ULTRA-LIGHTWEIGHT MICROENDOSCOPE CREATED BY TWO-PHOTON DIRECT LASER WRITING

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KEY WORDS: Fibre-optical imaging, two-photon direct laser writing, free-form optics.

Fibre-optical microendoscopy has been widely used in *in-vivo* fluorescent imaging with sub-micrometre resolution in research and clinical applications [1]. However, the miniaturization and resolution of the conventional fibre-optical microendoscope is limited because the size, shape and dimensions of the optical components are restricted by manufacturing methods. Recently, two-photon direct laser writing has enabled manufacturing miniaturized optical components with the sizes of around 100 micrometres and high performance [2]. Here, we report on the development of an ultra-lightweight fibre-optical microendoscope (UFOME) created by two-photon direct laser writing in the photo-resist on fibre tips. An aberration-free free-form lens with a numerical aperture of 0.6 is fabricated on one fibre tip for illuminating a sample. The lens has a diameter of 60 micrometres and a height of 100 micrometres. Meanwhile, a collection lens and a beam splitter are fabricated on the other fibre tip. A laser source is used to be coupled into the fibre for illumination, and the reflective or fluorescent light signals can be measured by a detector. The free-form imaging lens and the collection lens are characterized on the glass by measuring the point spread function and axial chromatic aberration. The presented UFOME provides a further miniaturized and flexible tool for microendoscopy imaging.

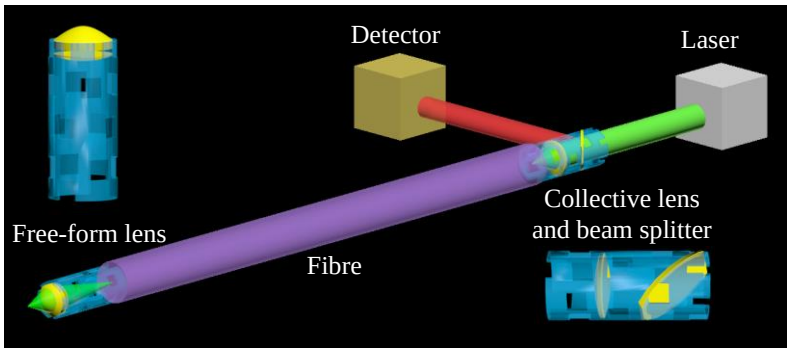

Figure 1: Schematic of an ultra-lightweight fibre-optical endoscope

[1] Flusberg, Benjamin A., Eric D. Cocker, Wibool Piyawattanametha, Juergen C. Jung, Eunice LM Cheung, and Mark J. Schnitzer. "Fiber-optic fluorescence imaging," Nature methods, **2**, 941-950 (2005).
[2] Gissibl, Timo, Simon Thiele, Alois Herkommer, and Harald Giessen. "Two-photon direct laser writing of ultracompact multi-lens objectives," Nature Photonics, **10**, 554-560 (2016).