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POSTER #30

LIGHT SCATTERING BY METAL PARTICLE EMBEDDED IN DIELECTRIC

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A metallic particle embedded in the dielectric substrate leads to frustration of the total internal reflection at the plane between the dielectric and free space. We study the scattering by a gold cylinder in order to develop the optical diagnostics methods for microstructures. The scattering of wave running by the angle of total reflection is calculated by the modified boundary elements method. We have found the magnetic and electric fields and scattering diagrams in near and far field.

The scattering of evanescent wave by particles is an important elementary process of near-field optics [1], in particular, in near-field scanning optical microscopy (NSOM) [2]. The potential source of artifacts in NSOM is the distortion of near field by the probe. In order to describe the nonlinear effect we have built up the simplest 2-dimensional model of NSOM with elongated elliptic probe taking into account the interference of waves scattered by the object on the glass substrate and the probe [3]. The metal object is illuminated by an evanescent wave. As distinct from a running wave, the evanescent wave is not a limited solution of Maxwell equations in the whole space. That is why its scattering should be considered together with its source, in our problem the dielectric half-space with incident and reflected waves.

Other interesting case of metallic particle embedded in dielectric has a number of specific technical applications, for instance, the tomographic reconstruction of hidden object [4]. A cylinder parallel to the dielectric surface object is illuminated by the incident wave near the angle close to total internal reflection (TIR). TIR is frustrated by the scattering and strongly depends on the object parameters. The goal is to study the near-field and angular diagram of scattering. For calculation we exploit the modified boundary elements method [5,6]. The main modification is the special Green function taking into account both the free and dielectric half-spaces exactly [7].

We choose p-wave, where the magnetic field has a component along the axis. The calculations are performed for gold cylinder with diameter 100-300 nm at 50-150 nm from the interface between glass (dielectric permittivity 2.25) and free space. The incidence angle θ is close to TIR angle 41.81^0 at the wavelength $\lambda = 1.512$ μm. Figure 1 shows the square of tangential electric (a) and magnetic (b) fields at the plane. Its diameter is 200, the depth (from plane to the axis) is 150 nm. Maximal contrast of the magnetic field is close to TIR angle. A clearly defined peak in the coordinate dependence appears over the object. We see also the oscillations at $x < 0$ due to the interference of incident and reflected waves. A similar effect has been observed in [3] where the wire was in free space. Order of the curves in (b) is reversed compared to (a). The peak of the magnetic field occurs at $\theta = 42°$ close to TIR (red line). At the same time the electric field at this angle gets its minimum. The reason is electric field having its minimum at TIR angle, where the unperturbed magnetic field reaches its maximum according to Fresnel formulas.

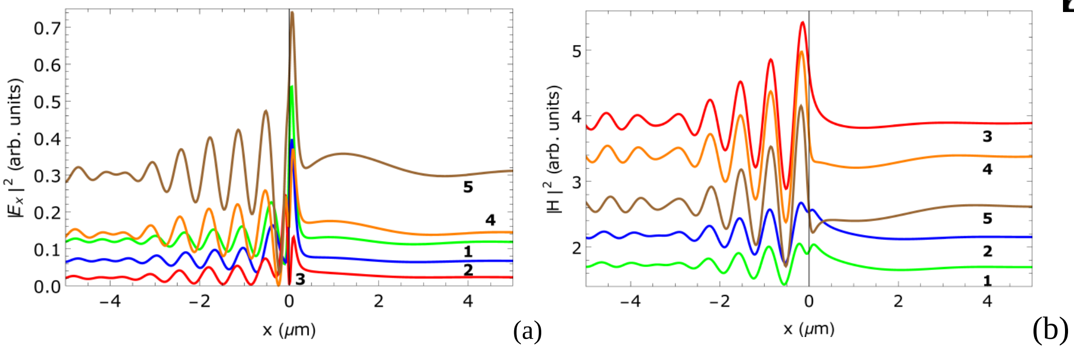

Figure 1: Square of tangential electric field (a) and magnetic field (b) at the surface of dielectric as a function of coordinate at different incidence angles: θ =40° (curve 1), 41° (2), 42° (3), 43° (4), 45° (5).

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