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## ***PREFACE***

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The interest in organic semiconducting materials has rapidly increased in recent decades due to the exceptional advantages and unique properties of organic semiconducting materials over inorganic semiconducting materials. Organic semiconductor's promising features in terms of room temperature processing, easy synthesis, tunable chemical structure, suitable band gap, optimization of sensor performance, adjusting sensitivity and selectivity to specific gases or light wavelengths, and compatibility with flexible substrates make them a viable choice for broad area applications in the sensing and medical domains in near future. Organic semiconductors-based thin film devices have inherent advantages in sensing applications due to their flexibility, lightweight, portable nature, compatibility with integrated circuits, and low-cost fabrication methods, such as solution processing and printing techniques, which make them economically viable in future applications.

The present thesis consists of work carried out on organic semiconducting material for the fabrication and characterization of the visible photodetector and ammonia gas sensors for domestic and commercial uses. In the thesis work, the polythiophene derivative, **PTB7** (Poly[[4,8-bis[(2-ethylhexyl)oxy]benzo[1,2-b:4,5-b']dithiophene-2,6-diyl][3-fluoro-2-[(2-ethylhexyl)carbonyl]thieno[3,4-b]thiophenediyl]] [molecular formula,  $(C_{41}H_{53}FO_4S_4)_n$ ] is used as a p-type material with remarkable properties such as high absorbance coefficient, good mobility for thin film device fabrication. Polymer PTB7 is explored for photodetection and ammonia gas-sensing applications. The device fabrication utilizes solution processible approaches such as the low-cost spin coating method and the floating film transfer method (FTM) for the growth of a PTB7 polymer thin film as a sensing layer throughout all-thesis work and further investigated for thin

film properties and sensing characteristics. The spin coating has been reported as the easy, uniform and scalable process to get thin film coating of active material but suffered from a large amount of material wastage and poor directional as well as the inability to form a self-assembled layer. Therefore, another solution processible technique FTM has been used to make better quality self-assembled as well as oriented polymer film and minimise material wastage.

The selection of device structure for any electronic device impacts the device's performance in many aspects in the sensing domain. Therefore, selecting a device structure is a crucial decision during device planning. In this thesis, vertical and MSM structures have been utilized for device architectures for photodetection and gas sensing applications. This thesis is divided into five chapters that explore the development of PTB7-based devices and their uses as selective photo-sensing and gas-sensing. Each chapter starts with a synopsis of its contents, which is followed by the rationale for the research and additional graphical support.

**Chapter 1** introduces the organic/inorganic semiconducting materials, the advantages, and disadvantages of the organic/inorganic semiconducting materials, followed by the outstanding properties of PTB7 polymer are described. This chapter also includes a basic introduction to photodetectors, their key parameters, gas sensors, their key parameters, a literature review on organic polymer-based photodetectors and gas sensors, and the sensing mechanism of photodetectors and gas sensors in brief. Later, instrumentations for the fabrication and characterization of thin film devices reported in this thesis work have also been discussed in the chapter. At the end of the chapter, a brief literature review for the problem statement formation of the thesis work is presented.

In the next chapter, **Chapter 2**, a PTB7-based MSM structure device has been fabricated for visible light sensing. The thin film of the active layer has been deposited

on the Si/SiO<sub>2</sub> wafer through the spin coating technique. The as-fabricated device has been investigated for the visible light spectrum.

Next Chapter, **Chapter 3** discusses the light-sensing properties of vertical structure-based thin film devices using a PTB7 polymer thin layer as active material. The polymer layer has been achieved by the FTM to enhance the sensing properties of the fabricated device.

**Chapter 4**, explores the gas-sensing properties of PTB7-based thin film devices. ZnO nanorods layer has been used to enhance the sensing properties of the PTB7 active layer for room temperature ammonia gas sensing. The selectivity, stability and transient analysis have also been carried out to study the fabricated ammonia sensors.

In **Chapter 5**, the thesis concludes with the significant contribution and summary of the results achieved in this research work. This chapter also contains the future scope of the thesis work present in this thesis.