A versatile metasurface for meta-nanoprinting and bifocal metalens

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INTRODUCTION

Metasurfaces, ultrathin nanostructures composed of plasmonic or dielectric nanoantennas, have aroused the enormous attention owing to their unprecedented capability to manipulate the amplitude, phase, and polarization of electromagnetic waves. Recently, the versatile metasurfaces becomes a hot spot due to the unparalleled design freedoms of meta-atoms

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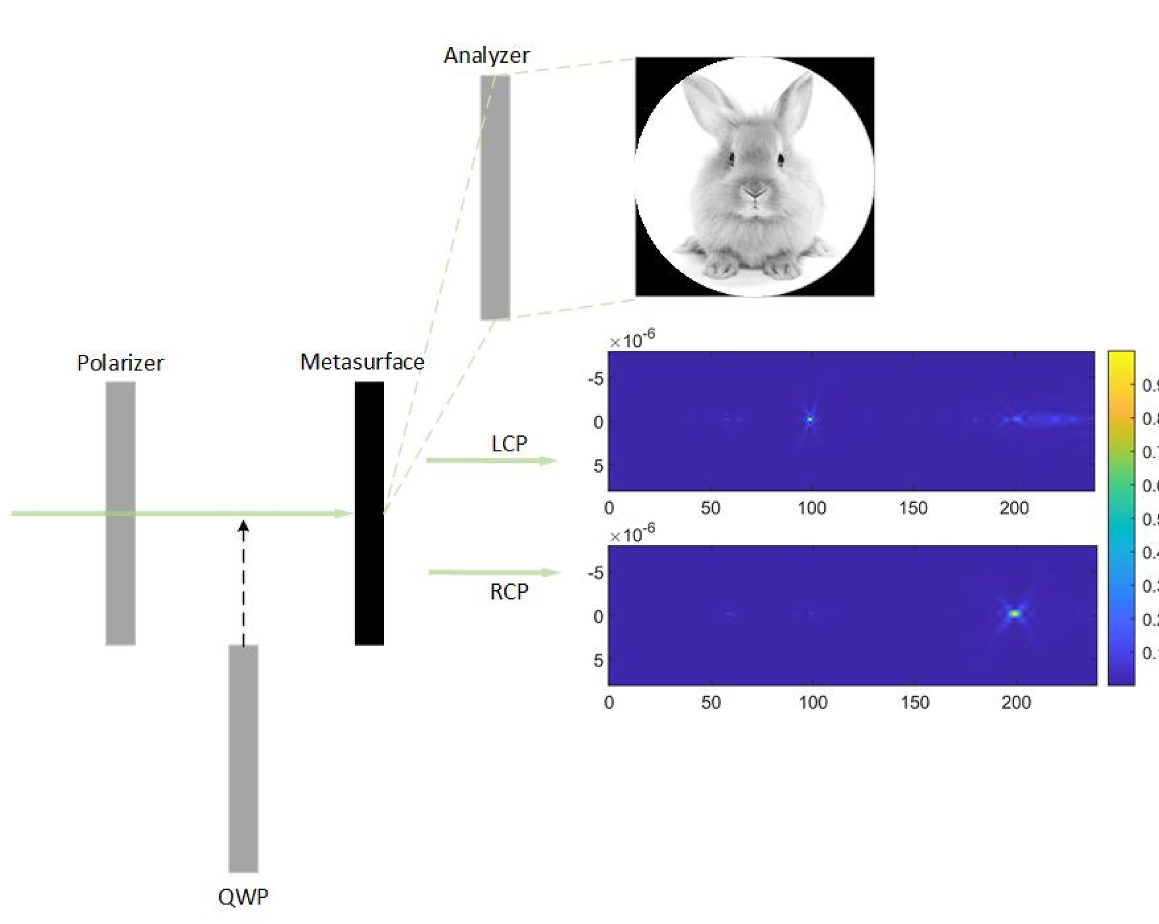

Figure 1. Schematic of the designed three-channel multifunctional metasurface

We propose a versatile metasurfaces which have functions of meta-nanoprinting and bifocal metalens designed by using geometric phase, propagation phase and Malus's law.

METHODS

Meta-nanoprinting

$$I = \left|\cos(2\alpha)\right|^2.$$

Set the polarizer and the analyzer to the corresponding angle, and rotate the nanorod regarded as the half-wave plate according to the above formula, a continuous gray-scale image can be obtained in the near field of metasurface.

Bifocal metalens

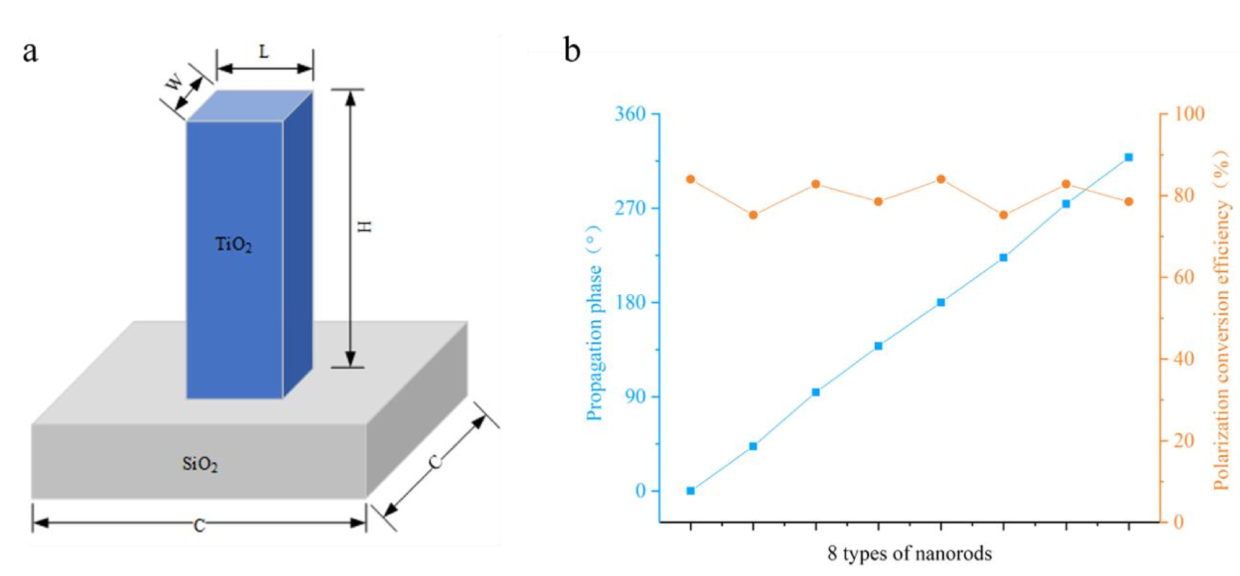

Figure 2. The design and selection of meta-atoms. a) Schematic of the meta-atom. b) The propagation phase and polarization conversion efficiency of the selected eight nanorods.

$$\varphi_{(1,2)}(x,y) = -\frac{2\pi}{\lambda}(\sqrt{(x^2+y^2+f_{(1,2)}^{\;2}} - f_{(1,2)}),$$

$$\chi = (\varphi_2 - \varphi_1)/2,$$

$$\psi = (\varphi_1 + \varphi_2)/2.$$

Geometric phase χ: four-step phase

propagation phase ψ: eight-step phase

RESULTS

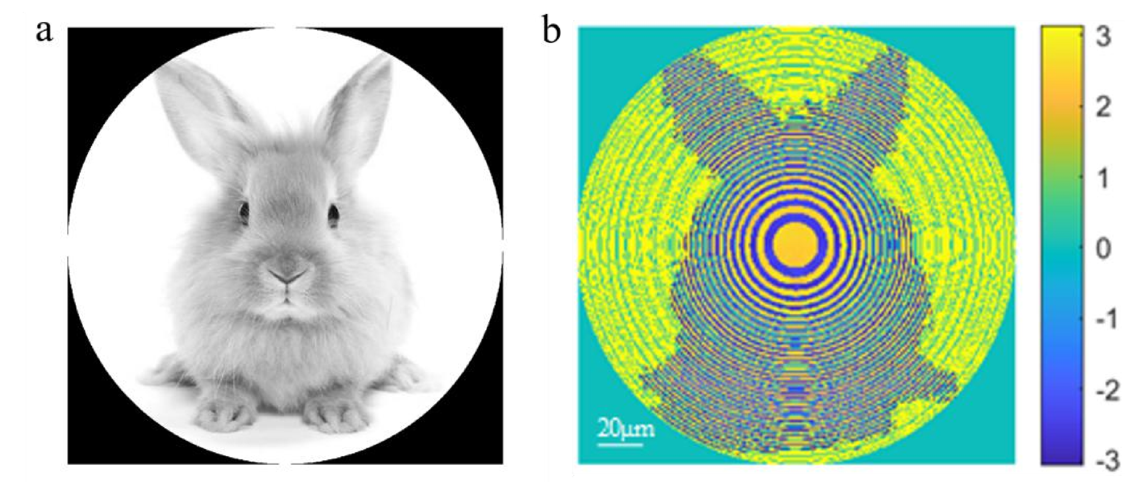

Figure 3. The image of near field and the phase profile of the designed metasurface. a) The simulation result of near-field grayscale image. b) Phase profile on metasurface.

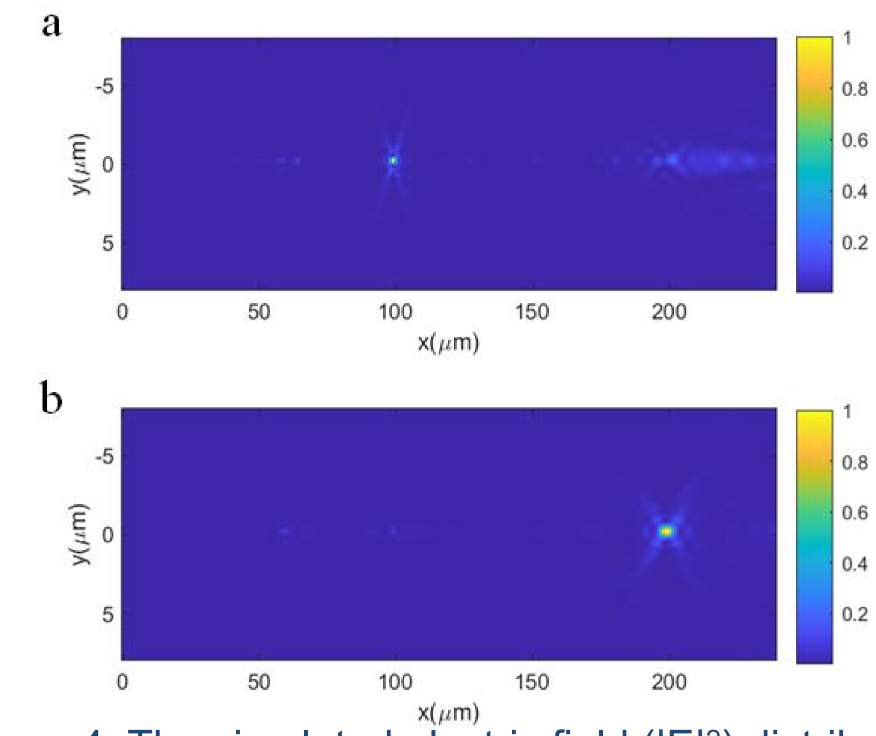

Figure 4. The simulated electric field ($|E|^2$) distributions in the x-z plane of the polarization-dependent bifocal metalens. a-b) The simulated electric field ($|E|^2$) distributions with LCP incident(a) and RCP incident(b).

According to the simulation results, the designed metasurface has a very ideal near field and an imperfect double focus spots.

CONCLUSIONS

An approach to design a versatile metasurface for meta-nanoprinting and bifocal metalens is proposed and numerically demonstrated. This original design expands the functional integration of metasurface and improves applications in image displays, optical storage, augmented reality, virtual reality, and many other related fields.

REFERENCES

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