Three-dimensional metallic micro/nanostructures fabricated by two-photon-induced reduction of metal ions

Abstract Text (~ 250 words)

We report on a technique that enables to fabricate three-dimensional (3D) metallic microstructures by means of two-photon-induced metal-ion reduction. A femtosecond near-infrared laser is focused by a high-NA objective lens into a metal-ion aqueous solution. Due to the nonlinear nature of the two-photon absorption (TPA) process, metal-ions are directly reduced only at the focused spot. By scanning the laser beam spot in three dimensions, we can directly obtain arbitrary 3D metallic structures. To fabricate silver and gold structures, we use a 0.2-M aqueous solution of silver nitrate ($AgNO_3$) and a 0.24-M aqueous solution of tetra chloroauric acid ($HAuCl_4$), respectively. We demonstrate the fabrication of a continuous and electrically conductive silver wire whose minimum width is 400 nm. Electrical measurement shows that the resistivity of the fabricated silver wire is 5.30×10^{-8} Ωm, which is only 3.3 times larger than that of bulk silver (1.62×10^{-8} Ωm). We also discuss the resolution of our technique in terms of ions diffusion based on the Fick's first law and the mobility of metal-ions in aqueous solution. Moreover, the realization of a self-standing 3D silver microstructure on the substrate is demonstrated. This method will become a promising technique for fabricating 3D plasmonic micro/nano structures with arbitrary shape.

Keywords (Maximum of 5 keywords)

Three-dimensional metallic structures, Two-photon absorption, Femtosecond pulsed laser, micro/nano plasmonic structures