

# Sensitivity Response of Pd doped TiO<sub>2</sub>-MnO<sub>2</sub> based Sensor to Human Urine Odour

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**ABSTRACT:** A new composite material Palladium doped TiO<sub>2</sub>-MnO<sub>2</sub> based mixed metal oxide thick film sensor has been fabricated by simple solid-state method first time for the detection of human urine odour. Sensitivity of the sensor to human urine odour improved by doping palladium.

**KEYWORDS:** Pd doped TiO<sub>2</sub>-MnO<sub>2</sub>, Sensor, Human urine, Odour.

## I. INTRODUCTION

A chemical sensor is a device which upon exposure to gas molecules changes one or more of its physical properties, such as dielectric response, mass, electrical conductivity, and optoelectronic properties in a way that is possible to measure and quantify [1]. These changes give rise to an electrical signal which is proportional to the concentration of gas under test, and is measured as quantity of gas to which the sensor is exposed. Chemical sensor based on mixed semiconducting metaloxide works on the principle of change in electrical conductivity by adsorption or desorption of gas molecules on the surface of mixed metal oxides have received a great attention, given good performance coupled with simple device design and low-cost materials. Currently the research on the gas sensors is aimed at obtaining new materials to achieve high sensitivity and selectivity with long term operating devices. Chemical sensor such as mixed metal oxide sensor [2] has significant applications in the area of environmental nursing, food safety, public health, automotive applications, and medical diagnosis. They possess an extensive range of chemical, physical and electronic properties, that are extremely sensitive to chemical environment. Metal oxides are highly sensitive to their chemical environments. Further, these semiconductorshave large energy band gap which are more stable and hence can be used in harsh chemical environments. These features make them superior to other chemical sensors in their sensitivity, reliability, durability and ease of synthesis.

Fabrication of chemical sensor using metal oxide such as SnO<sub>2</sub>, TiO<sub>2</sub>ZnO, In<sub>2</sub>O<sub>3</sub>, and CuO for e-nose [3].Sensors were also fabricated using mixed metal oxides such as WO<sub>3</sub>-SnO<sub>2</sub>, TiO<sub>2</sub>-SnO<sub>2</sub> and WO<sub>3</sub>-TiO<sub>2</sub> [4]. Gas sensing properties of TiO<sub>2</sub>-SnO<sub>2</sub> based sensor were studied [5]. Investigationswere carried out to improve response of In<sub>2</sub>O<sub>3</sub>-TiO<sub>2</sub> thick film gas sensors [6]. Gas sensing properties by thin film of MoO<sub>3</sub>-TiO<sub>2</sub> have been studied [7]. It has been observed sensor fabricated using mixed metal oxide enhanced sensitivity [2].

## II.RELATED WORK

Gas sensor based on spinel semiconductor ZnGa<sub>2</sub>O<sub>4</sub>doped with Pd [8]. Structural, optical and electrical properties of transparent V and Pd-doped TiO<sub>2</sub>thin films prepared by sputtering [10]. Mechanism of electrical conduction and sensing properties of gas by Pd-doped TiO<sub>2</sub>thin films [10]. Pd-doped TiO<sub>2</sub>nanowires preparation and gas sensing properties studied [12]. Gas sensing of CO and NH<sub>3</sub>by Pd-doped TiO<sub>2</sub>film sensors prepared by premixed stagnation flames [13]. In the current paper an attempt has been made to develop Pd doped TiO<sub>2</sub>-MnO<sub>2</sub> based mixed metal oxide thick film sensor with improved sensitivity to human urine odour. As far as the authors are aware, human urine odour sensing characteristic of this mixed metal oxide is not yet reported.

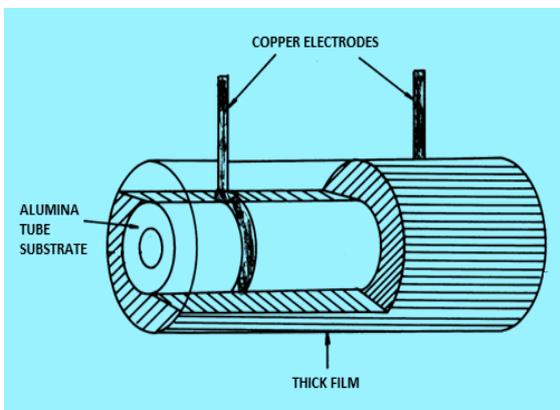
## III.MATERIAL AND METHOD

In the present work, Pd doped TiO<sub>2</sub>-MnO<sub>2</sub> based mixed metal oxide sensor is fabricated by simple solid-state method similar to the conventional method [8][9]. In the first step of the fabrication of sensor, the sensing material which consists of titanium dioxide and manganese dioxide are taken in equal proportion i.e. 0.001 moles in powder form. The metal oxides are mixed properly and then ground in the presence of distilled water in agate mortar. The additive PdCl<sub>2</sub>1.5% by weight was added to base material TiO<sub>2</sub>-MnO<sub>2</sub>. The doped mixture was calcined at 600°C in order to

remove chlorine ion of PdCl<sub>2</sub>. This calcined compound was mixed with organic binder to make slurry. Cleaned alumina tube is tied with copper wire at its two ends which acts as electrodes. The fig.1(a) shows thick film of the sensing material coated on the alumina tube substrate and placed in the furnace at 300°C for sintering. The sensing material becomes rigid as a result of sintering as shown in fig. 1(b). Now the sensor is ready for the detection of odours. The fig. 1(c) shows setup for measurement of sensitivity of sensor. A standard resistance is connected in series with the sensor and Fluke 17B+ ammeter. A variable dc power supply PHY 8130 is used to apply the voltage. A digital voltmeter Mastech MS8239C is connected across the sensor. Now the sensor can be exposed to odour of human fluid placed in the enclosure. The sensitivity is defined as

$$S = \frac{(R_a - R_o)}{R_a} \quad (1)$$

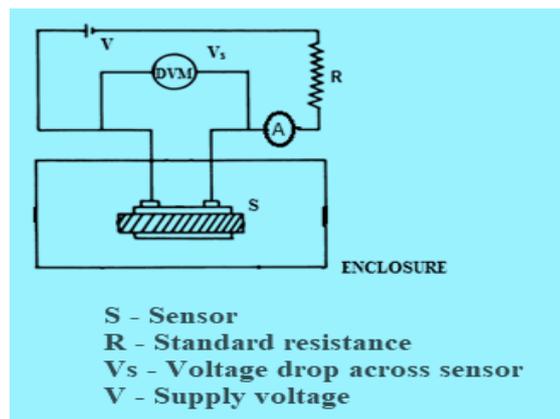
where R<sub>a</sub> is the resistance of the sensor in air measured in mega ohms and R<sub>o</sub> is the resistance of the sensor in odour measured in mega ohms.



(a)



(b)



(C)

#### IV. EXPERIMENTAL RESULTS

Figure 2 shows sensitivity response with time of TiO<sub>2</sub>-MnO<sub>2</sub> based sensor to human urine odour at room temperature. It is observed from the fig. 2 sensitivity of TiO<sub>2</sub>-MnO<sub>2</sub> mixed metal oxide sensor improved after doping palladium. The graph shows that sensitivity of Pd doped TiO<sub>2</sub>-MnO<sub>2</sub> based sensor is not deviating randomly over time unlike TiO<sub>2</sub>-MnO<sub>2</sub> based sensor which is one of the good characteristics of the sensor. The response time of the sensor is the time taken to reach 90% of the maximum value of sensitivity and recovery time of the sensor is the time

required to return 10% of the maximum value upon removal of target odour [13]. The sensitivity, response time and peak time of the Pd doped TiO<sub>2</sub>-MnO<sub>2</sub> based sensor as mentioned in Table 1 improved.

Table 1. Characteristics of Sensor

Sensing Material	Sensitivity	Response Time	Recovery Time	Peak Time
TiO <sub>2</sub> -MnO <sub>2</sub>	0.58	2 minutes	<30 sec	4 minutes
Pd doped TiO <sub>2</sub> -MnO <sub>2</sub>	0.83	1 minute	<30 sec	3 minutes

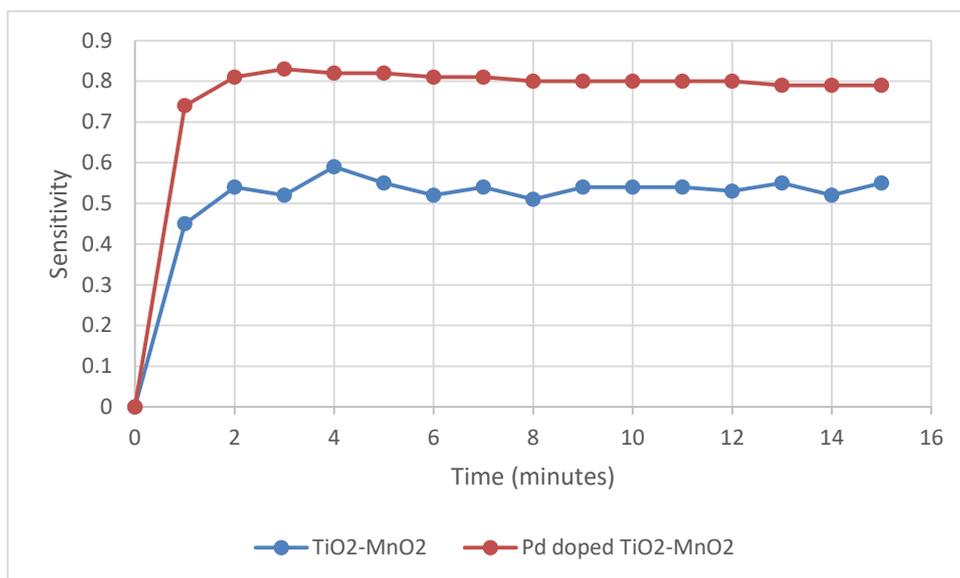


Fig.2 Sensitivity Response with Time

### V. CONCLUSION

A new composite material Pd doped TiO<sub>2</sub>-MnO<sub>2</sub> based mixed metal oxide thick film sensor has been developed by simple solid-state method first time for the detection of human urine odour. The sensor exhibited maximum sensitivity to urine odour compared to undoped TiO<sub>2</sub>-MnO<sub>2</sub> based sensor at room temperature with improved response time. With its high sensitivity, fast response and recovery Pd doped TiO<sub>2</sub>-MnO<sub>2</sub> seems to be a promising material for odour sensor in nose systems for medical diagnosis.

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