Low Loss (34 dB/km) Silica Hollow Core Fiber for the 3 μm Spectral Region

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Abstract: We describe the characteristics of a silica hollow-core fiber for transmission around 3 μm wavelength, with minimum attenuation of 34 dB/km. The design is based on the use of a negative curvature core wall.
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1. Introduction

Hollow core fibers formed from silica offer the possibility to extend the spectral window for silica-based fiber optics into the mid-infra-red. Such fibers can support truly confined modes by use of a photonic bandgap cladding, or can operate as enhanced capillary guides by careful design of the core surround. Photonic bandgap fibers for 3 μm transmission have previously been reported to have below 1 dB/m attenuation [1]. Pryamikov *et al.* reported [2] measurements on a 63 cm fiber without a photonic bandgap cladding but with a negative curvature core wall and demonstrated transmission bands extending to beyond 4 μm wavelength. In this paper we report measurements through an 83 m length of fiber based on improvements to that design, and with a minimum attenuation of just 34 dB/km at a wavelength of 3.05 μm. The absorption of bulk silica at this wavelength is around 70 dB/m.

2. Experimental Results

The fiber was fabricated using the stack and draw technique, by placing 8 identical capillaries drawn from thin-walled silica tube (Suprasil F300, Heraeus) inside a larger jacketing tube. The core in the final fiber as shown in Fig. 1(a) is 94 μm across the narrowest diameter. The core wall thickness is 2.7 μm. The attenuation (Fig. 1(b)) was determined using a cut-back measurement using a tungsten lamp as a light source and a scanning monochromator for detection (10 nm resolution). The total fiber length in the measurement was 83 m, cut back to 3.1 m.

We have investigated the confinement of the guided light by using a fiber-butt coupling technique. The tungsten lamp was coupled into a 80 m length of fiber, which was then butt-coupled to a second 3 m length of fiber coupled directly to the monochromator. The transmitted signal was then recorded as we translated one fiber relative to the other. The recorded data (Fig. 1(c)) are consistent with the guided light being confined to the hollow core.

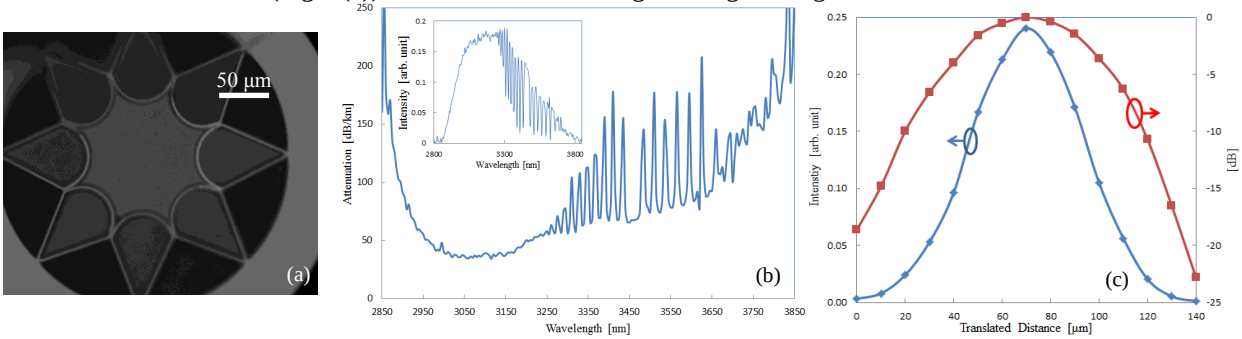

Fig. 1: (a). Optical micrograph of the fiber . (b) Measured attenuation and (inset) transmission spectra through 83 m of fiber. (c) Results of the mode-field experiment as described in the text (on linear and logarithmic scales). The data shown were recorded at a wavelength of 3.15 μm. No deconvolution has been applied.

3. Acknowledgements

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4. References

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[2] A. D. Pryamikov et al., "Demonstration of a waveguide regime for a silica hollow-core microstructured optical fiber with a negative curvature of the core boundary in the spectral region > 3.5 μm," Opt. Express 19, 1441-1448 (2011).