ANALYSIS ON DIFFERENT LENGTH OF SENSOR AREA TOWARDS THE PERFORMANCE OF FIBER OPTIC SENSOR FOR REFRACTIVE INDEX MEASUREMENT

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DEDICATION

This humble effort especially to my beloved parents, family, lecturers and friends, whose love can never be forgotten, whose support, guidance and encouragement upon completing this research and thesis.

ABSTRACT

The massive increase in electronic communication during the last decades has spurred the development of ways to transport and process large quantities of data. There are various types of methods used based on electrical detector for liquid concentration measurement. Optical fiber sensor has received a great attention in recent years due to their specialty on sensitivity, size and technology which capable to measure various space area and conditions. In this project, Single mode-Multimode-Single mode (SMS) and Multimode-Single mode-Multimode (MSM) were tested in five different lengths of sensing region which are 4 cm, 6 cm, 8 cm, 10 cm and 12 cm at 1310 nm and 1550 nm. The etched sensor region tested in water (1.333 RIU), 1 mol of sucrose (1.386 RIU) and oil (1.464 RIU) with different values of refractive index. The change of the refractive index affects the resonant wavelength. For SMS, it observed that the longest sensor demonstrate the best sensitivity of 11.751 nm/RIU at 12 cm length for 1310 nm. Meanwhile, for MSM fiber the best sensitivity is -11.154 nm/RIU which is for 12 cm length sensor region and the best wavelength for optical light source is 1310 nm.

ABSTRAK

Peningkatan besar dalam komunikasi elektronik dalam dekad yang lalu telah mendorong perkembangan cara untuk mengangkut dan memproses data yang banyak. Terdapat pelbagai jenis kaedah yang digunakan berdasarkan pengesan elektrik untuk mengukur kepekatan cecair. Sensor serat optik telah mendapat perhatian yang sangat baik dalam tahun-tahun kebelakangan ini kerana kepakaran mereka terhadap kepekaan, saiz dan teknologi yang mampu mengukur pelbagai ruang dan keadaan ruang. Dalam projek ini, mod Single-Multimode-Single (SMS) dan Multimode-Single mode-Multimode (MSM) telah diuji dalam lima panjang sensing region iaitu 4 cm, 6 cm, 8 cm, 10 cm dan 12 cm pada 1310 nm dan 1550 nm. Kawasan sensor yang terukir diuji dalam air (1.333 RIU), 1 mol sucrose (1.386 RIU) dan minyak (1.464 RIU) yang mempunyai nilai indeks biasan yang berbeza. Perubahan indeks biasan memberi kesan kepada panjang gelombang resonan. Untuk SMS, diperhatikan bahawa sensor terpanjang menunjukkan kepekaan terbaik 11.751 nm / RIU pada panjang 12 cm untuk 1310 nm. Sementara itu, bagi gentian MSM, kepekaan yang terbaik adalah -11.154 nm/RIU yang merupakan kawasan sensor panjang 12 cm dan panjang gelombang terbaik untuk sumber cahaya optik ialah 1310 nm

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LIST OF SYMBOLS AND ABBREVIATIONS

SMF	:	Single mode fiber
MMF	:	Multimode fiber
SMS	:	Single mode-multimode-single mode
MSM	:	Multimode-Single mode-Multimode
HF	:	Hydrofluoric Acid
SiO_2	:	Silica
FOS	:	Fiber optic sensor
OSA	:	Optical Spectrum Analyzer
RI	:	Refractive Index
nm	:	Nanometer
FBG	:	Fiber Bragg Grating
POF	:	Plastic optical fiber
EMI	:	Electromagnetic interference
GaAs	:	Gallium arsenide
NaCl	:	Sodium Chloride
NH_4F	:	Ammonium Fluoride
$(NH_4)_2SO_4$	:	Ammonium Sulfate
H_2SO_4	:	Sulfuric acid

LED	:	Light emitting diode
H_2O	:	Water
nm/RIU	:	Nanometer/refractive index per unit
H2SO4	:	Sulfuric acid
H2SO4	:	Sulfuric acid

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CHAPTER 1

INTRODUCTION

This chapter consist of introduction, problem statement, objective and scope of the study.

1.1 Introduction

The massive increase in electronic communication during the last decades has spurred the development of ways to transport and process large quantities of data. One important contribution to this development has been the invention and development of optical fibers. Optical fiber sensor has received a great attention in recent years due to their specialty on sensitivity, size and immunity to electromagnetic interference in the biological, chemical and environment industries [1]. Fiber optic sensor is a technology which capable to measure various space area and conditions. This is a step forward for fiber optic sensor because other sensing device cannot reach and

unsuitable. The advantage of the fiber optic sensor includes that it carries more information than conventional copper wire [2].

The main fiber optic sensor used are single mode and multimode fiber optic sensor that mainly made from silica (SiO_2). Single mode diameter normally between range of 8.3 to 10 microns that has one mode of transmission and has a relatively narrow diameter. While for multimode fiber, it has a little bit bigger diameter with a common diameters in the 50-100 micron range for the light carry all the data and component through it. This project is focusing on the performance of the single mode and multimode fiber sensor on different length because both fiber will be spliced together. Single mode-Multimode-Single mode (SMS) and Multimode-Single mode-Multimode (MSM) are used to detect the refractive index for different concentration of liquid. The proposed of the system can be implied widely in chemical and others industries that face with dangerous solutions.

By doing so, it can be assure the exact safeness when operating at highly dangerous industries. It is very crucial to ensure the safety of the workers and the structure of the buildings. Although it is focused on industrial and dangerous area, it also can be used as home appliance which allow consumer to monitor their premise form others dangerous solution that can harm their families members. The usage of a refractive sensor is unlimited due to it can be used for almost anywhere but the equipment used for the sensor determined the scope of the product.

1.2 Problem Statement

There are various types of sensors used for liquid concentration measurement especially based on electrical devices. Electrical devices may cause flammable due to the electricity that flow through the wire. However, fiber optic are made of silica and have various advantages such as immune to electromagnetic interference and use light pulse to transmit information and it safe to use for all solutions. In addition, the sensitivity of the sensor will be effected when different length is applied on the fiber. Then it will give various output power and increase the evanescent wave output. Measurement of liquid concentration in really important especially in the chemical industries, so fiber optic is the best way to have save measurement and avoid any major damage.

1.3 Objective

The objective of this project are:

i. To design the single mode and multimode for SMS and MSM fiber optic sensor
ii. To analyze the effect of different lengths on single mode and multimode fiber optic sensor
iii. To evaluate the sensitivity of the refractive index on liquid concentration based on different length fiber.

1.4 Scope of work

The scope of work on this project is to analyze the effect of different length on single mode and multimode fiber optic sensors (FOS). Both sensor will be test on the refractive index of the liquid concentration to check the sensitivity of the sensors. The fiber optic sensor were developed by using a fusion arc splicing technique.