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Reflective Metasurface and Plasmonic Hologram Application

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1. Introduction

Holograms, the optical devices to reconstruct pre-designed images, have been advanced dramatically with the development of today's nanotechnology [1-2]. However, applications of hologram are still limited by the constituent materials, and their working range is rather narrow. In the past decade, plasmonic metamaterials [3] have attracted many attentions, which exhibit strong variations in their reflectance and/or transmittance spectra. Moreover, metasurfaces show the abilities to exhibit extraordinary light-manipulation abilities [4-5]. In this paper, we reported the high-efficiency and broadband meta-hologram consisted of plasmonic metamaterials, which functions for both coherent and incoherent light sources within a broad spectral range under a wide range of incidence angles [6].

2. Results and Discussion

We performed a high-efficiency broadband reflected metasurface and meta-hologram in 4-level phase by reflected metasurface made of subwavelength 6×6 gold cross nano-antennas of 16 different shapes which is designed and fabricated in optical frequencies. To characterize the performance of the fabricated meta-hologram, we use 780-nm diode laser as well as white light source to characterize the reconstructed images of proposed plasmonic meta-hologram. Figure 1(a) shows the schematic diagram of the functionalities of our designed meta-hologram under 45° linearly-polarized illumination. Figure 1(b) to 1(d) present three experimental reconstructed images of the meta-hologram under x-, 45°- and y-polarized incidence at wavelength λ = 780 nm, respectively. The projected patterns are selectively produced as "NTU" for x-polarization and "RCAS" for y-polarization incident light, and the intensities of two non-overlap patterns will be rise and fall according to the polarization, which is in excellent agreement with the design. For both x- and y-polarized incidence, the measured polarization contrasts are ~ 20 (the averaged intensity of "NTU" divided by the intensity of "RCAS" in the case of x-polarized illumination), confirmed the polarization-selective ability of our device. Furthermore, the reconstructed images of meta-hologram exhibit far more efficient (reaches 18% for 780 nm illumination).

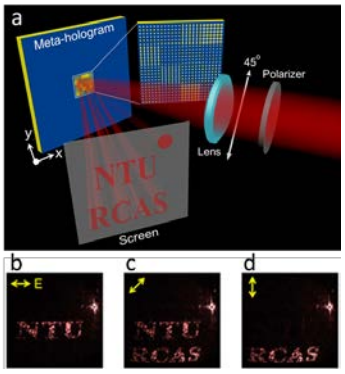

Figure 1. (a) The functionality of our designed meta-hologram under linearly-polarized illumination. Reconstructed images of meta-hologram for case of (b) x-polarized, (c) 45°-polarized, and (d) y-polarized incidence by a 780-nm laser.

3. Conclusions

We utilized the phase modulation at plasmonic resonance of gold cross-nanoantennas to record two polarization-controlled images on a meta-hologram. Our meta-hologram is reflective type with significantly higher efficiencies than what have been designed and achieved so far using metamaterials. The reflective hologram has a number of advantages such as simple fabrication process, low metal absorption, broad working spectral range, and greater tolerance to variation of incident angle and light incoherence. By combining with the techniques of tunable metasurfaces, meta-hologram can potentially be used to realize the active hologram that works at arbitrary electromagnetic wave region.

References

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