Nonreciprocal Scattering of Si nanoparticles with gold films

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Abstract: The nonreciprocal scattering of silicon nanoparticle on gold film is studied. The scattering cross section is simulated. When light oblique incidents from the air, it shows different spectra due to the different polarization of light. When light incidents from the gold film, the spectrum change less with the different polarization of light. In addition, a new peak appears because of the interference of the electric dipole and magnetic dipole.

1. Introduction

Silicon nanoparticles have gathered attentions to enhance the scattering by placed on the metal film because they have larger scattering and less absorption than metal nanoparticles. Also, electric dipole (ED) and magnetic dipole (MD) can be induced due to high refractive index (HRI) property. In this work, we further studied the nonreciprocal scattering when light incidents with different polarization from contrary direction.

2. Simulation

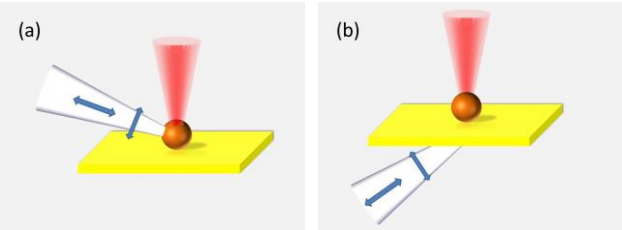

Fig. 1 Schematics show Si nanoparticle on the gold film and light incidents from (a) the air and (b) the substrate.

COMSOL is used to simulate the scattering cross section. Light incidents at 53 degree from the air. The diameter of the silicon nanoparticle is 185 nm and the thickness of the gold film is 70 nm. FDTD (Lumerical) is also used to simulate the case which light incidents at 34 degree from the substrate. The diameter of the silicon nanoparticle is 190 nm with the same thickness of gold film. The substrate is glass which refractive index is 1.52.

3. Conclusion

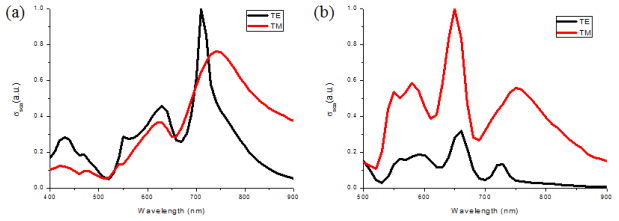

Fig. 2 (a) Light incidents with different polarizations from the air with a silicon nanoparticle (r = 92.5 nm) on gold film (d = 70 nm) at 53 degree. (b) From the substrate with silicon nanoparticle (r = 95 nm) on gold film (d = 70 nm) at 34 degree.

In figure 2(a), when light incidents with s polarization at 53 degree from the air, the MD mode which is perpendicular to the gold film will be induced. Due to the coupling, a sharp peak resonance is induced (black line). However, with p polarization, the ED mode which is perpendicular to the gold film will be induced and cause a broad peak (red line). In figure 2(b), light incidents at 34 degree from the substrate, and a sharp peak will appear which does not appear in figure 2(a) no matter what polarization is. The reason is the mirror effect of ED which will induce a circular electric field like MD. This new MD and the original MD will cause the constructive interference in the forward direction. This result can be explained by Kerker effect.

4. References

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