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SnO_2 and SnO_2-AgO thick films: Preparation and Characterization

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Abstract- **Today's modern research work related to material science always based on the preparation of a well adhered film (thin or thick) of suitable base material on a suitable substrate.**

In our work we used base material as a most popular oxide material i.e. SnO_2 (tin oxide), commercially available and AgO powder (lab prepared). The new thing in our work is that, we prepared a thick film of SnO_2, SnO_2 + AgO (5%), SnO_2 + AgO (10%) and SnO_2 + AgO (15%) on electrode pattern PCB. Then the I-V characteristic of all prepared thick film were investigated by simple lab prepared two probe method.

Keywords: **SnO_2, SnO_2-AgO, thick films, I-V characteristics etc.**

1. Introduction

In the various research works, preparation of a thin or thick film of base material is one of the important processes. Using market available AR grade powder as base material or synthesizing such base material is another important step of many research works. Many researchers are working in different fields [1-12] are in the need of well adhered film of suitable oxide materials on glass plate or alumina substrate. Also variation in conductivity is important parameter in various types of research to achieve certain specific useful applications. Variation in conductivity can be achieved by adding different oxide material in different proportion with that of base material.

In our work we used the most popular oxide material i.e. SnO_2 (tin oxide), commercially available and AgO powder (lab synthesized). The new thing in our work is that, we prepared a thick film of SnO_2, SnO_2 + AgO (5%), SnO_2 + AgO (10%) and SnO_2 + AgO (15%) on electrode pattern PCB. Then the I-V characteristic of all prepared thick film was investigated by simple lab prepared two probe method. The variation in conductivity of SnO_2 film with variation of AgO powder was also studied.

2. Experimental

Crushing of SnO_2 powder

Commercially available AR grade SnO_2 powder (1gm) was crushed in agate type mortar pestle for 24 hours.

Preparation of AgO powder

Sodium boro-hydride solution ($NaBH_4$), 30ml and 0.002M molarity, was chilled in an ice bath and different volume of 0.001M silver nitrate was added slowly drop wise. The reaction mixture was stirred vigorously using a magnetic stirrer for 2 hours. Then solution was filtered and the product was dried for 1 hour. Then the product was calcinated in muffle furnace at 500° C for 1 hour. The obtained AgO powder was crushed for 15 min with a mortar pestle [13].

Preparation of electrode pattern PCB

A Comb type structure is drawn and painted on a suitable size copper clad and etched with concentrated $FeCl_3$ solution to obtain a microelectrode pattern.

Preparation steps of SnO_2, SnO_2 + AgO (5%), SnO_2 + AgO (10%) and SnO_2 + AgO (15%) thick films

One gm of grinded AR grade SnO_2 powder was taken in petry dish. Few drops of distilled water were well mixed with SnO_2 grinded powder so as to form a paste. The paste so obtained was applied on comb type micro electrode in 4 x 1.5 cm dimensions by using a suitable brush to form a thick film [14]. Then by same procedure the thick of SnO_2, SnO_2 + AgO (5%), SnO_2 + AgO (10%) and SnO_2 + AgO (15%) powder was prepared. Fig.1 shows photograph of the prepared SnO_2 and SnO_2 + AgO (15%), thick films.

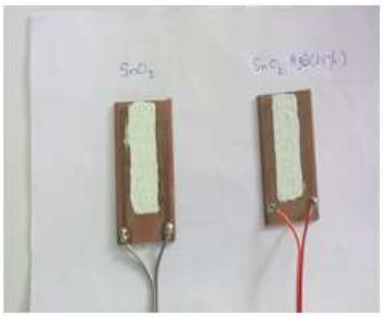

Fig. 1: Photograph showing thick film of SnO_2 and SnO_2 +AgO (15%) on electrode printed PCB

I-V characteristics of SnO_2, SnO_2 + AgO (5%), SnO_2 + AgO (10%) and SnO_2 + AgO (15%) thick films

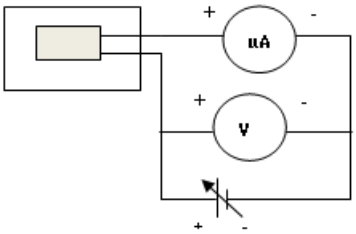

Fig.2: I-V characteristics circuit diagram (two probe method)

The I-V characteristics of prepared thick film of SnO_2 and SnO_2 +AgO (15%) were investigated with the help of simple lab prepared two probe method. Fig. 2 shows circuit diagram of I-V characteristics set up (two probe method). Fig. 3 shows photograph of I-V characteristics set up (two probe method).

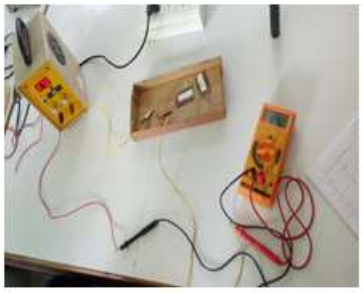

Fig.3: Photograph showing I-V characteristics set up (two probe method)

3. Characterization, Results and Discussions

I-V characteristics

The I-V characteristics of prepared thick film of SnO_2, SnO_2 + AgO (5%), SnO_2 + AgO (10%) and SnO_2 + AgO (15%) were investigated with the help of simple lab prepared two probe method. The I-V characteristics of prepared thick films of SnO_2, SnO_2 + AgO (5%), SnO_2 + AgO (10%) and SnO_2 +AgO (15%) are shown in fig. 4, 5, 6 and 7 respectively. Fig. 8. shows comparative graph of I-V Characteristics of all thick films.

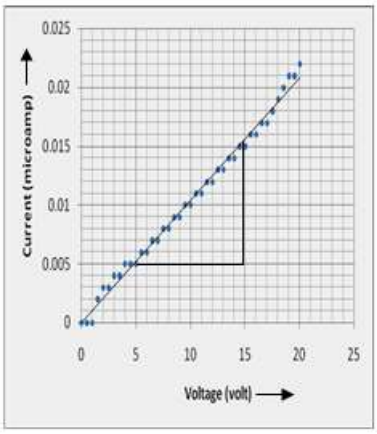

Fig.4: I-V characteristics of Pure SnO_2 thick film

The resistance of the prepared SnO_2 thick film was calculated from slope of the graph as ~ 952.38 mega ohm.

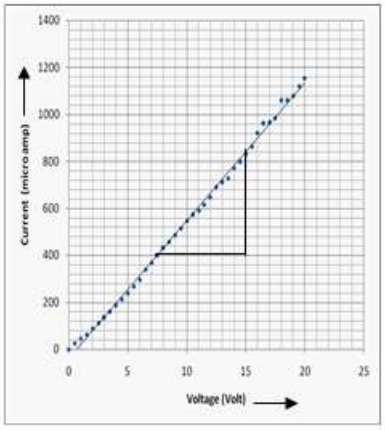

Fig. 5: I-V characteristics of SnO_2 + (5%) AgO thick film

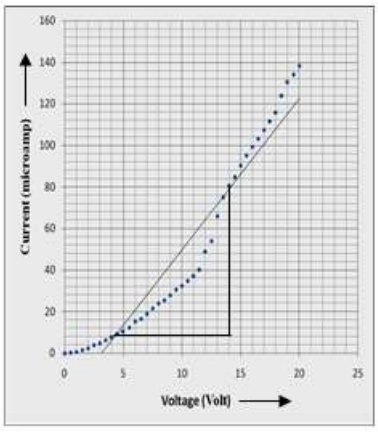

Fig. 6: I-V characteristics of SnO_2 + (10%) AgO thick film

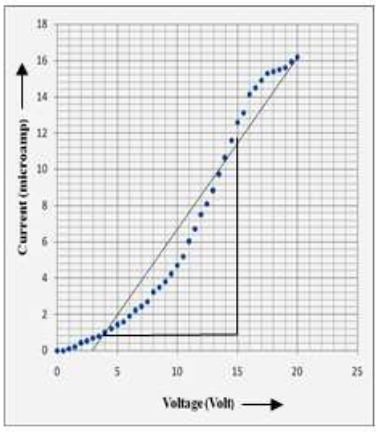

Fig. 7: I-V characteristics of SnO_2 + (15%) AgO thick film

→ The resistance of the prepared SnO_2 + (5%) AgO thick film was calculated from slope of the graph as ~ 17.04 kilo-ohm (fig.5).

→The resistance of the prepared SnO_2 + (10%) AgO thick film was calculated from slope of the graph as ~ 159.74 kilo-ohm (fig.6).

→ The resistance of the prepared SnO_2 + (15%) AgO thick film was calculated from slope of the graph as ~ 1105.50 kilo-ohm (fig.7).

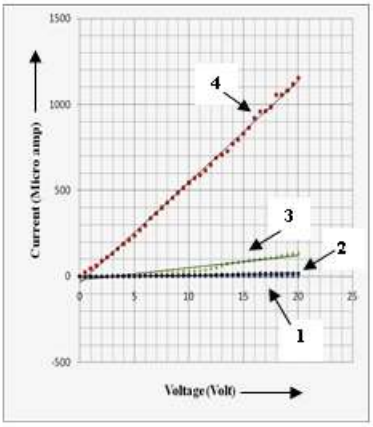

Fig. 8: Comparative graph of I-V characteristics of (1) SnO_2 (2) SnO_2 + (5%) AgO (3) SnO_2 + (10%) AgO (4) SnO_2 + (15%) AgO thick films

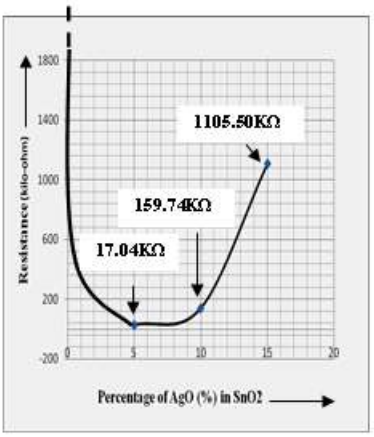

Fig. 9: Variation of resistance of SnO_2 thick film with percentage addition of AgO

Following Tabel I shows resistances of different prepared thick films.

Film	Resistance
SnO_2	952.38MΩ
SnO_2 + (5%) AgO	17.04KΩ
SnO_2 + (10%) AgO	159.74KΩ
SnO_2 + (15%) AgO	1105.50 KΩ

4. Conclusions

1. Thick films of SnO_2, SnO_2 + AgO (5%), SnO_2 + AgO (10%) and SnO_2 + AgO (15%) can be prepared on preprinted electrode PCB.
2. The I-V characteristics prepared SnO_2, SnO_2 + AgO (5%), SnO_2 + AgO (10%) and SnO_2 + AgO (15%) thick films can be investigated by simple lab prepared two probe method.

3. From graph it was concluded that addition of (5%) AgO in SnO_2 thick film enhances the conductivity in very large manner but further addition of AgO (10%) and (15%) reduces the conductivity.

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