SoM2F.2.pdf Advanced Photonics Congress 2016 (IPR, NOMA, Sensors, Networks, SPPCom, SOF) © OSA 2016

64 Core Ultra Dense Multicore Fiber Design for Optical Fronthaul Systems

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Abstract: to make the most of spatial efficiency, we design 64-core trench-assisted multi-core fiber with the maximum crosstalk less than -14dB/20km, which is appropriate for the optical wireless fronthaul systems with inherent MIMO function.
OCIS codes: (060.0060) Fiber optics and optical communications; (060.2280) Fiber design and fabrication;

1. Introduction

Multicore fiber (MCF) is being intensely investigated from the access network to the long haul transmission systems [1, 2]. In view of enhancing capacity, high density MCF is always preferable and now 31-core high density single mode MCF has been realized [3]. While, researchers are sparing no efforts to optimize the index profile to suppress the crosstalk, to avoid the complex multiple input multiple output (MIMO) mitigation algorithms. It seems that increasing more cores is irreconcilable with suppressing the crosstalk.

In addition, to deal with a huge growth of mobile services, cloud radio access network (C-RAN) is proposed, requiring the introduction of optical fronthaul segment for remote feeding from central office to different antennas, featuring inherent MIMO technique per sector [4]. MCF has great advantages in future 5G wireless C-RAN architecture by serving a number of users simultaneously. It has been investigated that the inter-core crosstalk can be tolerated as high as -10dB/20km in the MIMO-OFDM-OQAM radio over MCF system [5]. Therefore, the space efficiency of MCF can be made the best of in optical fronthaul system through structure optimization.

2. Results and conclusions

Finite element method (FEM) is used for MCF design, and there are three important issues in such design. The first one is to suppress the inter-core crosstalk, and we choose the heterogeneous core with the trench-assisted index profile. Although the core pitch is only 18um, the crosstalk can still be in target because when the bending radius is larger than the threshold bending radius, the adjacent cores are no longer in the phase-matching region and the crosstalk is suppressed greatly [6]. The second issue is the cutoff wavelength lengthen due to the trench existence [7]. To solve this problem, each core is enclosed with 4 cores but not 6 cores. The third issue is the excess loss of the outer cores. We set the cladding diameter to 260um, with the failure probability of 10^{-6} at the proof of level 1% with the bending radius 30 mm [8]. Furthermore, the outer cladding thickness is set to 30um and the excess loss can be lower than 0.001 dB/km with the effective area far less than 80 um^2. [9]

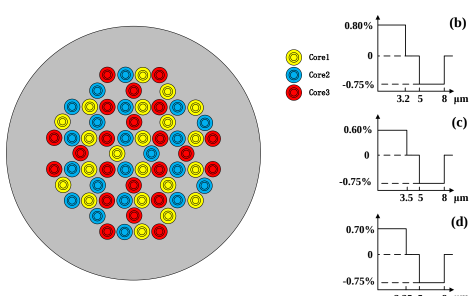

Table: Each kind of core's crosstalk and effective area

Core index		Core1	Core2	Core3
Crosstalk (dB/20km)	Core1	/	-22.7000	-19.3000
	Core2	-15.3000	/	-15.7000
	Core3	-14.1000	-15.8000	/
Effective area (μm^2)		35.41	41.96	38.58

Fig. 1. (a) Cross section view of 64-core MCF and refractive index profile of (b) core1, (c) core2 and (d) core3; Inset: properties of MCF.

In conclusion, we have designed a 64 core ultra-dense MCF for the potential application in the optical fronthaul systems to support a higher density of radio-access points in 5G cellular system.

3. References

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