DESIGN AND ANALYSIS OF NARINGIN CONCENTRATION SENSING BASED SIDE-POLISHED POLYMER OPTICAL FIBER (POF)

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DEDICATION

Dedicated to my beloved parents : Pn Sarmiah Jusoh, Abdul Manan Embong and Wan Zahari Wan Alwi.

ABSTRACT

This thesis presents the design and analysis of naringin concentration sensing based side-polished polymer optical fiber. Measuring naringin solution concentration play an important role incommercial and technological applications. For years, polymer optical fibers (POFs) have been very attractive for industrial applications because of their unique characteristics. In this project, I created simple, low cost and efficient set-up for sensing naringin solution concentration using POFs. The purposes for this research are to design a Polymer Optical Fibre (POF) sensor, to design a sensor for single side-polished and multiple side- polished POF, to analyze the performance of the POF sensor by applying naringin concentration sensing and to develop prototype system of the side-polished POF sensor. The varies distance and energy of the source which is non-contact LED (RGB), then single and multiple side-polished optical fiber, also the different concentration of naringin have been chosen as the manipulated variables. All the elements are experimentally analyzed in order to optimize the output voltage. At the end of the project, the performance liquid concentration sensor-based side-polished for naringin concentration detector using Arduino is successfully designed and analyzed. The experimental results show that when the naringin concentration was increased, its response showed a greater loss of

optical power due to the light rays in the submerged region of the POF tend to be refracted out of the fiber instead of being totally internally reflected and transmitted when index of refraction of the surrounding liquid medium is increased. This research is useful to be implemented in food industry to ensure the concentration of naringin in the food does not exceed the prescribed value.

ABSTRAK

Tesis ini membentangkan reka bentuk dan analisis naringin kepekatan pengesan berasaskan polimer gentian optik polimer sisi. Mengukur kepekatan penyelesaian naringin memainkan peranan penting dalam aplikasi komersil dan teknologi. Selama bertahun-tahun, serat optik polimer (POF) telah sangat menarik untuk aplikasi perindustrian kerana ciri-ciri unik mereka. Dalam projek ini, saya mencipta penjanaan mudah, kos rendah dan cekap untuk mengesan kepekatan larutan naringin menggunakan POF. Tujuan kajian ini adalah untuk merancang sensor Fibre Optik Polimer (POF) untuk merekabentuk sensor untuk POF yang dipoles sebelah dan berganda sisi tunggal untuk menganalisis prestasi sensor POF dengan menggunakan kepekatan naringin penderiaan dan untuk membangunkan sistem prototaip sensor POF digilap sisi. Jarak yang berlainan dan tenaga sumber yang tidak bersentuhan LED (RGB), maka serat optik yang dipoles bersilang dan berganda, juga kepekatan naringin yang berbeza telah dipilih sebagai pemboleh ubah yang dimanipulasi. Semua elemen dianalisis secara eksperimen untuk mengoptimumkan voltan keluaran. Pada akhir projek, prestasi sensor cecair yang berasaskan sensor dipolitikkan untuk pengesan kepekatan naringin menggunakan Arduino berjaya direka dan dianalisis. Keputusan eksperimen menunjukkan bahawa apabila kepekatan naringin meningkat, tindak

balasnya menunjukkan kehilangan kuasa optik yang lebih besar disebabkan oleh sinaran cahaya di kawasan yang terendam POF cenderung dibiaskan daripada gentian bukannya secara keseluruhannya dicerminkan dan dihantar ketika indeks pembiasan media cecair sekitarnya meningkat. Penyelidikan ini berguna untuk dilaksanakan dalam industri makanan untuk memastikan kepekatan naringin dalam makanan tidak melebihi nilai yang ditetapkan.

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LIST OF SYMBOLS AND ABBREVIATIONS

For examples:

POF	:	Polymer Optical Fiber
PMMA	:	Polymethyl Methacrylate
RGB	:	Red Green Blue
S	:	Seconds

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CHAPTER 1

INTRODUCTION

This chapter is discussed about the project background, the problems statements of the project, the objectives of the project and project scope. In this chapter, these will be briefly explained.

1.1 Project Background

In recent years, optical fibers are just used in telecommunication system as a data transmission medium and it is also widely used in variety of applications such as transmitting transmit voice, data signals through small flexible threads of glass or plastic, military, medical environment to the broadcasting industry, television and images. Fiber optic cables are long, thin strands of very pure glass about the size of a human hair. They are arranged in bundles called optical cable and used to transmit signals over long distances. Optical fiber does not conduct electricity and also immune to electromagnetic interference. Therefore, it is suitable for highly inflammable material or high volume electricity [1].

In the development of fiber optic technology, different researches had been conducted which are focused on suitable design of fibers. Some of the studies being done were directed to the designing of sensing systems with the use of these optical fibers, which led to the production of fiber-based sensing devices and components. At present, the development of sensors is remarkably responding to the needs and demands of consumers. Nowadays, fiber optic technologies have been developed for application communication systems. However, the developments of high quality and competitively priced optoelectronic components and fibers have contributed to the growth of fiber optic technology in sensing applications [2,3]. In addition, low production cost and installation have contributed to the prevalent use of optical fibers in sensing. In recent years, optical fiber based sensors have attracted increasing interest owing to their inherent characteristics such as immunity to electrical noise, ease of miniaturization, the possibility of real time monitoring and remote sensing [4]. Additional advantages of fiber optic sensors in comparison with conventional sensors are immunity to electromagnetic interference, multiplexing capability, distributive sensing and non-intrusiveness, lightweight, high sensitivity and spark-free [5]. These features make them a powerful tool for environmental and industrial process monitoring. Liquid-level measurements in practice have been attracted by the splendid properties of optical fiber sensors. Level detection plays an important role in commercial and technological applications [6] such as monitoring of the water level in catchment areas, scrutinizing of illegal dumping of trash and pollution in canals, early warning of impending drought [5], monitoring of liquid level in oil tanks which is important in the petroleum and chemical industries [7]. Chemical industries widely require fiber-based liquid sensors since they are non-electrical and spark-free, and would not likely cause severe disasters when controlling volatile liquids. Correspondingly important is the measuring and controlling of the concentration of solutions in chemical industries, sugar-manufacturing and pharmaceutics, to guarantee and improve product quality [8]. The use of optical fibers in measuring solution concentration is a necessity to some industries since they are safe to be used in volatile liquids. Plastic optical fibers (POF) are also resistant to certain organic acids which allow them to be used to measure concentrations of some strong acids in water [9, 10]. In the present work, we characterized POFs made form Polymethyl Methacrylate (PMMA) core material and fluorinated polymer cladding material for liquid level sensing and concentration sensing applications. Single POF sensor system was constructed and utilized for the liquid-level sensing tests. Two single POFs were used to create the sensor arrangement—one was unstripped and the other fiber's cladding was stripped—to examine how would the stripping of cladding affects the response of the fiber sensor to the increasing level of liquid. Two fiber bundles were also made for the sensing of variation in concentration of glycerin solution. The prepared POF was then subsequently subjected for numerical aperture measurement and structure examination.

An optical fiber is divided into three parts which are the cladding, and the coating or plastic buffer. The core is a central tube of a very thin size that made up of the optically transparent dielectric medium and carries the light from the transmitter to the receiver. The core diameter can vary from about 5µm to 100µm [11]. Besides, the cladding is an outer optical material surrounding the core having a reflecting index lower than the core. It helps to keep the light within the core throughout the phenomena of total internal reflection while the plastic buffer is a plastic coating that