エクストリームフォトニクスセミナー

Extreme Photonics Seminar

No. 8

Language: Japanese

Date: October 28(Fri), 2011, 15:00 ～ 17:00

Location: Cooperation Center, 5F Meeting Room, W524
(研究交流棟5階会議室 W524)

Title: Nanostructuring of Solid Surfaces with Femtosecond- Laser-Induced Near-field

Speaker: Dr. Godai MIYAJI (Inst. of Advanced Energy, Kyoto Univ.)

During the last two decades, high-intensity femtosecond (fs) laser pulses have been demonstrated to be extremely effective for high energy density deposition onto solid surfaces and resulting precision processing of materials. In such light-matter interactions, the spatial resolution is usually limited to the order of the laser wavelength λ_0 by the diffraction limit of light. Despite this well-known limitation, my collaborators and I have reported that nanostructure with a period of $\lambda_0/10$ - $\lambda_0/4$, can be formed on hard thin films such as diamond-like carbon and TiN, and semiconductor materials such as silicon and gallium nitride in femtosecond laser ablation at low fluence, and that the shape and size can be controlled with the laser parameters - polarization, fluence, wavelength, and superimposed pulse number. Several researchers have studied the interaction process for the purposes of potential applications of fs lasers to nano-processing of materials, but the physical mechanism is not understood in detail. Based on the experimental results obtained, we have demonstrated that (1) the nanoscale ablation is preferentially initiated with a local electric field, or *near-field,* generated in the vicinity of surface roughness, (2) the formation of the periodicity can be attributed to the excitation of *surface plasmon polaritons* to induce the periodic enhancement of near-fields in the surface layer, and (3) the nanostructured surface can be shaped by means of changing the distribution of the near-fields on the surface.
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Title: Chemical applications of metallic nanostructures showing localized surface plasmon resonance

Speaker: Assoc. Prof. Kosei UENO (Res. Inst. Electr. Sci., Hokkaido Univ.)

Nanoparticles of noble metals such as gold or silver exhibit Characteristic bands of optical attenuation at visible and infrared wavelengths due to localized surface plasmon (LSP) resonances. The LSP bands are also associated with enhancement of electromagnetic field due to its localization. The locally enhanced near-field may also promote various nonlinear optical effects such as surface-enhanced Raman scattering, thus opening the possibility to employ metallic nanoparticles in ultra-sensitive chemical- and/or bio-sensors. However, the commonly used chemical synthesis methods produce nanoparticles of strongly varying size and orientation, while arrays of homogeneous nanoparticles are required to explore enhancement of electromagnetic field and elucidate photochemical properties in detail. We have fabricated monodisperse arrays of nano-engineered gold particles using a highly accurate lithographic technique with nanometric precision, and explored their functionalities as enhanced optical near-field as well as a photochemical reaction place. Here, we report on the chemical applications of metallic nanostructures showing localized surface plasmon resonance. As one of the applications, we will show homogeneous nano-patterning on photoresist films using the directional scattering components of light coupled with the radiation mode of plasmon resonance (higher-order plasmon resonance) as an exposure source. Secondly, we will introduce the first successful plasmonic photoelectric conversion from visible to near-infrared wavelengths using electrodes in which gold nanostructures are elaborately arrayed on the surface of titanium dioxide single-crystal electrodes.

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