Title of Project : UV Plasmonics

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Research Area : Engineering

Keyword : Optical measurement, Plasmonics

【Purpose and Background of the Research】

This project aims at investigating the science of plasmonics in the ultraviolet (UV) region. Plasmonics is an emerging science that describes the interactions between light and electrons in metal nanostructures. Plasmonics has attracted tremendous attentions because it provides a way of manipulating light within nanoscale, that is beyond the diffraction limit of light. Plasmonics has been so far applied to obtain optical images of nanomaterials such as carbon nanotubes (CNT) and DNA molecules with a resolution of several nanometers. Moreover, they are also applied in SPR sensors, super lenses and plasmonic metamaterials where negative refraction can be realized.

The heart of plasmonics is the ability to confine photons having large momenta (wavenumbers) onto the surface of metal nanostructures. However, metals behave simply as dielectrics (not metal) in UV. Hence, we cannot expect plasmonic effect in the UV wavelength region. Thus, the word plasmonics refers only to the science of light-metal interaction in visible spectrum.

UV becomes increasingly important in the field of bio-imaging and characterization of semiconductor devices. In this project, we explore the science of "UV plasmonics" and contribute to diverse area of science from biotechnology to device engineering and nano-material science.

【Research Methods】

1. Principle of UV plasmonics

We start the project with development of the principle of UV plasmonics. Metals have been a key component for the conventional plasmonics in visible, however, metal is no longer "metal" in UV. We develop the principle to obtain plasmonic effect in UV. We establish techniques to control plasmon resonance from near UV to deep UV wavelength region. We fabricate nanostructures based on the developed principle of UV plasmonics and characterize them to validate the principle.

2. Application of UV plasmonic nanoprobe to bio-imaging

We establish techniques to obtain optical images of biological samples with nanoscale resolution. Most biological molecules show electronic resonance in UV, which provides unique information that cannot be probed by visible. Combined with the feature of UV light with the plasmonic nanoprobe, local analysis and nanoscale imaging can be realized beyond the diffraction limit of light.

【Expected Research Achievements and Scientific Significance】

UV plasmonics is totally a new science that has never been explored previously in the world. The photon energy of UV light corresponds to the electronic resonance energy of materials, which makes the UV light useful for spectral analyses. This project combines the powerful UV technologies with nanophotonics. This becomes possible with the proposed "UV plasmonics". UV plasmonics has a great potential in establishing a new field of science and technology as well as to promote new industry.

【Publications Relevant to the Project】

1. S. Kawata, "Near-Field Optics and Surface Plasmon Polaritons," Springer (2001).
2. S. Kawata and V. M. Shalaev, "Tip Enhancement," Elsevier (2007).
3. A. Taguchi, N. Hayazawa, K. Furusawa, H. Ishitobi, S. Kawata, "Deep-UV tip-enhanced Raman scattering", J. Raman Spectrosc (in press).

【Term of Project】 FY2009-2013

【Budget Allocation】 150,700 Thousand Yen

【Homepage Address and Other Contact Information】
http://lasie.ap.eng.osaka-u.ac.jp/home.html