Investigation of Optical Loss Properties of Bend-Insensitive Fibers using FDTD Simulation

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Now-a-days, fiber-to-the-home (FTTH) application is experiencing upward growth due to the steady increase of the number of subscribers for internet. Along with the increase in FTTH subscribers, a new kind of specialty fibers so called bending loss insensitive fibers(BIF) has been developed to make installation and maintenance easier.[1,2] It usually incorporates several air holes around a germanium-doped core, and exhibits remarkable small bending loss compared that of conventional SM fiber. In this study we have investigated bend loss properties in BIF to find important factors affecting the bend loss, based on both simulation and experiments. Here, we applied FDTD algorithm which is well suited to simulate light field dynamics and propagation to calculate bending loss.[3]

The BIF used in this report has a conventional raised-index core surrounded by six air holes as shown in Fig. 1. The core and hole diameters were D=10 μm, and d=15 μm. The distance between the air holes was Λ =22 μm.

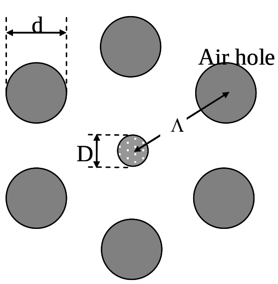

Fig. 1 Configuration of bend insensitive fiber

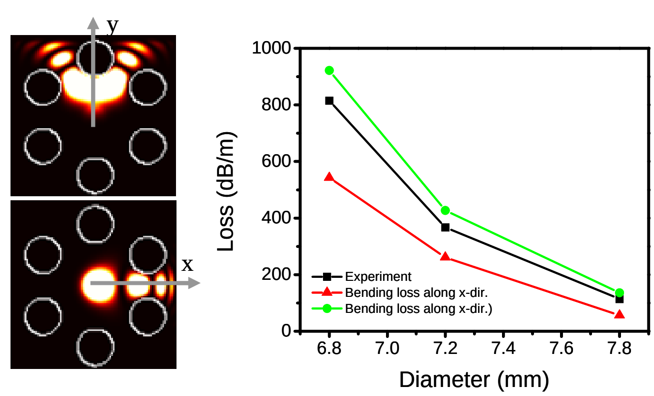

Fig. 2. Computed optical intensity distribution in the cross section, and loss-diameter plot. The fiber is curved in y and x directions, respectively.

Figure 2(a) and (b) show the optical intensity distributions in the cross section with a bend diameter of 7.2 mm when fiber was bent along y and x direction, respectively. The bending loss as function of bending diameters is plotted in Fig 2 (c). In experiment, the bend axis was not specified, and not maintained along the curve to produce an averaging effect of the two extreme cases.

Fig. 3 shows the polarization dependence of the bend loss. The bend axis was fixed (x-direction) in simulation. It showed negligible polarization dependence.

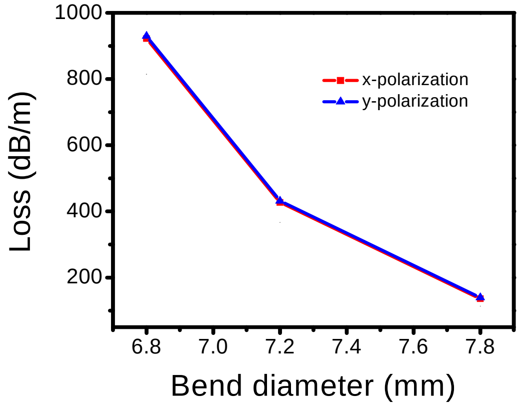

Fig.3. The bending loss as function of bent diameter for x and y polarization state

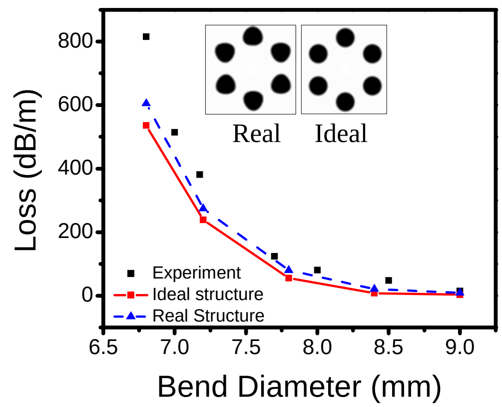

Fig.4. The dashed line is simulation results from real structure, solid line is simulation result from ideal structure and open shape line is experimental results of BIF

Since the air holes of real fibers are not perfectly circular, the idealization of structure in simulation may raise some errors. To solve this problem, we added a new function in our FDTD program which acquires an image file for an input structure of FDTD. Insets of Fig. 4 shows the real and ideal profiles used in calculation. In the loss-diameter curve in Fig. 4, we see the non-negligible difference between the two cases. Better agreement was obtained between the experimental data and simulation data based on the real structure.

In conclusion, experimental, and simulation-based investigation of bend insensitive fiber was performed. It was found that the loss can be affected by the bend direction, and the air hole shape, as well as bend diameter, wavelength, and air hole size. It showed no polarization dependence.

Reference

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