ACETONE GAS DETECTION USING MACHINE LEARNING TECHNIQUES

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Abstract*— During the last fifty years, different studies have established various branches of gas technology. Among them, three of major areas that receive the most attention are investigation of the different types of sensor, research about sensing principles and different fabrication technologies. We have made intensive effect toward right and successful direction to analyze the sensitivity, response of SnO_2 based thick film gas sensor 1 % Pd-doped for acetone detection. During the process of fabrication of SnO_2 based thick film gas sensor, the alumina substrate having the dimension 1” x 1” was suitably selected. The constituted of a gas sensitive layer SnO_2 doped with 1% Pd, a pair of electrodes underneath the gas sensing layer serving as a contact pad for sensor. The heater element on the backside of the substrate propagates heat and temperature to the SnO_2 based thick film gas sensor. The various temperatures (150°C-300°C) are chosen to make fruitful analysis of sensitivity of sensor under the exposure to Acetone.

Key Words- Thick film sensor, Sensitivity

1. Introduction

Recent past has witnessed an increased industrial growth worldwide which has led to improved conditions of living. However, this development has caused a negative impact on human health and ecosystem due to an exponential increase in pollution. A significant effort has been made during the last decades to improve the quality of the environment and makes it pollution free.

To meet the demand of low level gas detection, gas sensors should be upgraded in sensitivity, selectivity, and speed of response [1]. The cost effectiveness and reliability over the long term industrial application, these two vital and prominent factors are deliberately emphasized [2].

Metal oxide semiconductor sensors based on electric conductivity measurement have been used extensively for gas detection. The material SnO_2 is considered to be cheap, durable and reproducible semi-conductor oxide for the use of constructing the sensitive sensor. [3,4] ,thick film SnO_2 device are most suitable and most considerable due to their high level of sensitivity ,simple design, low weight and cost effectiveness.

SnO_2 is an n –type, wide–band gap (3.6 Ev) semiconductor [5]. The microstructure of the SnO_2 is one of the most cardinal factor, which control the sensitivity of gas sensor [5, 6]. The electrical conductivity of SnO2 is depend on the function of non-stoichiometric compositions due to oxygen deficiency [6].The sensing properties of the thick film gas sensor are depended on the adsorption of the gas molecules on its surface which inculcate the successive changes in their conductivity [7].

When exposed to air, freshly prepared tin-oxide particles adsorbed on the particle adsorb oxygen atoms on the surface [8].

These oxygen atoms pick up the e-s from the conduction band of tin oxide and are adsorbed on the particle surface as O- ions. Each tin oxide particle is covered with negativity charged O- ions on the surface. On the other hand, due to depletion e-s, there exits a layer of positively charged donor atoms just below the particle surface.

When the sensor is exposed to reducing gases at elevated temperature, the O- adsorbents react with the gases and release the e-s to the conduction band. Consequently, the avalanche of the space negative charge layer decreases, which finally gives rise to decrease in the height of the potential barrier for the electronic conduction at the grain boundaries.

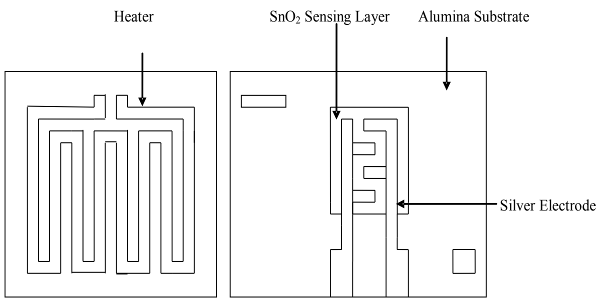
These gas sensors could achieve more improved sensitivity to organic compounds by the control of particle size and addition of promoter [9, 10].

Despite the high sensitivity, disadvantages such as lack of reproducibility, long term stability and selectivity for specific gases are frequently observed; moreover, the sensitivity to ambient moisture strongly interferes with the conduction mechanism.

A better control of the number, distribution and size of the grains and of the intergranular boundaries, together with the addition of catalysts and other promoters during preparation, can contribute in limiting the effect of the previously mentioned disadvantages [11].

III. Experimental

The Figure 1. Illustrates about schematic and line diagram of fabricated gas sensor. Tin oxide was available in the form of Platinum doped tin oxide paste, supplied by Electro Science Laboratories (ESL3050, USA). This 1 % Pd- doped sensor with tin oxide paste has been taken as the base sensing material. The doped pastes were prepared by adding 1% Pd (by weight) in base SnO_2 paste with cellulose based thinner.



thermistor pattern is screen printed first (paste NTC 2413 ESL),and then heated at a temperature of 100˚C and fired at 700˚C. In the second step, finger electrode pattern is screen printed using silver conductor paste (No. PD 6176, DuPont) and dried at a temperature of 100˚C. As a concatenation with in the same process, a heater element is screen printed on the back side of the substrate using silver palladium conductor paste (No. C1214, Heraeus, Gmbh) which is dried at the same temperature. Now the dried screen printed films are fired at 700˚C. In the third step, Pd-doped tin oxide pastes were screen printed over the electrode pattern and the print was allowed to dry at a temperature 100˚C for 20 min. The dried film was then fired in a thick film furnace (DEK model 840) in a set temperature profile with peak temperature zone of 700˚C.

Sensing Characteristics of the sensor

Gas response is define as the ratio of change in resistance of the sample on exposure to a test gas to resistance in the presence of air.

S=Ra-Rg/Ra

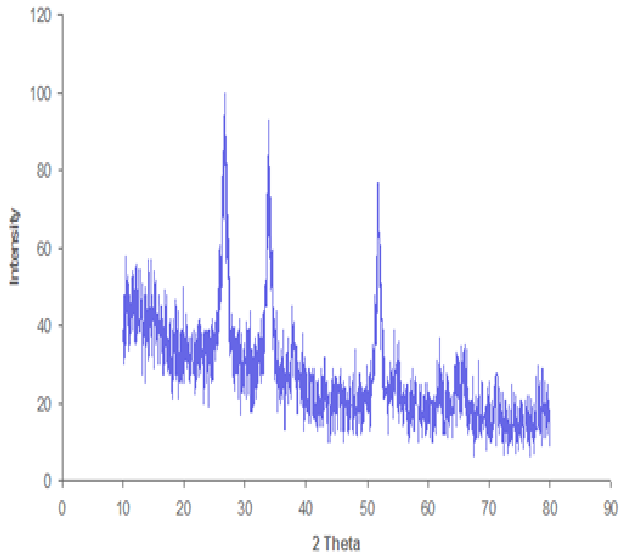
Where

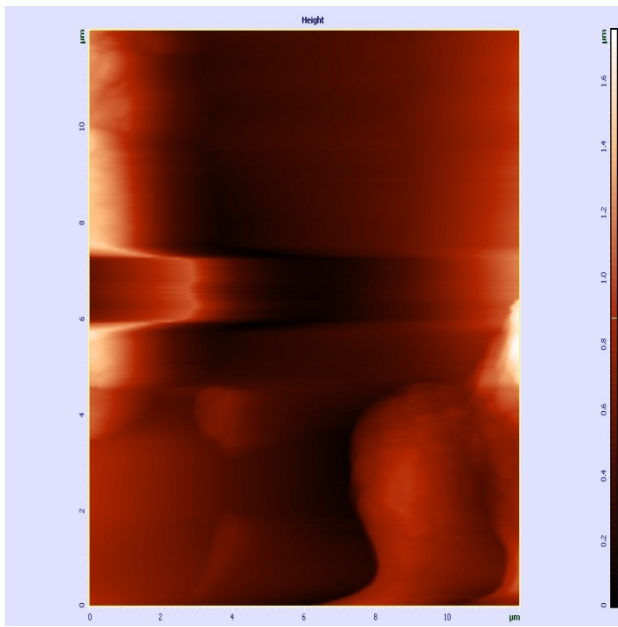
S= Sensitivity

Ra=Resistance in a test gas

Rg=Resistance in a sample gas

ΔR=Change of Resistance





I. Experimental details:

1.5 gm of commercial anisate TiO2 was dispersed in 160 ml of 10M NaOH aqueous solution and stirred for 3h in air. The mixture was placed in 250 ml capacity Teflon-lined autoclave maintained in an oven at 180oC under autogenous pressure for time 6 h, 12 h and 24 h, and then cooled to room temperature naturally.

The white precipitate were alternatively washed with HCl solution (≈1M) and de-ionized water at least three times and dried at 100oC for 7 h. The thixotropic paste [33, 34] was prepared by mixing the fine synthesized power of TiO2, ethyl cellulose (100 mg) and organic solvents.

The paste was screen printed on glass substrate in desired patterns. The prepared films were fired at 550oC for 30 min. to remove the temporary binder. The sensing performance of the thick films was examined by using a static gas sensing system [35-36].

Proposed Work:

The presented instances in HD dataset using various clustering techniques K-Mean clustering and hierarchal clusteringwhich are discussed below:

K-Means Clustering

K-means clustering technique which identifies mutual exclusive clusters of circular shape. In addition, a particular number ofdisjoint, flat (non-hierarchical) clusters are created.

Linear Regression

Linear regression is one of the easiest and most popular machine learning algorithms. It is a statistical method that is used for predictive analysis. Linear regression makes predictions for continuous/real or numeric variables.

Results & Discussions:

Performance Characteristics of the Sensor at Individual Temperatures using Linear Regression

The concept validation graph accomplished between Concentration Vs Sensitivity at 150°C. temperatures for Acetone is shown in Fig.4. The temperature for the sensitivity of Acetone for 1% Pd doped SnO2 based thick film gas sensor was quantitative evaluation.

It is seen in the graph that the sensitivity first increases and after some time reached an Impregnation quality, this sampled data set is shown in Fig 4 at 1000ppm and respected simulation on Linear Regression is illustrated in Fig.5

Its corresponding graph indicates that the sensitivity primarily increases rapidly and after the same time attains achroma value. The maximum sensitivity was found to belts corresponding graph indicates that the sensitivity primarily increases rapidly and after the same time attains achroma value.

The maximum sensitivity was found to 72.70% for Acetone(Hydrogen Sulphide) at 1000ppm.

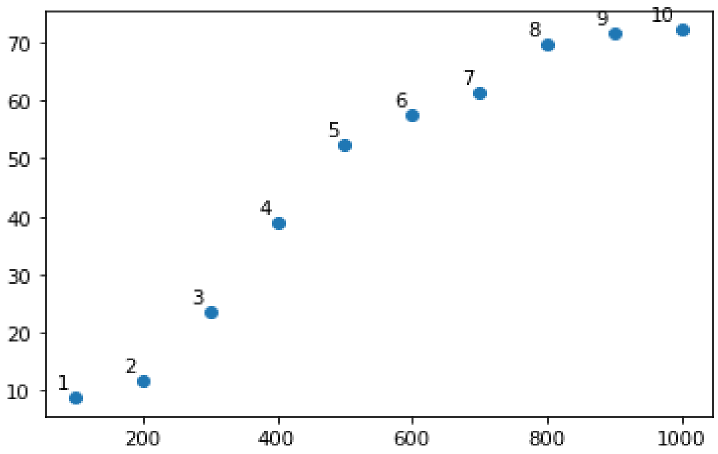


Fig. 4. Response of SnO_2 sensor (1% Pd doped on Linear Regression on the exposure of Acetone at 1000ppm) at 150 °C.

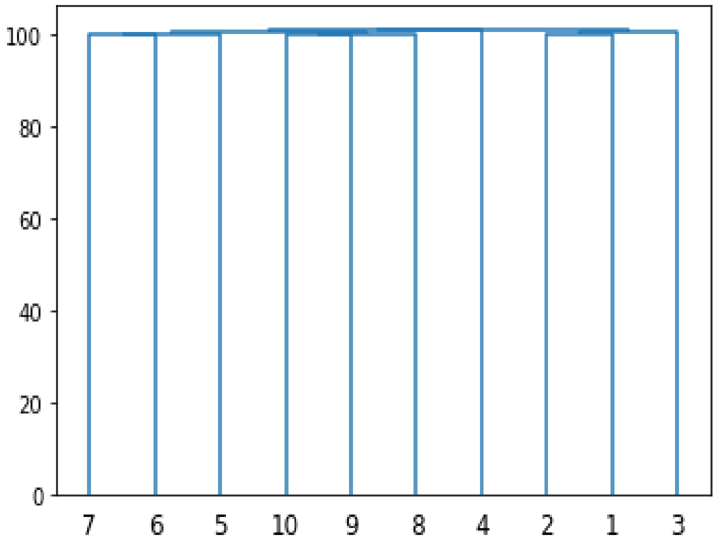


Fig. 5 Simulated Linear Regression Result for 1000ppm at 150 C

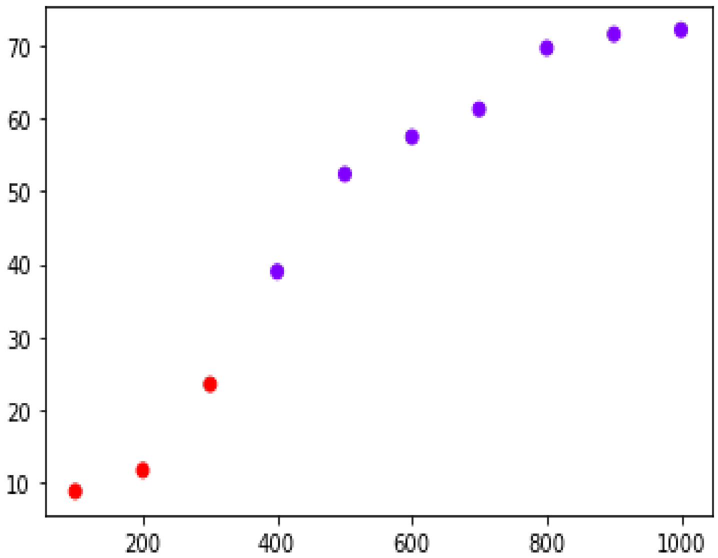


Fig. 6. Trained and Sampling Data of Output at 1000ppm at 150 C

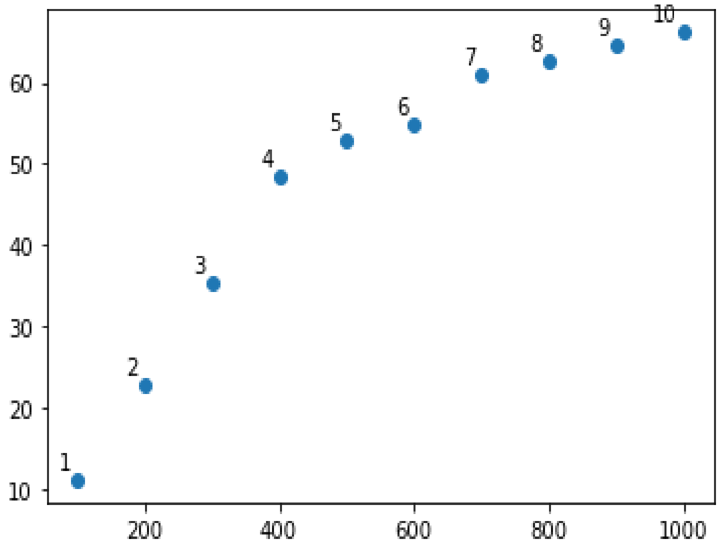


Fig. 7. Response of SnO_2 sensor (1% Pd doped on Linear Regression on the exposure of Acetone as 1000 ppm at 200˚C.)

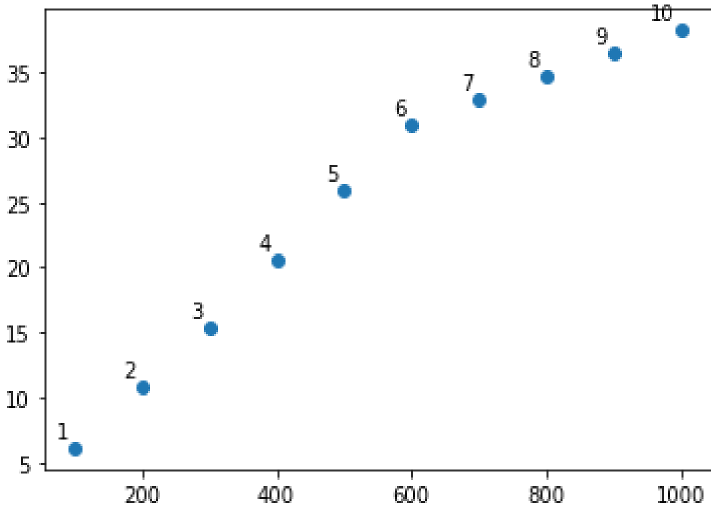


Fig. 10.Response of SnO_2 sensor (1% Pd doped on Linear Regression on the exposure of Acetone at 1000ppm) at 250 ˚C.

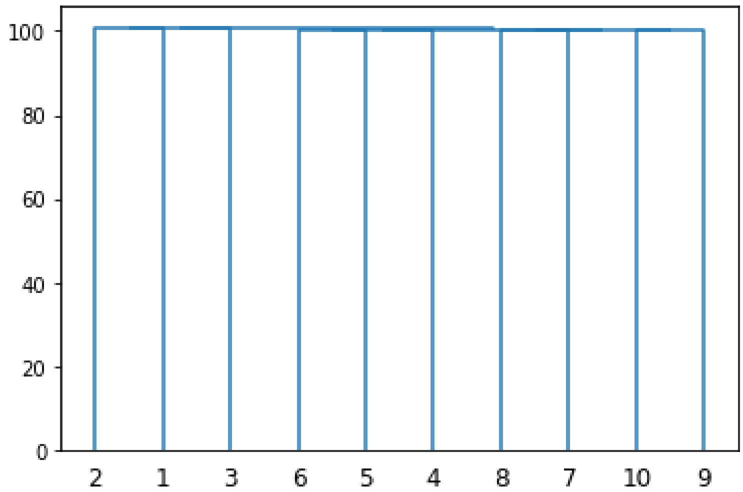


Fig. 8. Simulated Linear Regression Result for 1000ppm at 200 ˚C.

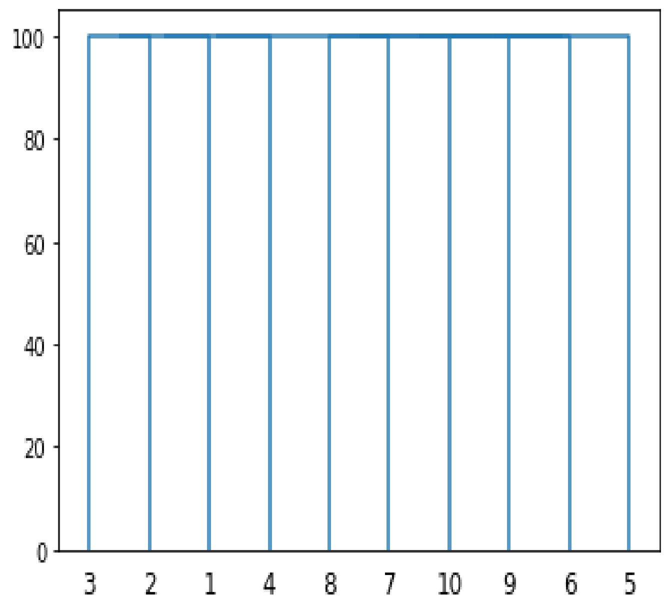


Fig. 11 Simulated Linear Regression Result for 1000ppm at 250 ˚C.

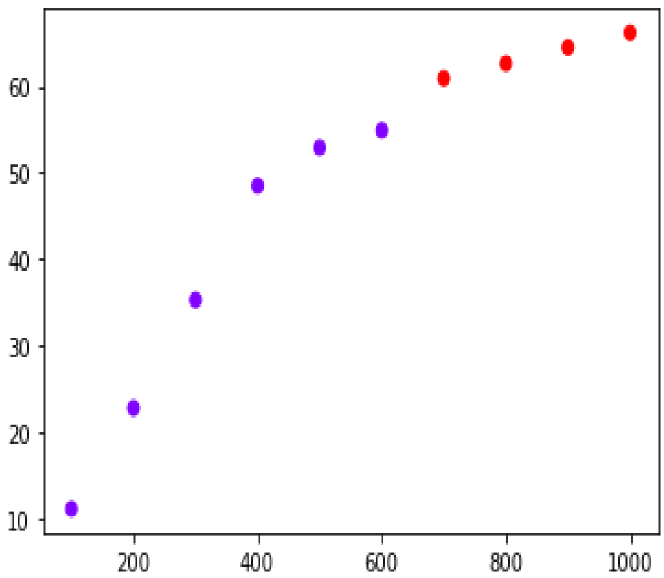


Fig. 9. Trained and Sampling Data of Output at 1000ppm at 200 ˚C.

II.

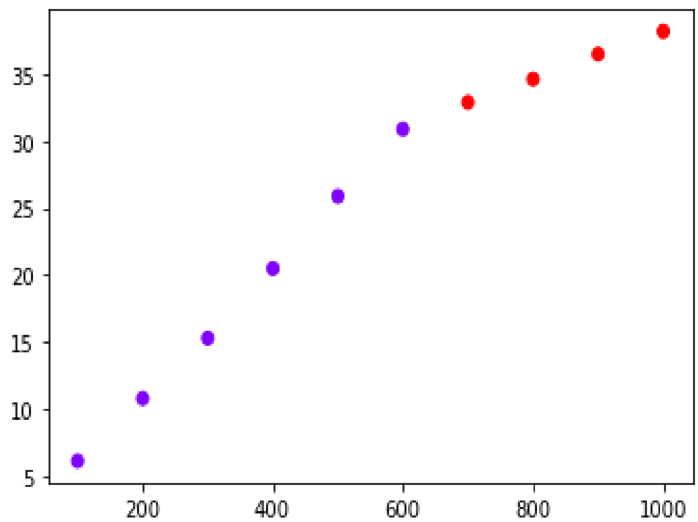


Fig. 9. Trained and Sampling Data of Output at

1000ppm at 200°C.

III. Conclusion:

The maximum sensitivity recorded for a 1% Cu doped sensor for Acetone sensitivity 72.2 is at 150°C .Similarly, when a concentration of Acetone is transmitted to 1% CuO doped sensor at 200°C the Maximum sensitivity recorded is 72.3%. To see the further variation the temperature was increased to 250°C with the same concentration of propanol and 1% Pd doped sensor the sensitivityrecorded was 657%.

The fluctuations in temperature will affect the sensitivity to an extent but more or less Sensitivity remains almost constant with the variation in the atmospheric conditions.

IV.References:

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