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SUMMARY OF Ph.D. DISSERTATION

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Title

Design of Plastic Optical Fiber for Home Network

Abstract

A graded index plastic optical fiber (GI POF) with the high capacity, flexibility, and easy handling has been investigated as an optimal transmission medium for very short reach networks, such as local area networks in buildings where many bends and connections are required. Since the first GI POF was reported in 1982, numerous improvements have been made, and the enhanced GI POF was started to be laid down in buildings in 2001. However, the GI POF has not been widely utilized due to the high material and production cost, and there is no prospect of practical using for home network infrastructures, where the exceptionally high demand will be expected in the near future. From the perspective of the high transparency (amorphous conformation), multiple material designs, free radical polymerization without catalysts and solvents, and low synthesis cost, the author focused on acrylic polymers. This dissertation is intended as an investigation of a novel GI POF based on inexpensive materials with enough transmission properties and thermal stabilities for gigabit in–home communications.

Chapter 1 reviews the basic concept of fiber-optic communications, the history of GI POF, and current issues we have to conquer for realizing a desired home network.

Chapter 2 summarizes background knowledge for POF base materials especially optical and thermal properties.

Chapter 3 describes the attenuation of fibers. Given the laying distance in a house, the attenuation of the fiber should be less than 200 dB/km. The author focused on partially fluorinated and chlorinated methacrylates with few C-H bonds per unit volume. In both cases, GI POFs with attenuations of less than the required value at the emission wavelength of the light source (670-680 nm) were successfully obtained.

Chapter 4 discusses thermal properties of base materials. The base polymer should have a glass transition temperature (T_g) and heat decomposition temperature (T_{d5}) of at least 110 ^{o}C and 295 ^{o}C, respectively. Poly(pentafluorophenyl methacrylate) (PFPMA) exhibited excellent thermal characteristics and an enough transmittance, whereas the bulky structure lowered the polymerization conversion, resulting much lower T_g and T_{d5} in bulk state.

Chapter 5 describes a copolymerization. By copolymerizing with methyl methacrylate (MMA), the residual PFPMA was drastically decreased due to the difference of monomer reactivity ratios. As the result, copolymer bulks with higher T_g and T_{d5} than required values were obtained when the PFPMA content was 0-60 mol%. Furthermore, the increment of isotropic scattering loss accompanied with general copolymerization was clarified to be negligibly small since the refractive index of poly(PFPMA) and PMMA are almost identical. Finally, we succeeded to prepare the copolymeric GI POF with attenuation of 172-185 dB/km at 670-680 nm. The -3dB bandwidth was 1.34 GHz for 50-m length and the high capacity of 1.25 Gbps was demonstrated.

Chapter 6 provides brief conclusions of this dissertation and suggests some directions for future works.