Hexagonal three-dimensional plasmonic nanoantenna arrays

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Abstract-Nanoantenna metamaterial can be used for many important applications in photonics and optoelectronics. However, most of previous nanoantenna structures are simple wires or rods due to the limitation of nanofabrication. In this work, a series of hexagonal three dimensional gold nanoantenna arrays were fabricated. The optical responses of such nanoantenna arrays were systematic studied by varying the incidence polarization, geometry parameters of nanoantenna structure and dielectric-loads. It would improve the manipulation ability of nanoantenna metamaterials with more freedom and flexibility.

The interaction of light with designed metallic nanostructures provides an opportunity to manipulate light for novel applications in photonics and optoelectronics. Due to the unique optical resonances in such metallic nanostructures, the so-called metamaterials have become a topical focus of intense current interest. Nanoantenna arrays with simple one-dimensional metallic structures such as nanorods or nanowires can function as a metamaterial with tunable optical properties by dielectric load [1, 2]. Such nanoantenna metamaterial can be used for many applications such as surface enhanced Raman scattering, sensing, imaging and optical nonlinearity enhancement. However, in previous studies, most nanoantenna structures still are simple arrays of wires, rods or dots because of limitation in nanofabrication. Due to the essential geometry-dependence of its optical resonances, the study on three dimensional nanoantenna structures becomes extremely urgent and important.

In this work, a series of three dimensional gold nanoantenna arrays were fabricated. The unit cell of hexagonal array was consisted of crossing nanowires and standing nanorods, as shown in Fig. 1. By using a negative electron resist hydrogen silsesquioxane (HSQ) and gray-tone e-beam lithography, the three dimensional structure was realized in HSQ resist, and then was transferred onto a gold film by an inductively coupled plasma reactive ion etcher. Fig. 2. shows the SEM pictures of the gold three dimensional nanoantenna array, the linewidth of the unit structure is 40 nm. The optical responses of such nanoantenna arrays were systematic studied by varying the incidence polarization, geometry parameters of nanoantenna structure and dielectric-loads. This study would improve the manipulation ability of nanoantenna metamaterials with more freedom and flexibility.

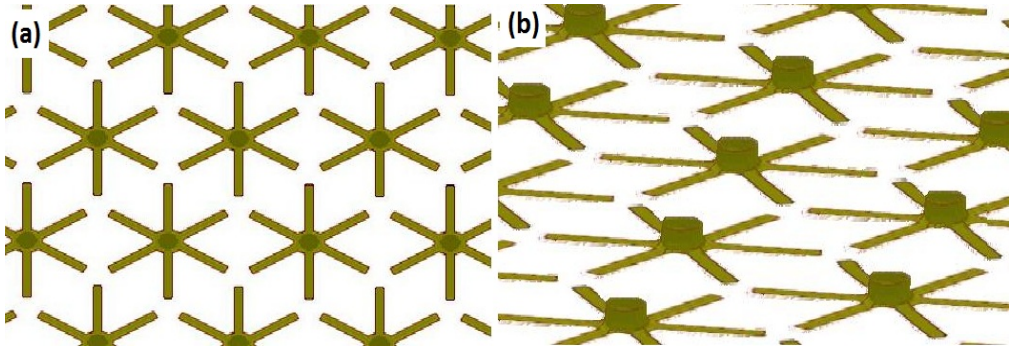

Figure 1 Schematic of the 3D nanoantenna arrays: (a) top view and (b) side view

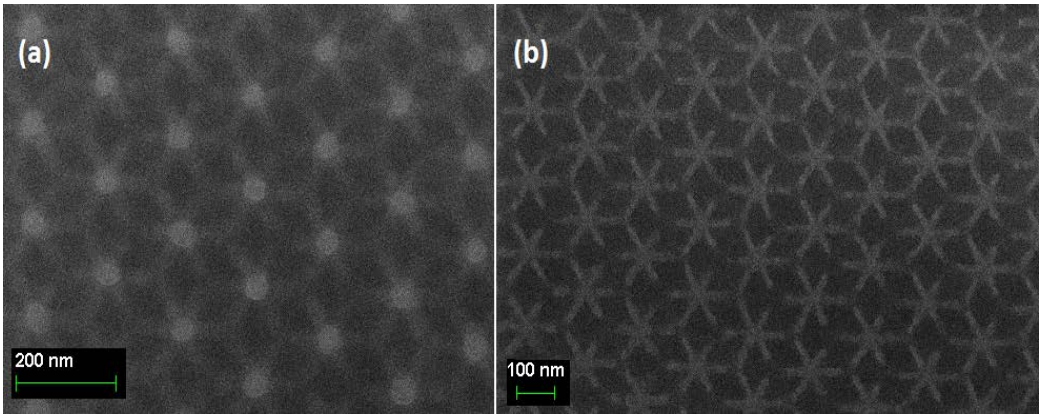

Figure 2 SEM pictures of the top view of 3D nanoantenna arrays:
(a) focused on the top; (b) focused on the bottom

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