Simulation for multimode fiber-waveguide coupling based on near field and far field pattern

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1. Introduction

Multimode fiber (MMF), especially graded-index multimode fiber (GI-MMF), has received widespread attention in the field of short-distance optical communication as one of the promising applications, with its characteristics of light in weight, free from electromagnetic interference, and higher bandwidth. For an optical transmission system to operate effectively, the loss of the fiber link must meet the loss budget. It is important to predict losses through simulation to reduce cost and time before integrating fiber into actual systems. Therefore, a practical simulation method needs to be established to accurately estimate the MMF connection loss. A calculation model of connection loss applicable to SI-MMFs and GI-MMFs has been demonstrated successfully [1]. In practical applications, we will encounter the case where the multimode fiber is connected to the optical waveguide, and the rectangular optical waveguide is especially used in this study. Different end face shapes may limit and affect applicability. Our purpose is to use the measured data of near field pattern (NFP) and far field pattern (FFP), and use NFP and FFP as the light source to simulate and finally get the connection loss.

2. Method

The simulation is operated on the optical design software, OpticStudio. Using the nonsequential component editor to establish the GI-MMF and rectangular optical waveguide models, and numerical analysis to calculate the connecting loss. The measured data of NFP and FFP was used as light source in surface emission. In this case, the graded index fiber has a core diameter of 50μm, and has 1.482 refractive index; the rectangular waveguide has an end face size of 50μm×50μm, and has 1.54 and 1.51 refractive index of core and cladding respectively; the wavelength is set to be 850nm.

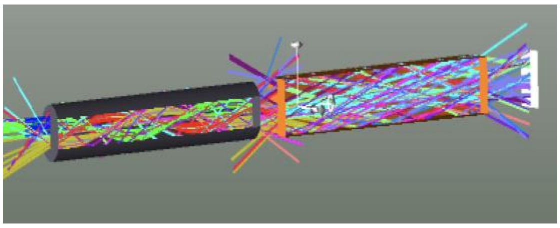

Fig.1 Geometric configuration of the simulation model of GI-MMF with SI-waveguide

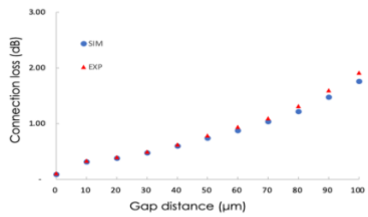

Fig.2 Simulation (SIM) and experiment (EXP) results of connection loss with axial variation

A comparison of the experimental and simulation results for the connection loss due to axial displacement in the direction of the extended optical axis was conducted. The results demonstrate that the experimental and simulated outcomes are analogous at the identical position, exhibiting a discrepancy of no more than 0.15 dB. With regard to the axial displacement variable, the connection loss is observed to approach 2.0 dB at a distance of 100 μm as the distance is increased. It is noted that the loss is generated when the GI-MMF is in physical contact with the SI-waveguide, which is due to the mismatch of the two end-face shapes. Furthermore, when the two components are separated from their physi-cal contact state, an air gap is created between the end faces, which causes a significant increase in the refractive index difference, resulting in the formation of Fresnel losses..

3. Conclusion

In this study, a simulation model for calculating transmission loss is developed. The simulation objects were selected as GI-MMF and SI-waveguide, and the NFP and FFP of both were obtained. Subsequently, the data of NFP and FFP were integrated into the simulation for the surface light source, thereby enhancing the reliability and stability of the simulation model. The simulation model also yielded connection loss results that exhibited a similar trend as the experimental results, and it incorporated Fresnel loss due to the abrupt change of refractive index. The connection loss resulting from spatial variations between components can be analyzed, calculated, or even predicted through the use of simulation. It is our intention to ex examine the outcomes for substitute in forthcoming experiments and simulations

References

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