Optical Near-field Study of Dielectric Nanostructures

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The photon scanning tunneling microscope is based on the frustration of a total internal reflection beam by the end of an optical fiber. This microscope has been used to obtain topographic information generally on smooth samples. We study the influence on image formation of several parameters in scanning near-field microscopy. The numerical calculations have been carried out using the differential method. We consider the case of three-dimensional system including a translational symmetry in one direction. Various oscillations patterns are observed from both sides of the nanostructure, which we interpret as interference between the diffracted waves scattered by the nanostructure (with the components of the wave vector parallel to the surface) and the evanescent incident wave above the surface. The period of oscillations depends on several parameters. The numerically obtained period corresponds well to the expected theoretical value. Using an optical near-field analysis and by calculating the electric field intensity distribution, we investigate the probe-sample distance effect. It is found that the distribution of the intensity related to the electric field is depending on sample-probe distance. We noticed the loss of details in the image and the presence of strong oscillations. Also, both of the polarization state of the illuminating light effect and the angle of incidence are investigated. We show how the depth of penetration has an effect on the field intensity distribution. After that we pay more attention to the depth of penetration. The analytical values of the penetration depth of the incident electromagnetic field of the system are in good agreement with the numerical values obtained with a differential method. We conclude that a differential method provides physical insight into the main features of the different images.