

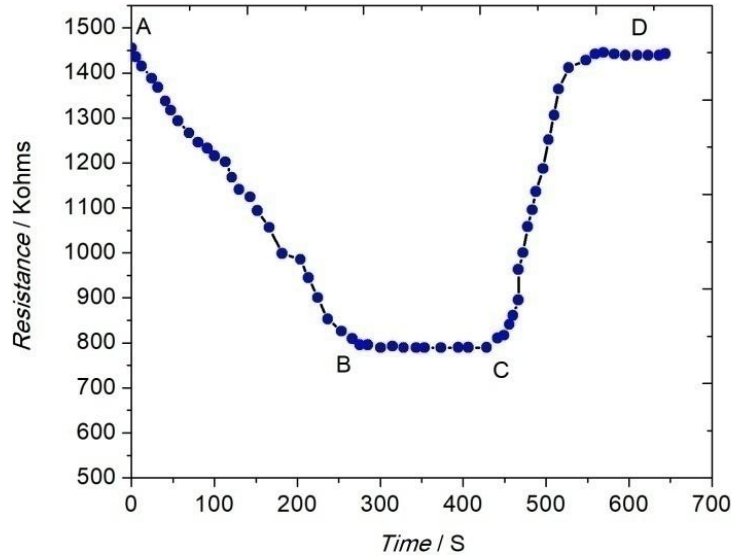
# METHANE SENSING AND DETECTION ACTIVITY OF UNDOPPED ZNO THIN FILMS

### 3.1 Introduction

This chapter deals with the application of undoped ZnO flat thin film in methane sensing study of the developed sensor. The testing of methane detection in the concentration range of 100 - 500 ppm at 75 °C to 200 °C, with selectivity in presence of hydrogen, a brief description of all is presented in this section and main focus on the application in sensing of methane.

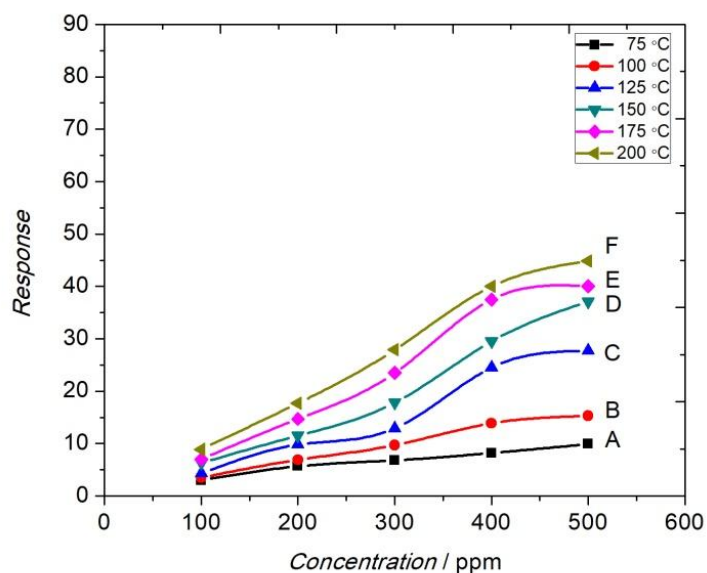
### 3.2 Results and Discussions

Target gas methane was flowed in the testing chamber, when sensor resistance was stable. Sensing activity and sensor response of fabricated undoped zinc oxide thin film for 500 ppm of methane at 200 °C is shown in the Fig.3.1, In this graph, point A represent gas inlet and point C represent outlet conditions. The resistance decreases in the presence of methane from point A to B and point B to C indicate that the sensor resistance was stable in the presence of methane and point C to D sensor recovered to the original stage in the absence of methane, while point A to B indicated the sensor response for methane. The approximate response and recovery time are 260 sec, 98 sec respectively for 500 ppm at 200 °C.

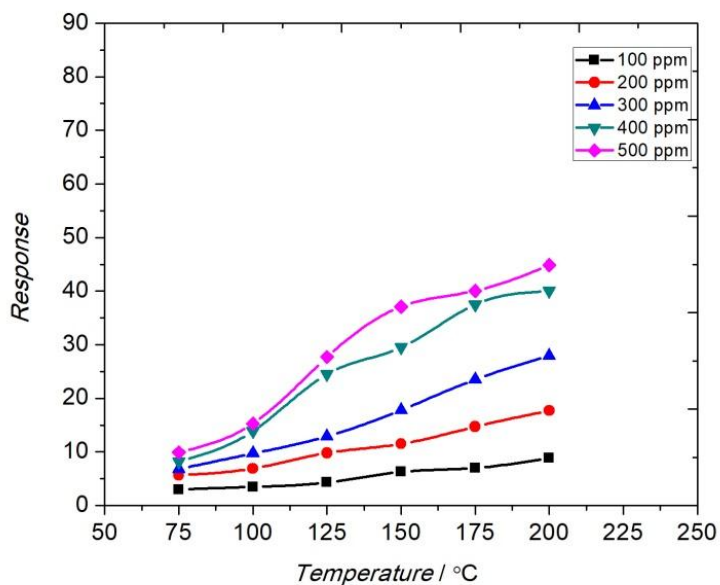


**Fig.3.1. Sensor response of undoped ZnO thin film with methane as target gas at 200°C.**

Response of the sensor for 100 ppm, 200 ppm, 300 ppm, 400 ppm, 500 ppm methane at different operating temperatures ranges from 75 °C to 200 °C, also shown in the Fig.3.2. These graphs indicated that the response increases on increasing concentrations at different operating temperatures. Similarly response increases with increase in temperatures. Fig.3.2, Fig.3.3, show the resultant response for 100 ppm, 200 ppm, 300 ppm, 400 ppm and 500 ppm of methane at operating temperatures of 75 °C, 100 °C, 125 °C, 150 °C, 175 °C and 200 °C respectively. The lowest response value was 2.93% for 100 ppm methane at 75 °C and highest value was 44.83 % for 500 ppm at 200 °C with ZnO films.

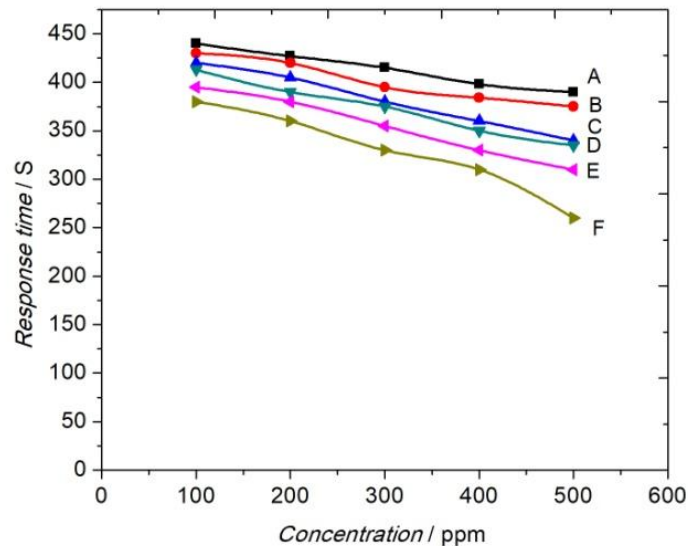


**Fig.3.2. Response of the sensor on various concentrations and curve A, B, C, D, E, F as 75 °C, 100 °C, 125 °C, 150 °C, 175 °C, 200 °C respectively (Response versus Concentration).**

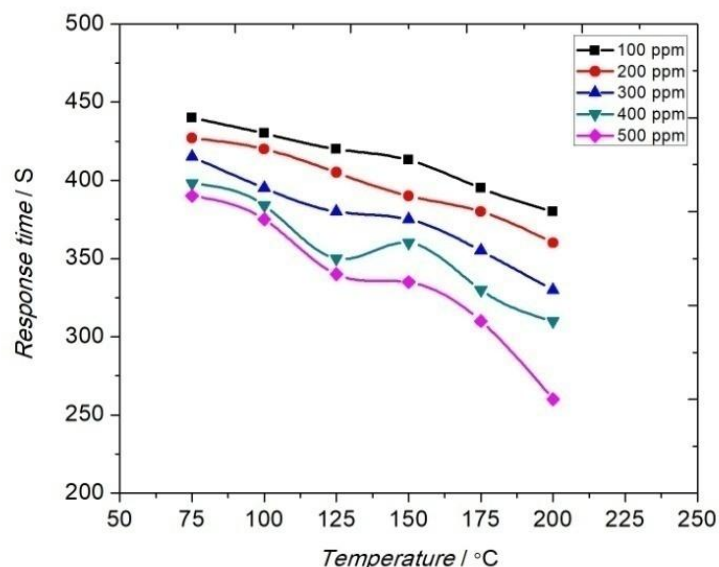


**Fig.3.3. Response for 100 ppm, 200 ppm, 300 ppm, 400 ppm concentrations at 75 °C, 100 °C, 125 °C, 150 °C, 175 °C, 200 °C temperatures (Response versus Temperature).**

Fig.3.4 and Fig.3.5, show the determined the response time of ZnO thin film for 100 ppm, 200 ppm, 300 ppm, 400 ppm, 500 ppm concentrations of methane at different operating temperatures ranging from 75 °C to 200 °C. The response time decreases with increasing concentrations at constant operating temperature. The response time decreases with increasing operating temperatures for same concentration. Resultantly, response time decreases with the combined effect of increase of concentration and temperatures. Response time is 440 sec for 100 ppm at 75°C and 260 sec for 500 ppm at 200°C. Sensor response was quickest for 500 ppm methane at 200°C. Fig.3.4 and Fig.3.5 are correlated to each other, and graph A, B, C, D, E, F denoted as operating temperature at 75°C, 100°C, 125°C, 150°C, 175°C, 200°C respectively.

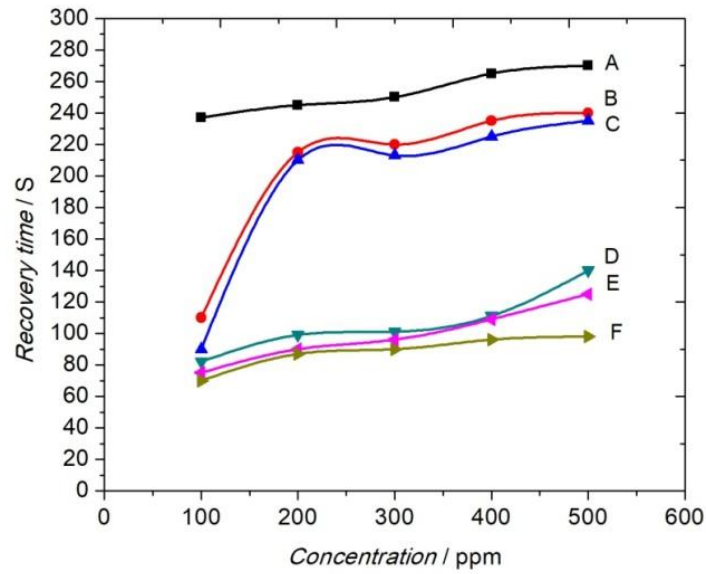


**Fig.3.4. Show response time of undoped ZnO thin film methane sensor for 100 to 500 ppm at operating temperatures 75 °C to 200 °C (Response time versus Concentration).**

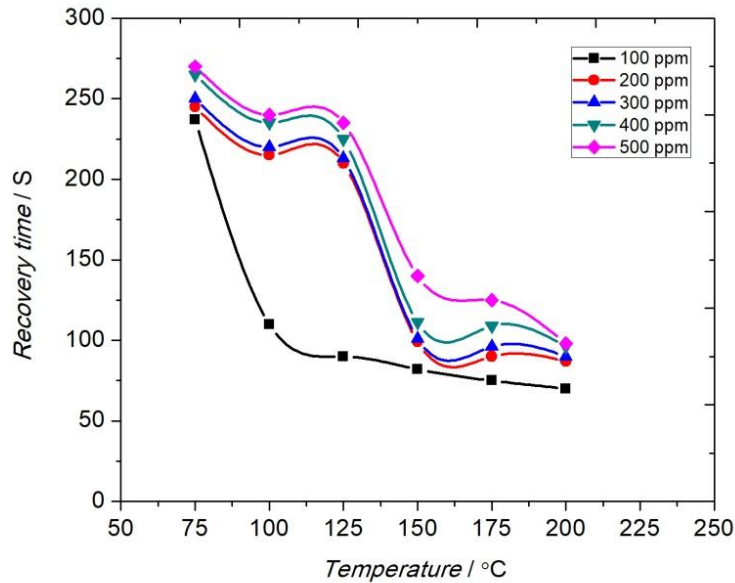


**Fig.3.5. Show response time of undoped ZnO thin film methane sensor for 100 to 500 ppm at operating temperatures 75 °C to 200 °C (Response time versus Temperatures).**

Recovery time increased with increasing concentration at constant operating temperature, while decreased with increasing of operating temperature for same concentration. Resultantly, recovery time decreases with the combine effect of increase in concentration and operating temperatures. Fig.3.6 and Fig. 3.7, show the recovery time for 100 ppm, 200 ppm, 300 ppm, 400 ppm, 500 ppm methane at operating temperatures 75 °C, 100 °C, 125 °C, 150 °C, 175 °C and 200 °C. Recovery time was 237 sec for 100 ppm at 75°C and 98 sec for 500 ppm at 200 °C. This developed ZnO flat film based sensor is suitable up to 250 °C. Desorption of gas molecules start from 250 °C. Fig.3.6 and Fig.3.7 are correlated to each other, and graph A, B, C, D, E, F denoted as operating temperature at 75°C, 100°C, 125°C, 150°C, 175°C, 200°C respectively.



**Fig.3.6. Show recovery time of undoped ZnO thin film methane sensor for 100 to 500 ppm at operating temperatures 75 °C to 200 °C (Recovery time versus Concentration).**



**Fig.3.7. Show recovery time of undoped ZnO thin film methane sensor for 100 to 500 ppm at operating temperatures 75 °C to 200 °C (Recovery time versus Temperature).**

### **3.3 Selectivity**

The separate experiment for selectivity study with hydrogen was carried out. The sensitivity response with hydrogen was found very poor for 100 to 500 ppm concentration at the operating temperature range of 75 °C to 200 °C.

### **3.4 Conclusion**

The developed methane sensor was sensible for 100 – 500 ppm concentration at operating temperatures ranges of 75 °C - 200 °C. The response was highest (44.83 %) for 500 ppm at 200 °C.

