SUMMARY OF Ph.D. DISSERTATION

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Title

High Bandwidth Graded Index Polymer Optical Fiber and Design of its High Speed Network

Abstract

In recent years, data traffic over private intranets and the Internet is growing explosively, in addition to the great increase in the available network bandwidth to the desktop. Graded index polymer optical fiber (GI POF) has been expected to be one of the promising physical media for the high speed home network.

Chapter 1 described the background and the brief summary of the motivation for recent work.

Chapter 2 introduced the theories of optical and propagation characteristics of the GI POF. Particularly, attenuation, dispersion, refractive index profile, mode dependence attenuation, mode coupling were described in detail.

Chapter 3 summarized the theory of communication in high speed optical network. This chapter indicated that the eye pattern, bit error rate and power penalty were important parameters to design an optical network.

Chapter 4 described the experimental methods to evaluate the characteristics of propagation in GI POF and communication in optical network.

Chapter 5 presented the materials and fabrication technique of GI POF. New fabrication methods were proposed to vary widely the refractive index profile, NA and core diameter.

Chapter 6 investigated the propagation characteristics of GI POFs with various waveguide parameters. The difference of propagation constants between adjacent modes could evaluate the mode coupling strength. The higher NA of the GI POF induced the larger difference of propagation constants, hence smaller mode coupling. The GI POF maintained the high bandwidth even under the fiber bending. The GI POF (NA=0.24, Core diameter=200 μm) exhibited 0 dB bending loss even under the severe fiber bending (Bending radius=5 mm). The lager mode coupling caused the larger bending loss. Therefore, the waveguide parameters of the GI POF which had the same difference of propagation constants as the GI POF (NA=0.24, Core diameter=200 μm) were calculated. These parameters indicated a guideline to eliminate the bending loss.

Chapter 7 investigated the relation between propagation mode characteristics of GI POF and communication performance of optical network. The GI POF with optimum waveguide parameters exhibited effectively no power penalty under various practical conditions and demonstrated very good performance in 100-m transmission without significant degradation. The GI POF with smaller core (40 μm) than silica MMF (50 μm) exhibited no modal noise. The refractive index profile should be not necessarily controlled to the optimum, in order to achieve a reliable Gigabit Ethernet communication, the allowed range was $1.7 < g < 3.5$. This chapter clarified the optimum waveguide parameters of GI POF and that the GI POF had large advantage for a physical medium in high speed optical networks.

Chapter 8 summarized this study.