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Title of the Thesis: Some Investigations into the Performance of Gas Sensors and Their Applications

ABSTRACT

This thesis deals with gas sensor mechanism for different dangerous gasses at a particular lethal concentration with respect to sensitivity, selectivity, humidity effect and temperature effect. The thesis presents the properties of sensing materials for detection of dangerous gasses to be implemented in gas sensors, the best technique adoption for gas sensing technology in terms of sensitivity, selectivity, drifts correction and power consumption, Mapping of the sensor's voltage output to sensor resistance profiles, Compensation for sensor drift, linear response of the used sensors, Performance evaluation of Gas Sensor for the identification and quantification of single gasses and common contaminants in air at concentrations in the parts-per-million range. We view these constituents as important contributions for the advancement of electronic sensing technology towards real application domains ranging from safety, security, medicine and environment to the food industry.

The first chapter is devoted to the introduction of the research work carried out in this thesis. The chapter wise organization of the thesis is also described here. Critical review of gas sensors based on material, lethal concentration, and polymer composition is done in chapter 2. Also it consist historical background of gas sensors. Chapter 3 gives the details of metal oxide semiconductor as sensing materials. It includes working principle, factors influencing sensitivity etc. Chapter 4 deal with experimental details of real time challenges of gas sensor like sensitivity, selectivity, humidity etc. Recent advancement in sensing technology is summarized in chapter 5. And a new circuit is being proposed for wireless gas sensor. Chapter 6 and 7 provide results, characteristics and conclusion of the thesis.

We found that the most often used dopant for SnO_2 gas sensors is palladium due to its well known catalytic properties. A similar situation is observed for other metal-oxide gas

sensors. Another popular doping element is copper. It was found that the doping of SnO_2 with Cu enhances the sensitivity and selectivity to H_2S. The same effect was observed for CuO-SnO_2 and SnO_2-CuO-SnO_2 hetero structures. ZnO (zinc oxide) gas sensor is sensitive to hydrocarbons. Hydrogen and volatile organic compounds. It is developed with higher bias voltages exhibits improved sensitivity. Metal oxide gas sensors with phase space method for analysis are used to thermal modulation and a step change in gas concentration. Tungsten oxide based sensor is used to detect ammonia nitrogen oxide. $Mo0_3$ gas sensors doped with Ti are more conductive for gas sensing at higher temperature and low power consumption. It is capable in detecting NO_2. Micro machined MOSFET gas sensors are good sensitive to hydrogen and ammonia. Tin oxide gas sensor using CMOS technology is sensitive for hydrogen and oxygen at 350-degree temp.

Three metal-oxide NO_2 sensors were evaluated and compared to an electrochemical NO_2 sensor as a reference. All metal-oxide sensors showed reasonable responses in the ranges provided by their respective datasheets; however, their performance was inferior to that of the electrochemical sensor. The sensors showed responses at levels out of their specified ranges, but with low accuracy. Humidity changes affected the performance of metal-oxide sensors. Therefore, recalibration of the sensors should be performed to compensate for the humidity effects. In investigating the temperature effects, the sensor responses were significantly affected, which might be due to thermally-induced air turbulence on the sensing material. In applications where the space is small and heated by nearby high-temperature sources, this may be a source for sensor signal deviation. The results of the selectivity tests showed that at lower target gas concentrations, the sensors had more difficulty providing accurate measurements in the presence of interference gases. Also, the tested NO_2 metal-oxide gas sensors are less affected by the presence of O_2 than by CO_2. Based on our results, provided that metal-oxide sensors have advantages of being small in sizes, low in costs and having long useful lifetimes, careful consideration should be exercised when choosing a sensor that will be suitable to a specific application.

A low power wireless gas sensor based on ultra-low input bias current amplifier, low power XE 8805 using concept of Zooming ADC, Distributed DSP has been developed and the experimental results evaluated. The gas detector data is finally transferred to the internet by using IEEE 1451 Protocol. The response of sensor on internet is satisfactory with ultra-low power consumption by the circuitry used at the transmitting end. This sensor network has a big advantage than the traditional gas sensors in terms of convenience and service life. Wireless communications instead of the original wire communication, to achieve the monitoring of the gas, Wireless sensor structure is simple, no moving parts, more stable performance, even under the harsh working environment .