Fabrication of Ordered Metal Nanostructures for Plasmonic Devices Using Anodic Porous Alumina

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Fabrication of functional devices based on the localized surface plasmon (LSP) in nanostructured metal structures has attracted increasing interest due to its capability for various application fields such as sensing or energy conversion [1]. Precise control of the sizes and shapes of the metal nanostructures is important because the properties of LSP devices are substantially dependent on the geometrical structure of the metals. Anodic porous alumina, which is formed by anodization of Al in acidic electrolyte, is a typical self-ordered material and is promising candidate for the starting structure of nanostructured metals [2,3]. Advantage of the use of anodic porous alumina for the preparation of is its controllability of the dimension of the metal nanostructures besides its easiness of the preparation. In the present report, fabrication of several types of ordered metal nanostructures with high aspect ratios for plasmonic devices using highly ordered anodic porous alumina are described. One example of nanostructured metals using anodic porous alumina is metal nanowires based on a high throughput process. The obtained metal nanowires show unique optical properties originated from the LSP, which was dependent on the geometrical structures. The metal nanohole arrays with high aspect features were also prepared with a two-step replication process using anodic porous alumina as a starting template[4]. The metal hole arrays act as a waveguide, in which the incident light can propagate on the basis of surface plasmon. Coaxial cable array structures were also prepared based on the ordered structures of anodic porous alumina. This structure was composed of a central metal wire and a surrounding metal wall with dielectric medium between metals. The obtained coaxial cable array structures could pass the incident light of wavelength longer than the cutoff wavelength in the hole array structures. The optical properties of the obtained metal nanostructure were analyzed by FDTD (finite-difference-time-domain) calculations.

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