Local photothermal conversion using metal semi-shell arrays

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【Introduction】 The high-efficient photothermal conversion on metal nanostructures by localized surface plasmon is attractive in these days. When incident light is absorbed by surface plasmons, hot carriers are generated and changed into heat due to the relaxation. For example, it has been experimentally confirmed that the local water temperature on gold nano particle arrays irradiated by laser exceeds 200°C just before micro bubble generation.[1] These heat generation phenomena are applied in various research fields such as photothermal therapy, solar thermal conversion, local chemical reaction, etc. Among these researches, with the mind of the catalytic effect on metal under general pressure and temperature, we fabricated various metal semi-shell arrays by colloidal self-assembly and investigated the generation of micro bubbles under laser light irradiation in water.

【Experimental】 SiO_2 2-dimensional colloidal crystals (2DCCs) with the particle diameter of 250 nm were fabricated by evaporation-driven self-assembly on quartz substrates. Gold was coated on the 2DCCs with the thickness of 8~77 nm, and metal semi-shell arrays were obtained. Water was dropped on the structure with the thickness of 0.15 μm covered with a cover slip. In-situ observation was carried out while irradiating laser with the wavelength of 785 nm, the spot diameter of 10 μm and the intensity of 75 $\mu W/\mu m^2$. Transmittance spectra were measured by an optical microscope with a vis-NIR spectrometer.

【Results and discussions】 The resonant wavelength of plasmon was red shifted as the film thickness increased. The growth rates of bubbles on the gold half shell arrays were 240 μm^3/sec, 6460 μm^3/sec for the film thickness of 8 nm and 40 nm, respectively, and no bubble was generated on the sample with film thickness of 77 nm. It was thought that the resonance wavelength of 8 nm thickness was closer to the laser irradiation wavelength and thus the light absorption was considered to be larger; however, the bubble generation rate became faster at 40 nm thickness. The 8-nm-thickness nanostructure might be broken under the light irradiation. The detail observation of nanostructures and other metal nanostructures will be discussed in the presentation.

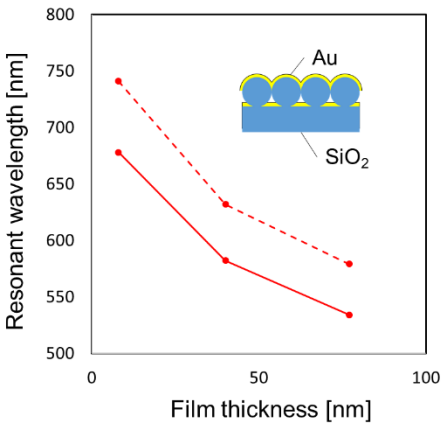

Fig. 1 Resonant wavelength of gold semi-shell array in air (solid line) and in water (dotted line).

[1] H. M. L. Robert, F. Kundrat, E. Bermúdez-Ureña, H. Rigneault, S. Monneret, R. Quidant, J. Polleux, and G. Baffou, ACS Omega **1**, 2 (2016).