CHAPTER I

INTRODUCTION

Currently, wiring in local area networks is based mainly on copper cables and glass fiber. Copper based technologies suffer strong susceptibility to electromagnetic interferences and have a limited capacity for digital transmission. Conventional silica based fibers are a costly solution because they require precise connecting and dedicated installation and handling. An alternative technology is the use of polymer optical fiber (POF) for data transmission. POF offer several advantages over conventional transmission media: large bandwidth over short distances (up to 1000 m), potential low cost associated with ease of installation, splicing, and connecting. Furthermore, POF has small volume and light weight. It guarantees electromagnetic immunity. In addition, POF is not brittle but ductile and will stretch rather than break under increased tension; even a thick bundle of POF is more flexible than a bundle of glass fiber. POF technology could be used for data transmission in many application areas ranging from in-house networking to the avionic environment deploying a variety of techniques.

POF has been used extensively in short-distance data communications applications, such as digital audio interface. POF are also used for data transmission equipment, control signal transmission for numerical control machine tools and railway rolling stocks, and so on.

POF consists of a plastic core and plastic cladding; both were made from highly transparent materials. As refractive index of core materials (n_{core}) have slightly higher than refractive index of cladding materials (n_{clad}), so light is kept in core by total internal reflection. A core and a cladding were coated again by plastic protective layers to protect the fiber from damage and moisture. POF has very large core diameters compared to those of glass optical fibers. Even when the diameter has a thickness of between 0.5 and 1mm in diameter, POF is flexible. These features enable easy installation and safe handling. There is no fear for POF to stick into human skin. Owing to the large diameter, high-positioning accuracy is not required for connections so that cost of connecting devices can be reduced.

POF used for data communications are made mostly of polymethyl methacrlylate (PMMA) and perfluorinated (PF) polymer material. Conventional PMMA-POF has a step index (SI) profile. SI PMMA-POF has been commercially available for many years. The core diameter of this fiber is typically 0.125–2.0 mm. This fiber has a large attenuation (150 dB/km at 650 nm wavelength) and limited bandwidth, e.g., 20 MHz km. Improvement in the bandwidth of this POF fiber has been obtained by grading the refractive index. Graded index (GI) PMMA-POF has shown a bandwidth-distance product of 0.5 GHz*km at the 650 nm wavelength (Monroy, *et al.* (2003)). Although by grading the index profile of significantly enhanced characteristics have been obtained, the bandwidth and attenuation still limit the transmission distances and capacity. Reduction of transmission loss has been achieved by using amorphous perfluorinated polymers for the core material. This new type of POF has been named perfluorinated POF (PF-POF). This new fiber with low attenuation and large bandwidth has opened the way for high capacity transmission over POF based systems. A cable of two fibers of GI PF-POF has been commercially available since June 2000 under the trademark Lucina.

The common polymer cores are poly(methyl methacrylate) (PMMA), polystyrene (PS), and polycarbonate (PC). PC core plastic optical fiber is developed for high temperature applications. General aliphatic polymer has high absorption loss due to carbon–hydrogen stretching vibration. Fluoropolymers have been developed to be used as cladding materials because C-F bonds do not absorb visible light. POF which has very low attenuation was achieved in a perfluorinated (PF) polymer-based GI POF, at wavelength of 1300 nm. Moreover, fluoropolymer can provide a good mechanical, chemical and thermal resistance to the core.

The most important property of POF is the optical transmission, which does depend on core materials, drawing process and also depend on the conditions of the manufacturing process. There are general methods for making optical fibers: the drawing a preform and the extrusion. The co-extrusion process is reasonable in industrial manufacturing because it is high-volume processing method. The co-extruder produces the core and simultaneously coats it with cladding material.

Since the light transmission loss through PC is large, the improvement transmitting characteristics of the optical fibers have been studied. A plastic having silane-crosslink structure may be chosen and used. In 1982, Clarke R. studied an optical fiber core and a cross-linked polyfluorosiloxane cladding having a various fluorine contents to produces a waveguide having a high numerical aperture. In 1988, Yamamoto T. and coworkers provided a POF capable of exhibit good light transmitting characteristic even at high temperatures having a silane cross-linked structure as a protective layer.

The purpose of this work is to produce plastic optical fiber having polycarbonate core for light transmission. PC cores were coated by synthesized polymer cladding materials simultaneously in co-extrusion process. Then, study the effect of cladding's compositions on optical properties and mechanical properties of polycarbonate fiber.

OBJECTIVES

1. To synthesize and characterize poly(arylene silyl ether) at various monomers ratio.
2. To study effect of cladding's compositions on optical and mechanical properties of the fiber.
3. To study effect of processing parameters on optical and mechanical properties of the fiber.
4. To prepare and characterize POF using PC as a core and poly(arylene silyl ether)/PMMA as cladding materials by co-extrusion technique.

SCOPE OF RESEARCH

The scope of this research will cover the following:

1. Poly(arylene silyl ether) is synthesized from the reaction of 4,4′-(hexafluoroisopropylidene) diphenol (6F-BPA), cross linkable bisphenol BHPFS and diphenyldichlorosilane at four ratio of silane:diphenol
2. 10%, 20% and 25% of poly(arylene silyl ether) is blended with PMMA in Barbender. The claddings are characterized by DSC, TGA and SEM
3. PC and synthesized cladding materials are co-extruded by varying draw ratio and piston speed.
4. Thermal properties—decomposition temperature and operating temperature, Optical properties—attenuation, NA and bending loss, Mechanical properties—toughness, tensile strength and elongation at break of POFs will be characterized.