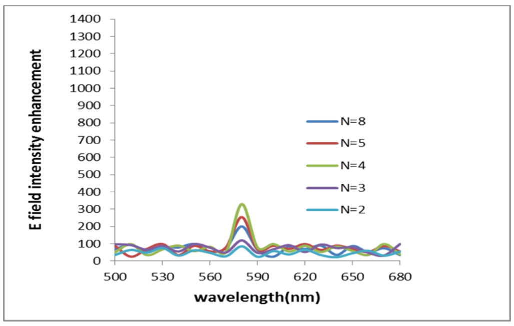
Fig. 1 The structure of dimer nanoantenna with different geometries (a) horizontal dimer, (b) parallel dimer, (c) parallel-horizontal dimer.



(a)With horizontal dimer



(b)With parallel dimer



(c)With parallel-horizontal dimer

Fig. 2 The electric field intensity enhancement with different geometry dimer as a function of the wavelength for different grating number N

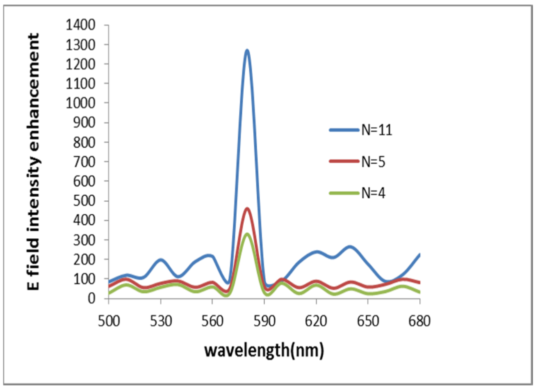


Fig. 3 Optimization number of grating periods compare for different geometry dimer nanoantenna

III. Conclution

In this study, we discuss the property of the elliptical shape dimer nanoantennas with different geometry base on the method of FDTD. And we simulate their internal field enhancement at the different geometries (horizontal dimer, parallel dimer, and parallel-horizontal dimer) of the elliptical shape dimer. And we compare these simulation results of three type geometries, we can find optimum electrical field enhancement of the elliptical shape dimer antenna with horizontal dimer. The proposed plasmonic structure would be a potential key component in the applications of optical nanosensors.

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