HIGH RESOLUTION APERTURELESS NEAR-FIELD OPTICAL IMAGING USING GOLD NANOSPHERE PROBES

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ABSTRACT

An apertureless near-field scanning optical microscope (ANSOM) that utilizes the enhanced field around a gold nanosphere, which is attached to the end of an atomic force microscope (AFM) tip, is used to image the local dielectric constant of the patterned metallic surfaces and local electric field around plasmonic nanosphere samples. A colloidal gold nanosphere (~50 nm diameter) is linked to the extremity of the conventional etched-silicon probe. The scattering of laser radiation (633 nm or 532 nm) is modulated by the oscillating nanosphere-functionalized silicon-tip, and the scattered radiation is detected. The approach curve (scattering intensity as a function of tip-sample distance), the polarization dependence (scattering intensity as a function of excitation polarization direction), and ANSOM image contrast confirm that the spherical nanosphere attached to the silicon tip acts as a point dipole that interacts with the sample surface via a dipole - dipole coupling, in which the dipole created by the field at the tip interacts with its own image dipole in the sample. The image obtained with the nano-particle functionalized tip provides a dielectric map of the sample surface with a spatial resolution better than 80 nm. In addition, we show that the functionalized tip is capable of imaging the local electric field distribution above the plasmonic nanosphere samples. Overall, the result shows that high-resolution ANSOM is possible without the aid of the lightning-rod effect. With an improved tip-fabrication method, we believe that the method can provide a versatile high-resolution chemical imaging that is not available from usual forms of ANSOM.