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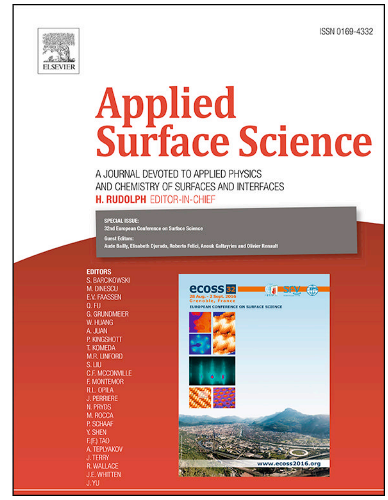

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Forming Sub-45-nm High-Aspect Circle-Symmetric Spots with Double Bowtie Aperture Combined with Metal-Insulator-Metal Structure

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Abstract: In this paper, high-aspect circle-symmetric spots can be obtained through a novel lithography structure, named as the double bowtie aperture combined with the metal/insulator/metal (Ag/Pr/Ag) structure (DBMIM). The double bowtie aperture, composing of four triangle-hollow areas and a square-hollow area, can concentrate light into deep-subwavelength volumes with the enhanced field. And Ag layers, respectively located onto and beneath photoresist layer, can enhance light transmission and compensate transmission loss. This advantage aforementioned contributes to prolong light transmission distance. With COMSOL simulation, we discuss the influences of the novel lithography structure parameters on the quality of spots, and the simulation results demonstrate that sub-45-nm (λ/8) spots are obtained under optimal values.

Keywords: high-aspect circle-symmetric spots; double bowtie aperture; metal/insulator/metal structure; deep-subwavelength

1. Introduction

Surface plasmon resonance (SPR), an electromagnetic mode formed by the interaction between free electrons inside metals and photons of incidence light, has aroused great interests of researchers because it can break the diffraction limit and concentrate electromagnetic fields into nanoscale zone [1, 2]. The development of lithography technology, such as sphere-lens-array lithography [3, 4], laser interference lithography [5, 6], and plasmonic nano lithography [7] et al, enables nanolithography structures down to sub-nanometer scale which promote the application of SPR in many research fields and enables nanolithography structures complex. The development of nanolithography structure, stimulating and manipulating SPR, contributes to accelerate the development of data storage [8], sensors [9] and nano-lithography technology [10]. Synge [11] first proposed to apply the sub-wavelength aperture to obtain high-resolution plasmonic spots. Subsequently, researchers begin to theoretically probe the properties of sub-wavelength apertures. These structures include circle, square or ridge shapes. However, results demonstrate that the transmission intensity is lower 1/10 than that of the incident field for circular or square apertures and the quality of spots, prepared by circular or square shapes, possesses poor contrast. To acquire high-resolution nanopatterns and improve the coupling efficiency, C-aperture, T-aperture, I-aperture and bowtie-aperture [12-15] have been proposed. Among these structures, bowtie aperture, with two metallic ridges, has greater advantage in enhancing electric field and has been applied in series of application. In 2006, Xu [16] first applied the bowtie aperture to the experiment and acquired sub-100-nm plasmonic spots. In 2012, J. Hahn [7, 17] reported that the