hot spots within the beam profile can have serious damage implications. There has been considerable work in enhancing the design algorithms used to optimise these DOEs to produce elements with very low non-uniformity and high efficiency. There are two issues which can lead to DOE performance being less than suggested by theoretical modelling - fabrication errors and non-plane wave illumination. Fabrication errors have been studied in some depth but here we investigate what influence non-plane wave illumination can have on the quality of the DOE output.

A number of different far-field, periodic, fan-out DOEs have been designed using many diffraction orders in each spot to create flat-top profiles. As these are periodic elements they are designed assuming plane wave illumination. By considering typical laser beam intensity profiles of varying widths the drop in performance caused by non-plane wave illumination is modelled using the angular spectrum of plane waves. From this analysis we see that even for considerable deviation from the plane wave input relatively little degradation is observed in the far-field image with relatively small increases in the peak intensities.

Design of two-dimensional finite aperture diffractive optical elements using the flip-flop method of optimization

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We have used the three-dimensional finite difference time-domain (3D-FDTD) method with unsplit step perfect matched layer (PML) absorbing boundary condition (ABC) as the analyzing method and the flip-flop search as the optimization method to design two-dimensional finite aperture diffractive optical elements (FADOE). To reduce the computational FDTD region, we used the angular spectrum method to model the wave propagation behind the FADOE. In the proposed method, we start with a random two-level FADOE. Then, the height of the first cell is changed (from 1 to 0 or vice-versa) and the intensity profile is computed at the observation plane. If the change improves the diffraction efficiency, it is kept; otherwise it is discarded. This process is repeated for each cell and it is continued until an acceptable characteristic is obtained. We used this method to design a two-level two-dimensional FADOE as a micro-lens and a 1-to-4 beamfanner. The DOE has a square aperture with a side length of $10\lambda0$, where $\lambda0$ is the wavelength of incident wave in free space. The distance between observation plane and output plane of DOE is $68\lambda0$ and the minimum feature is a cubic structure with a side length of $0.15\lambda0$. Since the feature size is very smaller than the wavelength, iterative angular spectrum and the optimal rotation angle methods cannot provide accurate results.

INVITED: Biophotonics workstation enabling interactive microscopic analysis and control

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We have developed an all-optical biophotonics workstation for trapping, manipulating and characterizing microscopic specimens in parallel. The workstation employs an optical mapping from a beam modulation module to obtain reconfigurable intensity patterns corresponding to two independently addressable regions relayed to the sample volume where the optical manipulation of a plurality of micro-objects takes place. The generated array of counter-propagating trapping-