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Spatial beam intensity shaping using phase masks on single mode optical fibers fabricated by femtosecond direct laser writing: supplementary materials

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1. SUPPLEMENTARY FIGURES

Figure S1 depicts different diffractive optical elements directly written onto an optical single mode fiber. The phase masks consist of four, five, and six rings and have a total diameter of 4.4 μm. Each ring is limited to a maximal height of 2 μm in simulation. As target a donut shaped intensity distribution is chosen. The numerical simulations of the circular phase masks consisting of four rings results in surface relief heights of 787 nm, 797 nm, 833 nm, and 970 nm beginning at the center (Fig. S1, bottom). The heights of the phase plate with five rings are 785 nm, 793 nm, 805 nm, 868 nm, and 979 nm (Fig. S1, middle) and for the six ring phase plate 680 nm, 666 nm, 663 nm, 720 nm, 622 nm, and 875 nm (Fig. S1, top).

Figure S2 shows the comparison between two different fabrication methods. In Fig. S2a the phase mask is written ring-by-ring, whereas in Fig. S2c a layer-by-layer approach is used. The corresponding measurements results are depicted in Fig. S2b and S2d. The two measurements are in excellent agreement.

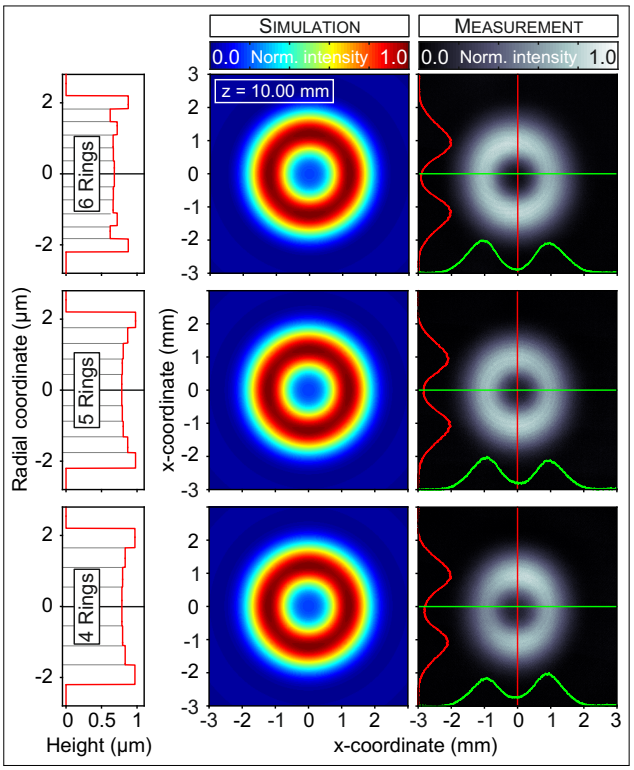

Fig. S1. Comparison of the intensity distribution at a distance of 10 mm behind the fiber end for different numbers of diffractive rings. Structure designs of diffractive optical elements for shaping a donut with different numbers of rings. For each structure the Huygens-Fresnel diffraction integral is numerically solved in an iterative optimization algorithm in order to obtain the desired donut shaped intensity distribution.

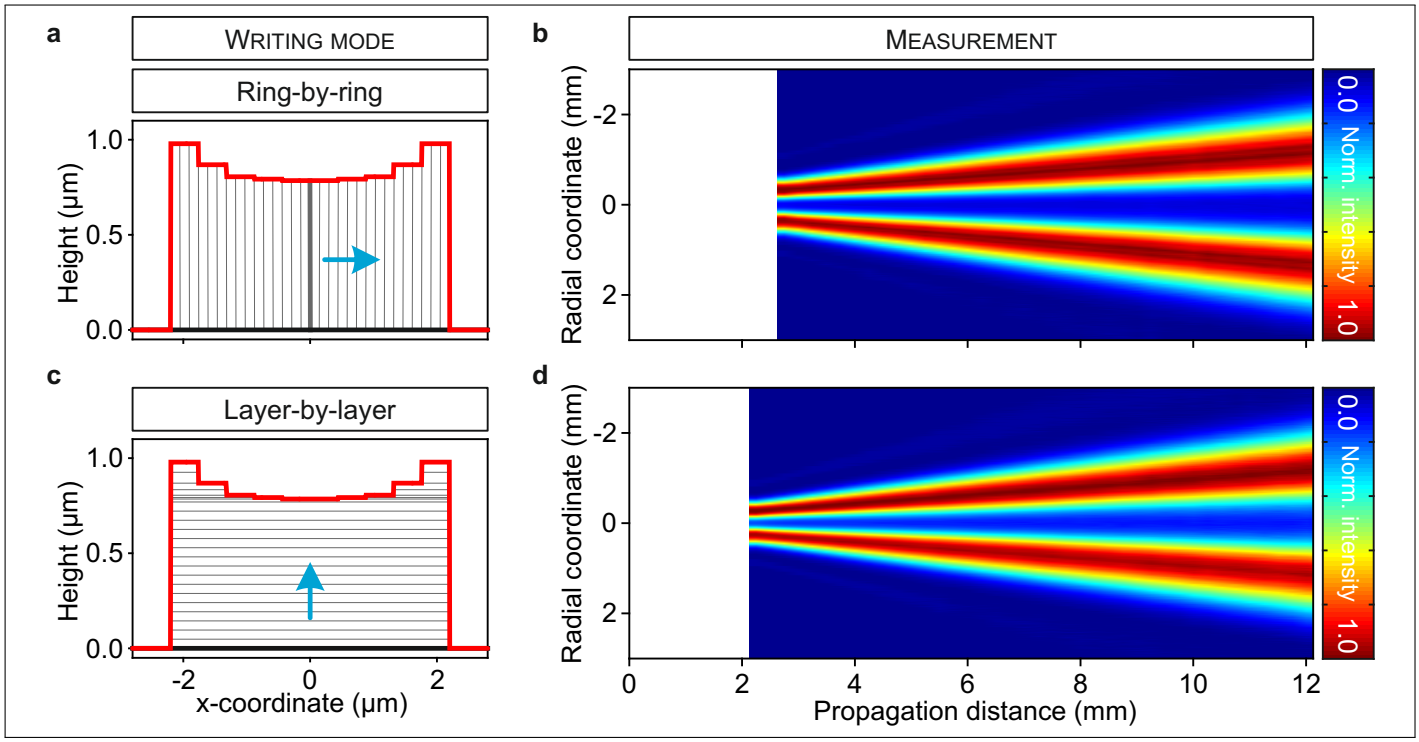

Fig. S2. Comparison of different fabrication methods using three-dimensional direct laser writing. (a) The diffractive optical element is fabricated ring-by-ring. (b) Measured intensity distribution at different distances behind the fiber end. (c) The diffractive optical element is fabricated layer-by-layer. (d) Measured intensity distribution at different distances behind the fiber end.