Information on datasets related to:

**Terahertz orbital angular momentum modes with flexible twisted hollow core antiresonant fiber**

Alessio Stefani,1,2,[[1]](#footnote-1)a) Simon C. Fleming,1 and Boris T. Kuhlmey1

1*Institute of Photonics and Optical Science (IPOS), The School of Physics, The University of Sydney, NSW 2006, Australia*

2*DTU Fotonik, Department of Photonics Engineering, Technical University of Denmark, 2800, Kgs. Lyngby, Denmark*

The dataset includes both the raw measurements data and the raw data extracted from the simulations. All measurements are performed with a home built THz time domain spectroscopy system, pumped with a Ti:sapphire oscillator providing pulses <150fs in duration at 80 MHz repetition rate at 800 nm. The laser pumps THz photoconductive antennas. The emission is done with an Ekspla antenna while detection is done with an Ekspla detector for the far-field measurement and with a Protemics microprobe for the near-field measurements. The lock-in detection (lock-in amplifier SR-844) is done by modulation of the bias of the emitter (40V peak to peak and 9kHz frequency). The THz beam coming out of the emitter is, after the Si lens provided, collimated with a 100 mm focal length Teflon lens and coupled in the fiber with a 75 mm focal length Teflon lens. The far-field transmission signal collection is done with the same set of lenses in a reciprocal configuration.

The files:

*20160412\_Far-field\_reference.txt*

*20160427\_Far-field\_straight\_6tubes\_10cm.txt*

*20160427\_Far-field\_twisted\_6tubes\_10cm.txt*

Are related to the far-field transmission measurements used to obtain Fig. 2(a) and S2. They contain the voltage output of the detector and the corresponding time delay. The “reference” file is used to normalize the two measurements and is done without the fiber in the system.

*2017-06-20\_020326\_Near-feild\_straight\_scan\_parameters.txt*

*2017-05-09\_100752\_Near-field\_twisted\_scan\_parameters.txt*

The parameter files contain the scan parameters used during the measurements for stages and lock-in detection.

*2017-06-20\_020326\_Near-feild\_straight\_scan\_data.txt*

*2017-05-09\_100752\_Near-field\_twisted\_scan\_data.txt*

Contain the voltage output of the detector and the corresponding time delay as function of the xy position of the scanning tip. They are used for Figs. 4 (both), 5, 6 and 7 (only the data for the twisted fiber).

*Simulations\_notwist400umlossPU1dbcm\_10GHz\_3mmcapi\_corepower.csv*

*Simulations\_notwist400umlossPU1dbcm\_10GHz\_3mmcapi\_modes.csv*

*Simulations\_notwist400umlossPU1dbcm\_10GHz\_3mmcapi\_neffs.csv*

*Simulations\_notwist400umlossPU1dbcm\_10GHz\_3mmcapi\_totpower.csv*

The files are the extracted data of the simulation of the untwisted fiber. The simulation is done with COMSOL Multiphysics version 5.3 by using the mode solver function. The model has 6 tubes of 3 mm diameter and wall thickness 400 µm, non-touching (a 3.2 mm tube can be fit inside the 6 tubes). The refractive index of the solid part of the tubes is set to 1.6 and the loss is 1 dB/cm. The simulation is done as a frequency sweep with 10 GHz steps. A PML layer is used outside the tube area. The extracted information is: the complex effective indexes of the modes as function of frequency (file ending in neffs); the $\left|E\right|^{2}$ (in COMSOL (norm.E)^2) integral over the entire model (file ending in totpower) and over the 3.2 mm circle inscribed in the fiber core (file ending in corepower); and $\left|E\right|^{2}$ as a function of y along the x=0 line. The power data is used to determine which modes are in the core (power in the core>0.5\*total power), while the profile is used to determine the nature of the mode (fundamental/high order). Confirmation of the mode type is done by looking at the actual 2D mode pointing vector/electric filed components/phase in COMSOL. These files are used to obtain Figs. 2(b) and S3(a).

*Simulation\_vs\_twist\_core\_power.csv*

*Simulation\_vs\_twist\_modes.csv*

*Simulation\_vs\_twist\_neffs.csv*

*Simulation\_vs\_twist\_tot\_power.csv*

*Simulation\_vs\_twist\_phasecircle.csv*

Extracted data of the simulations with the same model and procedure as above, but now the frequency is fixed at 720GHz and the twist period is changed by redefining the medium dielectric constant matrix with a helicoidal coordinate change. These files are used to obtain Figs. 8 (central part, while the modes are directly taken as pictures from COMSOL) and S3(b). The *phasecircle* file has the evolution of the phase (counterclockwise) for the modes on a circle inscribed within the core with a radius of 700um. It is used to classify the modes.

*Simulation\_10cm\_twist\_realEx\_OAM.csv*

*Simulation\_10cm\_twist\_realEx\_fund.csv*

*Simulation\_10cm\_twist\_imagEx\_OAM.csv*

*Simulation\_10cm\_twist\_imagEx\_fund.csv*

Are the extracted 2D x-component values of the electric field (real and imaginary part) from the simulation with twist at a twist period of 10 cm for the fundamental mode and the l=1 OAM mode. These files are used to obtain Figs. 9(a) and 10(top). These files are also used to calculate the overlap integrals.

*Simulations\_10cmtwistperiod\_vs\_frequency\_CorePower.csv*

*Simulations\_10cmtwistperiod\_vs\_frequency\_Modes.csv*

*Simulations\_10cmtwistperiod\_vs\_frequency\_neffs.csv*

*Simulations\_10cmtwistperiod\_vs\_frequency\_TotPower.csv*

*Simulations\_10cmtwistperiod\_vs\_frequency\_Phasecircle.csv*

Are used to obtain the results of Fig. S3(c) following the procedure used for Fig. S3(a). The extra *Phasecricle* file is again used to classify the different modes.

1. **a) Author to whom correspondence should be addressed. Electronic mail: alessio.stefani@sydney.edu.au.** [↑](#footnote-ref-1)