DESIGN OF DUAL-BEAM STIMULATED EMISSION DEPLETION MICROSCOPIES BASED ON DIELECTRIC METALENS

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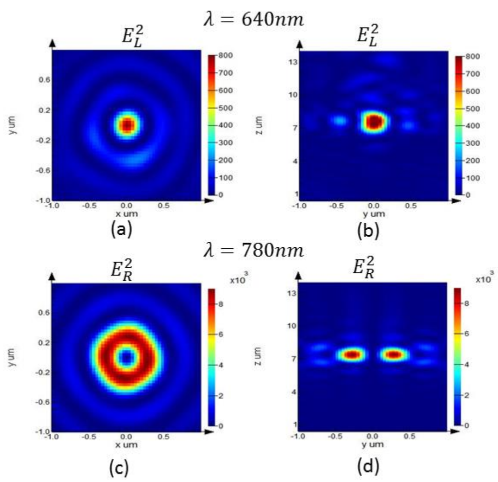
1. Introduction

A minimized and simplified optical setup for dual-beam super-resolution stimulated emission depletion microscopy (STED) is proposed. The whole bulky dual-beam optical paths are optimized and simplified to an optical configuration implemented by a customized metalens with photonic chip scale. Such metalens can generate a focused Gaussian beam and a donut beam overlapped perfectly in space, and can simultaneously collect fluorescence emitted from the sample. The specially designed metalens offers a chromatic aberration-free performance with adaptability to multiple dual-beam combinations. Our scheme has a great potential in constructing highly integrated, ultra-compact, mechanically stable, and user-friendly STED systems.

2. Simulation results



A right circularly polarized light beam at the wavelength of 640 nm and a left circularly polarized light at the wavelength of 780 nm impinge on the metalens at the same time. On the focal plane of the metalens, the normalized light intensity distributions are shown in Fig.1. We multiplex the Gaussian and vortex phase profile at these two wavelengths. The central points of the Gaussian beam at λ=640nm and the donut beam at λ=780nm overlap in 3D spatial domain. Our customized optical metalens offers a distinct performance of chromatic aberration-free design for STED optical path.

Fig. 1 Normalized light intensity distributions at the focal plane of the metalens for the left circularly polarized beam at the wavelength of 640nm in (a) the x-y cut plane and (b) the y-z cut plane, and for the right circularly polarized beam at the wavelength of 780nm in (c) the x-y cut plane and (d) the y-z cut plane.

[1] M. Khorasaninejad et al, "Metalenses at visible wavelengths: Diffraction-limited focusing and subwavelength resolution imaging," *Science*, **352**, 1190–1194, (2016).