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TiO_2 thick films – structural, electrical and gas sensing characterization

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Abstract - TiO2 (Titanium dioxide) thick film made using screen printing technology and alumina substrate used. Structural, Morphological, electrical properties and gas sensing of thick films studied using various techniques including XRD: X-ray diffraction technique, SEM: Scanning Electron Microscopy, and I-V characteristics respectively. Study of gas sensing characteristics of SMO like TiO2, The response was reported of gas Acetone, hydrogen sulphide gas, and ammonia, mixing would provide the detection of various gases in the air and also improve gas sensing efficiency.

Index Terms - Alumina substrate, electrical, gas sensing characteristics, Screen printing, SMO, structural Thick film.

INTRODUCTION

As per current situation importance of Semiconductor is more. In my topic semiconductor metal oxide (SMO) structural, electrical and gas sensing characteristics are studied. While studying this characteristics SMO thick films formed by using screen printing technique. After formation of thick film electrical, gas sensing characteristics are studied.

Different methods of deposition used to develop doped and undoped TiO_2 thick films such as screen printing technique, CVD, Spray pyrolysis and different techniques [1]

Then structural characteristics knew XRD and SEM. Rutile, brookite and anatase are three phases crystalline as observed SMO like TiO_2. SMO have many applications but some of like TiO_2 have variety of application energy storage and its oxides (spl. In anatase phase), corrosion protective coating, photo catalysis are used in gas sensing characteristics as gas sensors. Because of optical and electrical properties TiO_2 is very useful. In case of metals as temp increases conductivity decreases. Whereas in case of semiconductor resistivity increases conductivity increases. Similar observations in SMO.[2]Screen printing technique is non expensive method used, also old technique used for printing purpose SMO gas sensing thick films have been used in gas detection systems because low cost, simply manufacturing, small size. [3]

EXPERIMENTAL TECHNIQUES

TiO_2 (Titanium dioxide) grinded by mortal and pastels. After grinding TiO_2, it was calcinated at temperature 400 °C in muffle furnace for three-four hours. It is process of calcination. Calcinated chemical mixed grinded, glass frit permanent binder and ethyl cellulose temporary binder. The BCA then added drop by drop in mixture becomes paste. 70:30. ratio is taken .Permanent binder to ratio of should be kept as 95:5% in 70 % functional material. Deposition of Thick films from prepared solution or paste prepared, which dried.

Thick SMO films to a substrates such as tape casting, spraying, Electrophoresis, screen printing method. Structural characteristics by XRD, SEM, obtained. (TiO2) is knew because of its major range of applications in various fields. The increased interest in both the application and the basic research of material in the last twenty years due to its important electrical properties. [4]

STRUCTURAL AND MORPHOLOGICAL STUDIES:-

X Ray Diffraction is important mode in study of crystal structure in case various parameters. To obtain phase identification of crystalline materials, X Ray Diffraction, SEM, obtained. X Ray Diffraction is used to find things and structure of materials by finding different values liked d space, 2ϴ angles.

$D = 0.9\lambda / \beta \cos\theta$

SEM is mode to find structural characteristics by using electron microscopy to detect images of a material sample. SEM Resolution of as 1 nm [7]. Scanning of images SEM detects images of a material using microscopy.

I. Electrical characterization

I. I-V (Current – Voltage) characteristics

I – V characteristics provides important information of film. Information observed by placing thick film in two electrodes, through a resistor in the circuit. From measurement of current by mean of changing the voltage. By using the Ohm's law V = I R

Then I=V/R

Thick film was kept in two electrodes. Circuit connections from the thick film are taken by using 2 Cu plates

The circuit connections, are controlled I-V by temperature. Connected to Digital multi- meter. By using Digital Multi meter measured current and by a dimmerstat temperature controlled by changing its voltage. [5]

RESULTS

II. XRD (X-ray powder diffraction)

The crystalline structure, the TiO2 thick films are characterized by XRD technique. As shown in fig 1.1 and fig 1.2 [6]

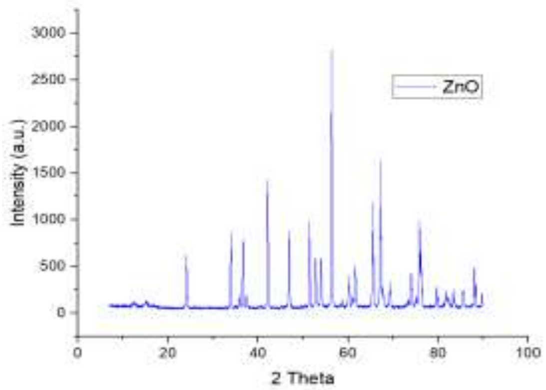

Fig 1.1 XRD graph

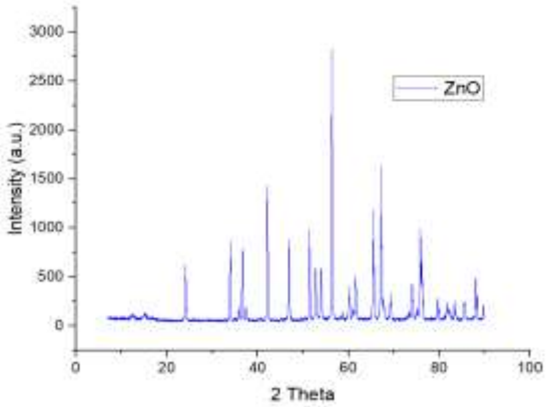

Fig 1.2 XRD graph

III. SEM -

Structural characterization studied using SEM

SEM of SMO thick film Images fired at 400 °C in Muffle furnace. SEM as shown variation in fig.2.1 to fig. 2.5 [7]

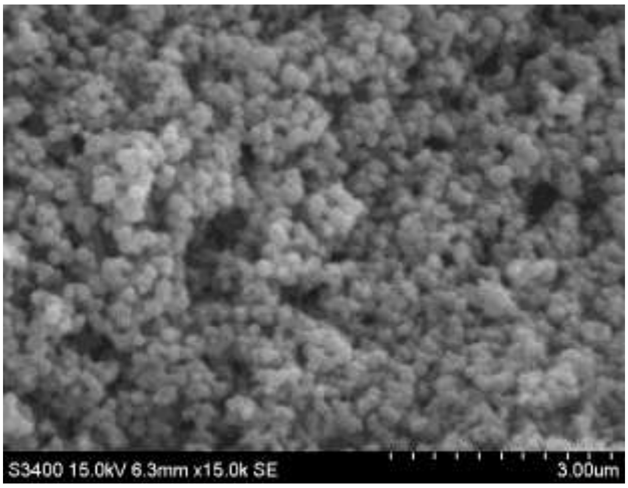

Fig 2.1 SEM

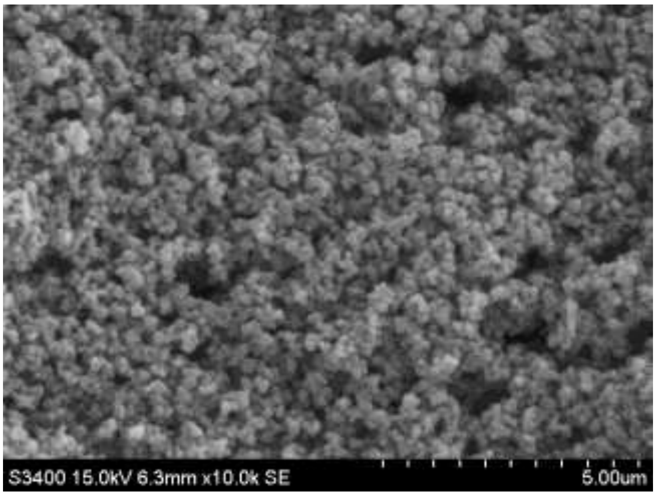

Fig 2.2 SEM

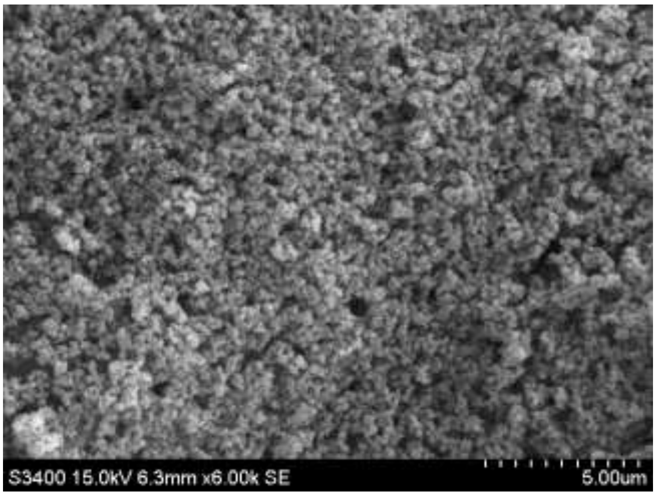

Fig 2.3 SEM

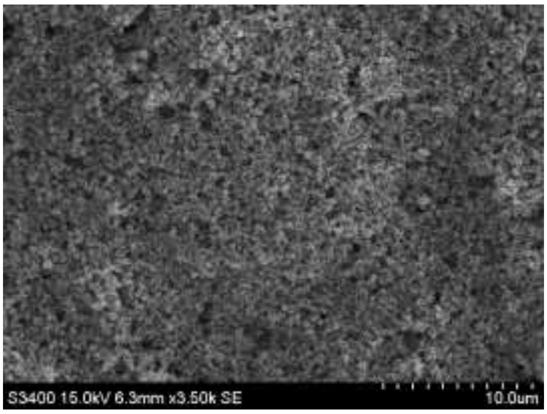

Fig 2.4 SEM

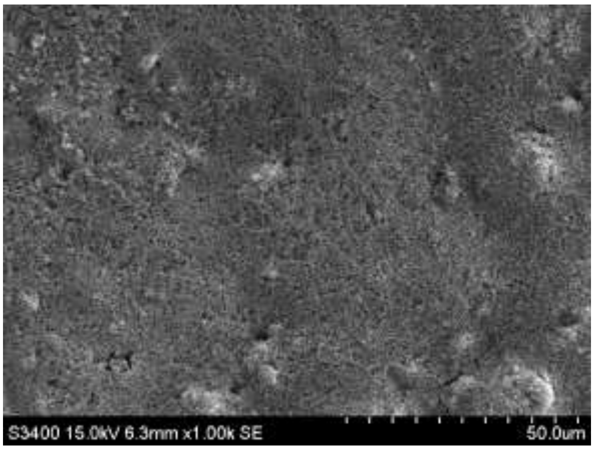

Fig 2.5 SEM

IV. I-V characteristics

1. I (Current) – V (Voltage) characteristics of thick film on a certain fixed temperature by increasing the voltage by range between 0 to 30 volts and variation of current observed. Graph plotted for resistance. [8]

Graph shows curved nature as fig 1.3 that as semiconductor material

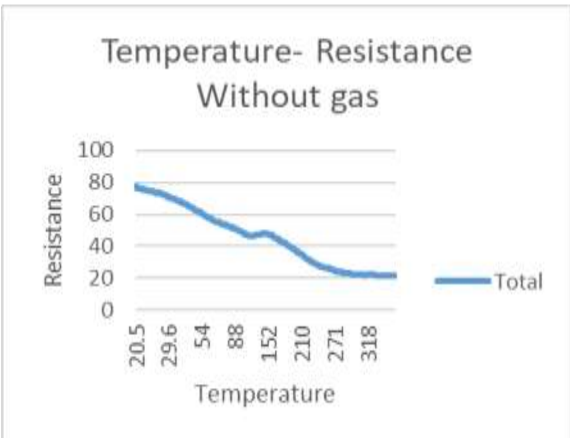

Fig 1.3 TR Curve

GAS SENSING CHARACTERISTICS

Gas sensing characteristics as shown in fig 1.4 .Thick with gas volume 50 ml. Current noted at various temperatures for the acetone gas (C_3H_6O) kept constant 10V are with different value of resistance. By plotting the graph of the resistance and temperature. After inserting the gas inside the glass tube the current increases from first observation.

The gas sensing studies were carried out on a static gas sensing system under normal laboratory conditions. The Ethanol response of thick films was studied in test assembly. The electrical resistances of thick film in air and in the presence of Ethanol gas [9]

Ammonia and H_2S gas sensing as shown in fig 1.5 and 1.6

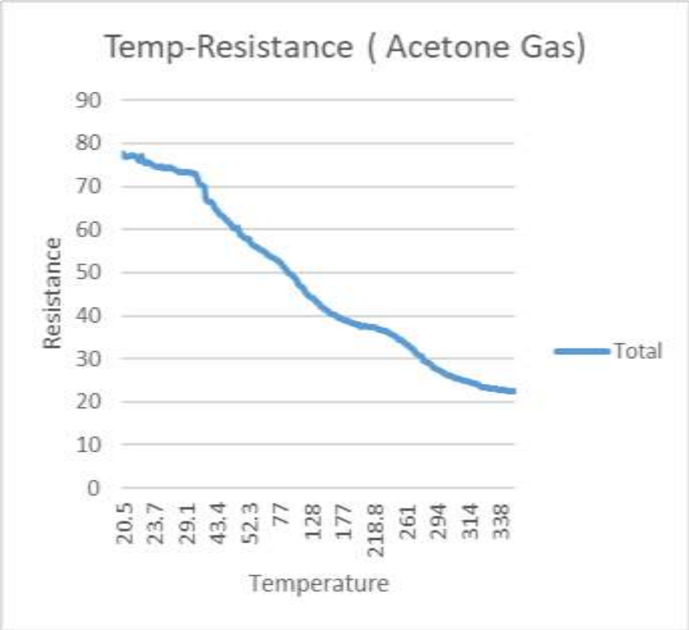

Fig 1.4 TR Curve Acetone

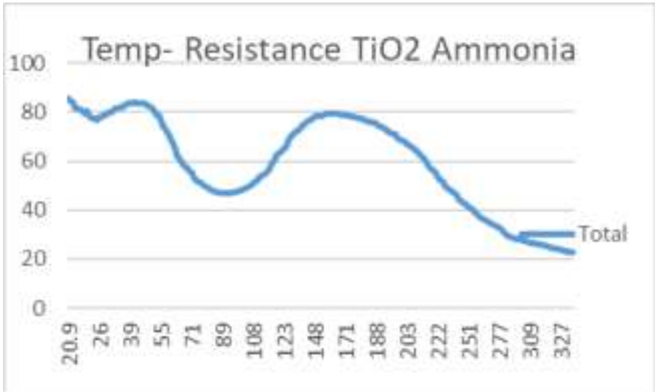

Fig 1.5 TR Curve Ammonia

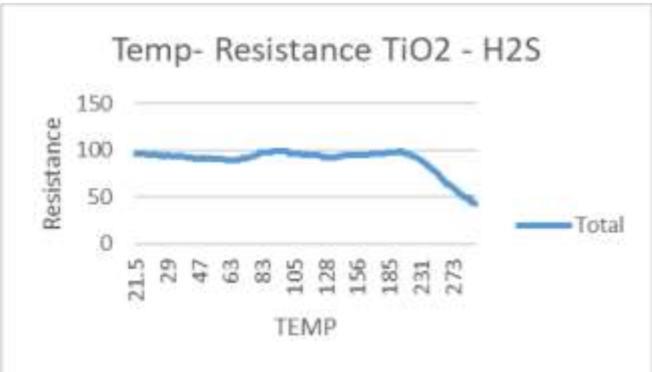

Fig 1.6 TR Curve H_2S

CONCLUSION

Above paper illustrates the preparation of TiO2 (Titanium dioxide) using screen printing technique thick film printed prepared. Alumina substrate showing adhesive property to less cost technology and property of the thick films for ammonia and acetone gases sensing. The plot of current I and voltage V characteristics shows film represents the semiconductor properties of materials. Performance of gas sensing to all three gases at various temperature Semiconductor Metal Oxide (SMO) thick film fired at 400 ºC

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