Control of Plasmon Active Au Nano Structures in an Atomic Scale

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Under the illumination of visible or near-infrared light, metal nano-dimer structures show the unique optical properties such as polarization anisotropy, or light concentration at the gap due to the excitation of localized surface plasmon resonance (LSPR). It is well known that these characteristics strongly depend on its shape and gap distance. When the gap distance is down to sub-nm, the intensity of the generated nearfield at the gap is extremely enhanced. In addition to this, in the case for the gap distance of less than 1 nm, the charge transfer plasmon (CTP) is generated because of the effect of the tunneling electrons.[1] From this background, it can be expected that the technique for the switching these plasmon properties would be applied for many various nano-photonic technologies, such as photovoltaic devices. In this study, we have attempted to establish novel approach for the control of the gap distance and/or the shape of Au nano-dimer structures in a single nanometer scales via tuning the electrochemical oxidation reaction. For the detail discussion about the optical property changes, *in-situ* electrochemical dark-field microscopic measurements were conducted.

Well-defined Au nano-dimer structures were fabricated on a conductive glass substrate by electron beam lithography method. Electrochemical dissolution of Au structures was performed under dark-field microscopy observation as shown in the Figure. The electrode potential was 0.91 V vs. Ag/AgCl for the dissolution of Au. SEM images which obtained before and after dissolved proved the formation of the controlled gap between Au nano-particles by the present method. In time series scattering spectra of Au nano-dimer, characteristic changes in the scattering spectra which are derived from the formation of the gap can be observed. It should be noteworthy that the rate for the optical property change is fully controlled by the applied electrode potential. Through all attempts, we can conclude that our method is quite useful for the control of the shape between Au nanoparticles in an atomic scale.

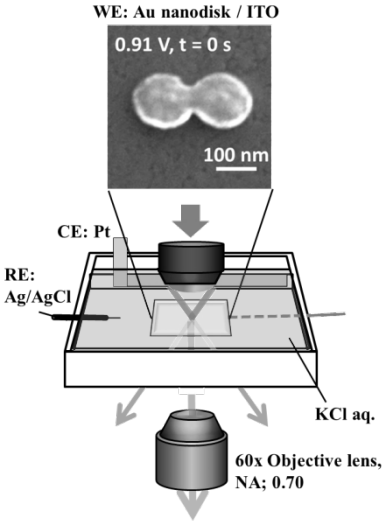

Figure. Schematic illustration of spectroscopic system under electrochemical potential control.

Reference

[1] K. J. Savage, M. M. Hawkeye, Others, Nature, 2012, 491, 574-577