CHAPTER 6

SENSOR FABRICATION
6.1 Introduction

The available gas / chemical sensors (Figaro, Japan & e2V, UK) relevant to the meat quality assessment are made up of thick film / pellet form of metal oxide materials. The responses of these sensors towards the identified biomarkers is very much limited. The transient response of the sensors available in the market is comparatively longer than the recently developed thin film form of nanostructured sensing elements. One of the most noted bottlenecks of the commercial metal oxide based gas / chemical sensors is their selectivity. Moreover, a separate power supply of 5 to 10 V is required for the micro-heater element of sensors. Because of this power requirement, the power consumption of the whole sensing system increases and hence the cost. Currently, scientists and engineers have been working on various linear and non-linear types of data classification algorithms. But still this remains a major challenge. These shortcomings can be reduced by using the nanostructured doped and undoped thin films of metal oxides.

In this scenario, the developed nanostructured ZnO based sensing elements in this thesis work have shown better room temperature response with inherent selectivity in the detection of meat spoilage markers such as ammonia, acetaldehyde and hydrogen sulfide thus outperforming the traditional gas sensors. Hence the prototype models of ammonia, acetaldehyde and hydrogen sulfide sensors were indigenously fabricated similar to commercial sensor models.
6.2 Methodology

Figure 6.1: Cross sectional view of indigenous sensor.

Figure 6.2: Sensor fabrication scheme.
Indigenous sensor fabrication scheme is depicted in Fig. 6.1. As a first step, the sensing elements for ammonia, acetaldehyde and hydrogen sulfide on glass substrates were deposited using spray pyrolysis technique and made into smaller pieces of size 1 cm x 1 cm using diamond cutter. After that, two gold electrode pads were deposited on the surface of the sensing element using DC sputtering with the standard interdigitated electrode masking. Contacts were established on the sensing element using zero resistance copper wire with highly conducting silver paste. Wire bonder with gold wire will be used to establish contact between sensing element and sensor housing. Cross sectional view of the indigenous sensor is shown in Fig. 6.2. And these sensors can be incorporated in the sensor array of an electronic nose for meat quality assessment. Specifications of an individual sensor is given in Table 6.1

<table>
<thead>
<tr>
<th>Table 6.1: Specifications of individual sensor.</th>
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<tbody>
<tr>
<td>Size of the sensing element</td>
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<tr>
<td>Dimension of the contact element</td>
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<tr>
<td>Dimension of the heater element</td>
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<td>Supply voltage</td>
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<td>Contact type</td>
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<td>Electrode materials</td>
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<td>Package material</td>
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6.3 Features and benefits of the developed sensors

- Typical detection range
  - **Ammonia** – 5 to 1000 ppm
  - **Acetaldehyde** – 10 to 1000 ppm
  - **Hydrogen sulfide** – 5 to 500 ppm

- Room temperature operation

- Durability – No damage was observed when exposed to higher concentrations of target gases

- Reversible - No need to replace sensors after exposure to target gases

- No expensive equipment are needed

- Minimal response to humidity

- Response is stable towards prolonged exposure

- Easy for continuous monitoring 24 / 7

- Low risk of false alarms

6.4 Features of the instrument / system proposed to be taken up for future development

- Sensor type : Chemiresistive

- Sensor technology : Metal oxide nanostructured thin films

- Number of sensors : 3

- Sensor life time : Long life time

- Measuring range : 5 - 100 ppm (for sensor array)

- Response time : 20 s
- **Housing**: Shock resistance plastic
- **Power supply**: Rechargeable batteries
- **Delay between successive tests**: 1 min.
- **Warm up time**: Not required
- **Sampling**: Head space sampling

### 6.5 Chapter summary

Ammonia, acetaldehyde and hydrogen sulfide have been indigenously developed as a part of this thesis work. The major advantages of these sensors are room temperature operation, highly selective to specific biomarkers of meat spoilage levels and faster response and recovery times. The developed sensors can be used to form a sensor array to design and develop a cost effective indigenous e-nose system for meat quality assessment.