TIGHT FOCUSING OF LIGHT

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1. INTRODUCTION

Tight focusing of light is important in many applications including laser scanning microscopy and laser micro-fabrication. If plane polarized light is focused by a high numerical aperture (NA) lens, cross-components of polarization are generated that increase the size of the focused spot [1]. It has been reported that focusing radially polarized solves this problem [2]. With a high NA lens, a strong longitudinal field is generated on-axis, which can result in a much tighter focal spot.

Another approach to produce a small focal spot is to use an amplitude shading of the lens pupil that increases the relative strength of the high aperture components. A particular example of such an approach is the use of an annular pupil [3], or arrays of annular elements [4]. This approach has been shown to work well with radially polarized illumination.

2. OTHER POLARIZATION DISTRIBUTIONS

We have recently shown that using illumination with other polarization distributions can produce even smaller focal spots than using radially polarized illumination. These polarization distributions are approximately linearly polarized so that the polarization along the axis is transverse. Two particular forms of polarization have been identified as having special properties.

The first form we find maximizes the intensity at the focal spot for a given input power, or relative to the strength of the side lobes. We call this electric dipole polarization [5]. The second form minimizes the width of the central focused spot. We call this case transverse electric (TE) polarization. It corresponds to a TE1 mode, rather than the TE0 mode used to give circumferential polarization.