Large mode area pixelated trench fiber

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Abstract: We propose a novel fiber that offers excellent suppression of higher-order-modes with loss higher than 10dB/m and low loss for fundamental mode (<0.1dB/m) at 1.06μm, with effective area as large as 1100μm^2 and excellent bend-robustness.
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1. Introduction

Large mode area (LMA) fibers have significantly contributed to the growth of fiber laser by mitigating non-linear effects. Several fiber designs such as Step-index fiber, Parabolic fiber, Bragg fiber, Multi-trench fibers (MTF), Photonic Crystal Fibers (PCFs), Leakage Channel Fibers (LCFs) and 2D-All Solid Photonic Bandgap fibers (ASPBGFs) have been demonstrated [1-3]. MTF offers high suppression of the higher order modes (HOMs), and can be fabricated using conventional CVD technique thanks to the circular symmetry of the fiber [1]. In this paper, for the first time, we propose Pixelated trench fiber (PTF) which enhances the suppression of the HOMs by employing two mechanisms simultaneously; namely modal sieving and resonance coupling of the HOMs.

2. Pixelated trench fiber (PTF)

Fig. 1(a) and 1(b) shows the schematic and fabricated refracted index profile (RIP) of the MTF which suppress the HOMs by resonant coupling between core and resonant ring modes [1]. However, in order to further enhance the suppression of the HOMs, we propose pixelated trench fiber, which has three circular arrays of air-holes as shown in Fig. 1(c). This pixelated trenches in place of circular trenches helps in sieving of the HOMs and provides a discrimination of the loss between HOMs and Fundamental mode (FM) in addition to the discrimination achieved by resonant coupling as shown in Fig. 1(d). Fig. 1(e) shows the maximum effective area (A_{eff}) achieved in bend configuration for different core diameter following the criterion of the FM loss lower than 0.1dB/m and HOM higher than 10dB/m. In addition to offering high loss to the HOMs there is delocalization of the HOMs as well (power fraction of the HOMs (<83%)/power fraction of the FM (>98%)). Fig. 1(e) also shows the illuminated fraction of core which is defined here as the ratio of the A_{eff} in bent and unbent case (a measure of mode distortion), which is higher than the illuminated fraction offered by ASPBGFs while keeping other parameters same (such as A_{eff}, bend radius, and HOMs loss) [3]. Numerical simulations show the potential for further mode area scaling. In conclusion, PTF offers excellent suppression of the HOMs by inducing high loss and delocalization to the HOMs.

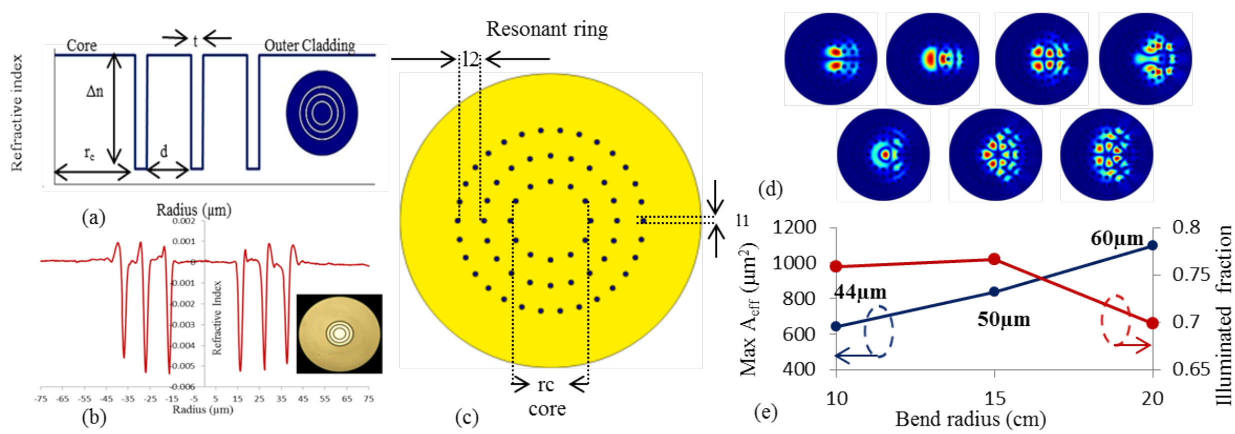

Fig. 1 (a) and (b) shows the schematic and fabricated RIP of the MTF. Inset shows the schematic of 2-d cross section of the fiber end and the microscope image of the fiber end. 1(c) shows the schematic of 2-d cross section of the proposed PTF. 1(d) shows the normalized electric field of few HOMs in 50μm core fiber (bend at 15cm radius) showing hybrid mechanism of the HOMs suppression. 1(e) shows the A_{eff} and illuminated fraction for different core diameter at different bend radii.

3. References

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