PREFACE

In view of the limited fossil fuels available in nature, hydrogen has been projected as one of the most potentials energy resources for future generation applications. However, the production, transportation, and use of hydrogen gas are very much risky due to its extremely explosive nature. Hydrogen gas produced by methane or coal-dust explosions or by the spontaneous heating and low-temperature oxidation of coal in the coal mines is also very dangerous. Therefore, highly efficient hydrogen gas sensors are required for the detection and monitoring of hydrogen gas in various areas including coal mines and industries producing and transporting the hydrogen gas. In general, metal oxides are widely used for efficient gas sensors due to their low cost, high gas response, easy to fabricate, and high selectivity to the target gas. That is why the present thesis reports some titanium dioxide (TiO_2) and zinc oxide (ZnO) thin film based hydrogen sensors with emphasis on their room-temperature hydrogen sensing features. Two device structures namely the metal oxide semiconductor (MOS) and metal-semiconductor-metal (MSM) structures have been explored for hydrogen-gas-sensing-applications. The thesis consists of SIX chapters, which are briefly discussed in the following chapters.

Chapter-1 briefly introduces the hydrogen gas sensors and their fabrication and characterization techniques. The working principle of metal oxide thin film based on the hydrogen sensors is discussed. A detailed literature survey has been carried out to define the scope of the present thesis.

Chapter-2 deals with the investigation of an interdigitated MSM structure-based hydrogen gas (H_2) sensor using a spin-coated TiO_2 thin film as the active material in the device. The TiO_2 active layer is deposited on a SiO_2 coated Si substrate in which the SiO_2 layer is first grown by thermal oxidation of the Si substrate. The electrical and hydrogen gas sensing properties of the proposed MSM sensor have been analysed in detail.

Chapter-3 investigates the room-temperature hydrogen sensing properties of the Pd/TiO_2/Si/Al-based MOS sensor. The TiO_2 film is deposited on the Si substrate by the thermal evaporation method. Palladium (Pd) metal dots are fabricated on the TiO_2 for electrode contact. The MOS sensor shows the maximum gas response of 84% when 4% of hydrogen gas is exposed.

Chapter-4 reports the H_2 detection properties of the electron beam evaporated (EBE) TiO_2 film based MOS sensor using the same structure as considered in Chapter-3. The electrical and hydrogen sensing properties of the fabricated device have also been investigated in detail. The maximum room-temperature gas response of 90% for 4% hydrogen is achieved in the proposed structure.

Chapter-5 investigates the H_2 sensing properties of colloidal zinc oxide (ZnO) quantum dots (QDs) based MSM sensor considered in Chapter-2. The ZnO QDs are synthesized by a low-cost hot-injection method. Various electrical and sensing parameters of the proposed sensor have been studied. A reasonably good gas response of 83.2% for 4% hydrogen at 175°C is obtained in ambient air condition.

Chapter-6 summarizes the major findings of the thesis. A brief outline for the future scope of research related to the present thesis is also presented.

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