Preface

In the present day scenario, the quantum use and release of hazardous gases has been increased manifold. Today the industries and automobile vehicles are the major contributing agents for environmental pollution. As almost all industries release hazardous gases in one form or the other. The growing awareness of the people about environmental hazards has placed the responsibility on health authorities to monitor the level of hazardious toxic gases in the environment to ensure a pollution free environment.

In view of the above, it has become very important to detect them to prevent explosion accidents, outbreak of fire, environmental pollution and exposure of employees and public. Therefore it is needed the development of smart, effective and user friendly sensor. In the last few decades, a great importance has been given to the sensors and actuators to bring about an industrial revolution. Amongst the various type of artificial sensors (viz. pressure sensor, aural sensor and optical sensor etc.), gas sensor is the most important but least developed area on which many field, e.g. industrial, consumer and environmental fields, rely to blend and monitor the ambient constituents.

The platinum gate MOS devices have emerged one of the most promising gas sensor for detection of hydrogen , hydrocarbon and the other hydrogen containing gases. Hydrogen gas is widely used as a fuel in industry, as a reducing agent in epitaxial reaction and in various other commercial and industrial applications. Leakage of hydrogen can result disastrous consequences. Therefore, monitoring of traces of hydrogen gas has become extremely important.

In the present investigation, hydrogen detection properties of platinum gate MOS structure on <100> silicon has been carried out. The characterization and performance study of the fabricated MOS sensors having SiO_2 as insulator have been investigated. An effort has also been made to improve the performance of Pt-gate MOS sensor by using plasma treated SiO_2 instead of conventional thermally grown SiO_2.

The thesis has been divided into six chapters:

Chapters 1 describes the need of gas sensors and then outlines the objectives and the strategy that has been followed to achieve these objectives. It also describes the various types of micro gas sensors based on the different micro technologies which have been used for fabrication and presents the literature survey that has been undertaken in the field with the special emphasis on the MOS gas sensors.

Chapter 2 includes the theory of MOS structures especially, MOS capacitor and its principle and gas sensing mechanism.The various adsorption isotherms which are generally used to describe the interaction between solid surface and the gases along with their utility in explaining gas sensing mechanism of the MOS structure have been discussed.

Chapter 3 discusses the fabrication facilities that have been involved in fabrication of MOS gas sensor and demonstrates the experimental facilities available in the laboratory. This chapter also illustrates the measurement set-up that has been used to characterize the fabricated MOS sensor. This chapter also describes the steps involved in fabrication of gridded Pt/ SiO_2 / Si MOS sensor.

Chapter 4 describes the response of gridded Pt/ SiO_2 / Si MOS sensor towards hydrogen (H_2), ammonia (NH_3), methane (CH_4) and hydrogen sulphide (H_2S). The microstructral studies have been carried out by using SEM and AFM to get an idea about the surface morphology of the gate material. This chapter deals the effect of H_2, NH_3, CH_4 and H_2S concentrations on the C-V, G-V and sensitivity of MOS gas sensors at room temperature. Interface trap charge density (Nit) has also been evaluated from G-V curve for all test gases. The gas sensing mechanism for gridded and un-gridded gate Pt/SiO_2/Si MOS sensor has been discussed with suitable diagrams.

Chapter 5 describes the effect of RF plasma on fixed charge density and sensitivity (%) both on gridded gate Pt/SiO_2/Si MOS sensor upon exposure to hydrogen. This chapter also describes the advantages of RF plasma in improving the surface properties of the SiO_2 with varying plasma power and exposure time both. AFM (atomic force microscopy) of plasma treated non plasma treated SiO_2 surfaces has been carried out to evaluate the surface morphology. The sensitivity of plasma treated MOS sensors has been studied as a function of RF power and exposure time.

Chapter 6 presents the summary, conclusion and future scope of the entire work.