A numerical study about optical trapping properties of nanoparticle on composite metallic film

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In recent years, optical trapping and manipulation of particles have been widely used in different areas of science particularly in researching the optical trapping properties of surface plasmon polaritons due to the advantages of being high precision and sensitivity [1], since the pioneering work of Ashkin *et al.* on trapping a dielectric microsphere using a single focused laser beam. Nowadays it has been applied to manipulate nanoparticle near the composite metallic film with periodic structure.

Based on the three-dimensional dispersive finite difference time domain method and Maxwell stress tensor equation, the optical trapping properties of nanoparticle placed on the composite metallic film are investigated numerically. Surface plasmon polaritons are excited on the metal-dielectric interface with particular emphasis on the crucial role in tailoring the optical force acting on a nearby nanoparticle. In order to obtain the detailed trapping properties of nanoparticle, selected calculations on the effects of beam waist radius, sizes of nanoparticle and circular holes, distance between incident Gaussian beam and composite metallic film, material of nanoparticle and polarization angles of incident wave are analyzed in detail to demonstrate that the optical trapping force can be interpreted as a virtual spring which has a restoring force to perform positive and negative forces as nanoparticle moving closer to or away from the centers of periodic structure. The results could provide guidelines for further research on the optical system design and manipulation of arbitrary composite nanoparticles.

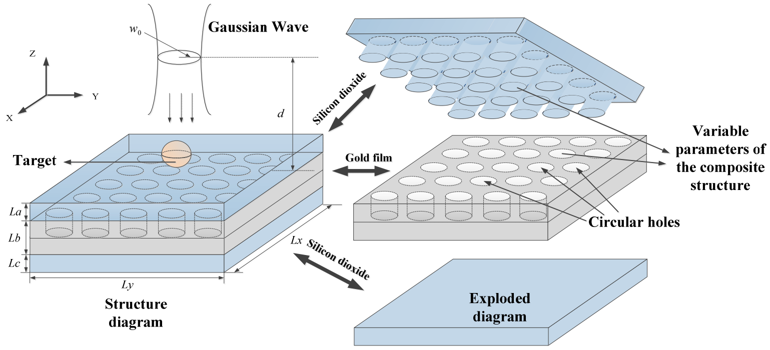

Fig. 1. Schematic of the target placed on the composite metallic film with periodic structure.

In this paper, the effects of various parameters on the composite model are investigated in detail to obtain the analytical results. Figure 1 shows the main schematic of the research. The meaning of the parameters will be discussed in our future work.

Reference

[1] Ashkin, A., J. M. Dziedzic, J. E. Bjorkholm, and S. Chu, 1986: *Opt. Lett.* **11**, 288.