PREFACE

Although guided waves in an optical fibre have potential use in telecommunication, their utilisation for sensing applications has become promising and hence fibre optic sensing has turned out to be an emerging field in photonics technology. Measurement of various physical and chemical variables, including pressure, temperature, magnetic field, current, rotation, acceleration, displacement, chemical concentration, reaction rate, pH, detection of pollutant gases etc. have been achieved using fibre optic sensors. Several meritorious features as well as attractive capabilities of fibre optic sensors have brought them to the forefront of other sensing methods. They offer immunity to electromagnetic interference, radio frequency interference and geometrical versatility. Since optical fibres are purely dielectric, it can be used in hazardous areas where conventional electrical or electronic sensors are not safe. Fibre optic sensors have added advantages like very short response time and remote-sensing capability, which mean that transmission of information from various sensor heads to the destination, could be easily achieved.

A variety of schemes including different modulation techniques have been adopted in the design and development of fibre optic sensors. Among these modulation schemes, intensity modulated fibre optic sensors are much more simple and inexpensive without pledging the sensitivity. The present thesis discusses the design, fabrication and characterization of some intensity modulated optical fibre sensors based on the evanescent wave in the cladding region of a multimode fibre.

The thesis is organised into five chapters. The contents of each chapter are outlined below.

Chapter 1 gives a general but brief introduction to Fibre Optic Sensors. This deals with the classification of fibre optic sensors and different modulation aspects of fibre based sensing techniques. This chapter discusses the various ongoing research and development activities in this frontier field all around the world. It reviews different
optical fibre based sensor design, methods and applications. Without much discussion about the basic theory behind each sensor development, the picture will not become clear and perfect.

Chapter 2 deals with evanescent wave theory and it also discusses the attenuated total internal reflection at the core-cladding interface and theoretical understanding of the evanescent field based fibre optic sensors. When light propagates in an optical fibre or wave-guide a fraction of the radiation extends to a short distance from the guiding region into the medium of lower refractive index that surrounds it. This evanescent field decays exponentially with distance from the wave-guide interface. This evanescent tail of the light propagating in the rarer medium is utilised for the development of various sensors. There are a lot of advantages like enhanced sensitivity, possibility of miniaturisation, capability to use in on-line measurements etc for the evanescent wave fibre optic sensors. Also no coupling optics is required in the sensor region for these sensors. These inherent merits are the motivating factors in the development of evanescent wave sensors. An awareness of the critical parameters that determine the extent of evanescent wave interactions is important for the optimal design of evanescent wave sensor. This chapter also deals with the theoretical background necessary for the optimisation of the sensor region.

In Chapter 3, we have introduced a novel method for the deposition rate measurement of thin films using optical fibre sensors. This technique overcomes most of the demerits of the conventional methods for the deposition rate measurement. A comparative analysis of the different conventional techniques is given in this chapter along with the relative merits and demerits of the new method. The characterization of this fibre optic evanescent wave sensor is carried out in the case of silver thin films produced by pulsed laser deposition. Also, the fibre optic sensor has been successfully employed for the deposition rate measurement of aluminium thin films produced by thermal evaporation method. With proper calibration, the sensor can be used to measure thickness of thin films as well. It offers much more advantages than a quartz crystal
monitor, which widely used for thickness monitoring. This fibre optic sensor is found to be highly sensitive and can also be used for remote sensing.

Sensing chemical variables and monitoring chemical processes are important aspects of chemical technology. Development of optical fibre based chemical sensors is one of the promising areas of research. Chapter 4 deals with the design and development aspects of a fibre optic sensor to measure glucose concentration. This sensor works on the principle of evanescent wave absorption phenomena. The fibre optic sensor system has been found to be very sensitive at low levels of glucose concentration with saturation at about 4 gm/litre. Compared to other methods, this fibre optic sensor is simple, inexpensive and works in a direct manner. This chapter also gives detailed description of the fabrication techniques of a hand held optical fibre based device for the measurement of glucose concentration. The system can be easily adapted to measure glucose concentration in urine.

Chapter 5 is devoted to the design and characterization of an evanescent wave fibre optic sensor to detect toxic gases. Sensitive detection of the pollutant gases like nitrogen dioxide, ammonia and methane etc. is found essential in industrial applications, environment pollution monitoring and in mines. This chapter discusses a novel approach for the detection of NO\textsubscript{2} utilising the evanescent waves in a multimode plastic clad silica fibre by replacing a portion of the cladding with organic materials such as metalphthalocyanines and rare earth phthalocyanines. A comparative study of these phthalocyanine coated fibre sensors as well as the reusability of the sensor is also included in this chapter.
SOME OF THE RESULTS OBTAINED WERE PUBLISHED:

a) Papers Published in Journals


b) Papers presented at conferences


