

Abstract (in Chinese)

Abstract (in English)

Acknowledgements

Contents

List of Figures

List of Tables

Chapter 1 Introduction1

1.1 Laser Trapping: Basic Physical Principles.....	1
1.1.1 Particle Trapping	1
1.1.2 Atom Trapping	4
1.2 Optical Bottle Beam	7
1.3 Supercontinuum Generation	8
1.4 Advantages of White Light Optical Trapping.....	9
1.5 Organization of Thesis	10

Chapter 2 Basic Theory11

2.1 Optical Bottle Beam.....	11
2.1.1 Fresnel-Kirchhoff's Diffraction Formula.....	14
2.1.2 Input Source Field	17
2.1.3 Theoretical Calculation	18
2.2 Supercontinuum Generation in MFs	21
2.3 Vectorial Field Theory.....	23
2.3.1 Vectorial Rayleigh Diffraction Integrals.....	23
2.3.2 Vectorial Field Calculation.....	26

Chapter 3 Experiments	32
3.1 How to Generate Supercontinuum Source.....	32
3.1.1 Pumping Laser Source.....	32
3.1.2 Supercontinuum Generation in MFs.....	33
3.2 Generation of Optical Bottle Beam.....	35
3.3 Measuring Supercontinuum Optical Bottle Beam.....	36
Chapter 4 Results and Discussion	38
4.1 Distribution of Optical Bottle Beam.....	38
4.2 Comparisons of Experiment and Theoretical Results.....	39
4.3 Discussion.....	42
Chapter 5 Vectorial Filed Simulation	43
5.1 Results of Vectorial Diffraction Integrals.....	43
5.2 Comparisons of Specific Input Polarization Field.....	45
5.3 Contribution of the Longitudinal Field.....	48
5.4 Discussion.....	52
Chapter 6 Conclusion and Future Works	54
References	56



List of Figures

Fig. 1.1	Optical force on a dielectric particle by a focused laser beam.....	2
Fig. 1.2	Schematic representation of the spatial distribution of trapping force from a focused laser.....	3
Fig. 1.3	Illustration of dipole traps with red and blue detuning.....	6
Fig. 1.4	The refractive index of atom versus incident light frequency.....	6
Fig. 1.5	Diagram of Optical bottle beam.....	7
Fig. 2.1	Geometric shape of an axicon.....	11
Fig. 2.2	Ray trace of axicon.....	12
Fig. 2.3	Phase change on passing through the axicon.....	12
Fig. 2.4	Ray trace of optical bottle beam by using assembly of an axicon with a focus lens.....	13
Fig. 2.5	The propagation of beam along z-axis from $z = 0$ to $z = L$	14
Fig. 2.6	A cascade of lenslike (paraxial) elements with an overall $ABCD$ matrix.....	15
Fig. 2.7	3D and 2D distribution of input beam.....	17
Fig. 2.8	Range of optical bottle beam from Z_1 to Z_2	18
Fig. 2.9	Calculations of optical bottle beam.....	18
Fig. 2.10	The diagram of on-axis intensity along propagation.....	20
Fig. 2.11	Structure of the microstructure fiber.....	21
Fig. 2.12	Demonstrated model of Török et al.....	24
Fig. 2.13	Schematic overview of the natural basis (k,l,m), polarization basis (k,s,p), and Cartesian basis (x,y,z).....	28
Fig. 2.14	Assembly of axicon and a lens.....	28
Fig. 3.1	Setup of Ti: sapphire laser system.....	32
Fig. 3.2	Interference autocorrelation and optical spectrum of the output laser	

pulses.....	33
Fig. 3.3 SEM image of the microstructured fiber.....	33
Fig. 3.4 Dispersion curve of the microstructured fiber.....	34
Fig. 3.5 Optical spectra of supercontinuum (460 nm~1530 nm).....	35
Fig. 3.6 Photograph of the microstructured fiber on working.....	35
Fig. 3.7 Experimental setup for generation of SC optical bottle beam.....	36
Fig. 3.8 Information of <i>WinCamD</i>	36
Fig. 4.1 1D intensity profiles and 3D Images of the bottle beam.....	38
Fig. 4.2 2D images of bottle beam.....	39
Fig. 4.3 Diagram of ring-diameter versus propagation distance at 532 nm and 670 nm, respectively.....	41
Fig. 5.1 Beam profiles of $\gamma = 5^0$ and $f = 35.08$ mm at various propagation distance	44
Fig. 5.2 Beam profiles of $\gamma = 0.5^0$ and $f = 5.08$ mm at various propagation distance.....	44
Fig. 5.3 On-axis intensity versus propagation for $\gamma = 5^0$ and $f = 35.08$ mm with radial polarization, x-polarization at observed angle $\beta = 0^0$, and x-polarization at observed angle $\beta = 90^0$	46
Fig. 5.4 On-axis intensity versus propagation for $\gamma = 0.5^0$ and $f = 5.08$ mm with radial polarization, x-polarization at observed angle $\beta = 0^0$, and x-polarization at observed angle $\beta = 90^0$	46
Fig. 5.5 Cross sectional 3D beam profile of radial polarization at $z = 37$ mm for $\gamma = 5^0$ and $f = 35.08$ mm.....	47
Fig. 5.6 Cross sectional 3D beam profile of x-polarization at $z = 37$ mm for $\gamma = 5^0$ and $f =$ 35.08 mm.....	47
Fig. 5.7 Cross sectional 3D beam profile of x-polarization at $z = 5.2$ mm for $\gamma = 0.5^0$ and f $= 5.08$ mm.....	48
Fig. 5.8 Cross sectional 3D beam profiles of x-polarization for $\gamma = 0.5^0$ and $f = 5.08$ mm	

at different position.....	50
Fig. 5.9 Intensity comparisons of the traverse field (I_p) and the longitudinal field (I_z) at individual Z_b for various γ and f	52



List of Tables

Table 2.1 Dispersion of refractive index and focal length.....21

Table 4.1 Optical bottle beam parameters for various central wavelengths and white light
supercontinuum.....40

Table 4.2 Results of experiment and theoretical calculation.....41

Table 5.1 Results of bottle range calculated from the scalar and vectorial diffraction.....43

