Near-Field mapping of metal nanostructures via laser ablation

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General introduction

Near-Field optics has attracted great attention during the past decades due to its prospect for spatially resolving optical fields at length scales far below the diffraction limit. As a result, many theoretical and experimental efforts have been devoted to the study of the optical near-fields of nanostructures. The approach shown here is a novel method for relatively straightforwardly resolving and quantifying confined optical near fields.

Research results

We have shown optically induced topographic modifications of polymer layers on gold nanostructures. Our idea of mapping the optical near-field of metallic nanostructures takes advantage of the transparent properties of poly (methyl methacrylate) (PMMA). The technique for near-field mapping has three separate steps. Carefully designed nanostructures with predicted plasmon resonances in the visible spectral range are first fabricated by electron-beam lithography, typically via the lift-off method. The second step is deposition of the polymer PMMA via spin-coating and baking at high temperatures to harden the polymer layer. The third step consists of illuminating the sample using a Laser Scanning Microscope (LSM), where a pulsed fs laser is used as the illumination source. The laser intensity was set below the ablation threshold of PMMA on unstructured gold so PMMA is ablated only with additional field enhancement from the nanostructures. Following the illumination process, the sample was covered with 3 nm Au-Pd film and the “imaging” of the optically induced changes in topography was performed with a Scanning Electron Microscope (SEM). As a result, in Fig. 1 topographic images of optical near fields around gold nanostructures are presented showing the dipolar response of excited metal nanostructures and the lightning rod effect at high spatial resolution.
Upcoming research 2011

Quantitative measurements of field enhancements for different dimensions and shapes of gold nanostructures will be performed.

Papers


*Figure1.* SEM images of optically induced topographic modifications of polymer layers on gold nanostructures. a) Substrate before PMMA coating. b) 80 nm PMMA layer after irradiation. c) - d) 200 nm PMMA layer after irradiation with different light intensities. Ablation occurs at positions of high electromagnetic field strength: at the corners and between the Au nanostructures.