

Study of Fabrication of Metal Structure through Two-photon Reduction of Metal Ion using Femtosecond Pulse Laser

Ryotaro Nakamura

Doctoral program of Material and Life Science
Graduate School of Science and Technology, Kyoto Institute of Technology

This thesis consists of seven chapters, and a fabrication of a structure using metal ions in a polymer matrix through two-photon excitation using by a femtosecond laser are described from Chapter 3 to Chapter 6. Poly(*N*-vinylpyrrolidone) (PVP) and a negative tone photoresist SU-8 as a matrix and a tetrachloride auric (iii) acid, a silver nitrate and a copper (ii) acetate as a ion source were used. At first, the sample including metal ion was prepared and then the femtosecond laser beam irradiated to the sample to fabricate the structure. After fabrication, the obtained structure was observed with an atomic force microscope (AFM) and a scanning electron microscope (SEM) and analyzed with an energy dispersive X-ray spectrometry (EDX), a micro X-ray diffractometer (μ -XRD) and an X-ray photoelectron spectroscopy (XPS).

In Chapter 3, the fabrication of the structure using the silver ion was investigated. After fabrication, the obtained structure was directly observed and analyzed with AFM, EDX and XPS. The XPS results indicate that the structure mainly consists of carbon element derived from PVP and the reduced silver atom interacts with the carbonyl group in PVP chain because of low concentration of the silver ion.

In Chapter 4, the fabrication of the structure using the high concentrated silver ion was investigated. The results of the elemental analysis indicates that the structure consists of the silver and the silver oxide which oxidized by the oxygen dissolved in the sample. Therefore, the fabrication from the degassed sample was investigated. The results suggest that the silver structure was successfully demonstrated.

In Chapter 5, the fabrication using the gold ion was investigated. After fabrication, the obtained structure was analyzed with EDX, μ -XRD and XPS. The results indicate that the structure consists of the triangle-shaped gold and small amount of the cross-linked SU-8. In addition, the results also indicate that the gold interacts with oxygen in SU-8.

In Chapter 6, the fabrication using the copper ion was investigated. The fabricated structure was observed and analyzed with AFM, EDX, μ -XRD and XPS. The results indicate that the structure consists of SU-8, photo-reduced copper and copper acetate.