

Study the impact of radiation on the electrical properties of SnO₂/Si reagents

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Abstract

This research examined the effect of irradiation on the synthetic properties of the SnO₂/n-Si membrane. The prepared membrane was prepared by vacuum fumigation and irradiated with 1.33Mev energy Gama rays, time periods and radiation doses (3h × 14Gy), (24 h × 14 Gy) and (3d × 14Gy).

Synthetic properties were studied through XRD screening before and after irradiation. The results of the study showed that exposure of the membrane to Gama rays and through XRD screening for three hours resulted in a decrease in relative intensity at the angle and a severe decrease in relative intensity at the angle. (150) with a slight increase in the intensity value at the angle $\Theta=44.24982$ this indicates crystal growth when irradiation increases for a day. When irradiated for three days, the relative intensity at the angle decreased $\Theta=59.18402$ indicating crystal defects that reduced the value of crystallization, accompanied by an increase in intensity at the $\Theta=44.24982$ and $\Theta=25.87862$ angles. Increased irradiation has, by examining XRD, clearly affected the improvement of synthetic properties. The characteristics of the current-voltage were also examined by forward and reverse biases in darkness and reverse only when illuminated by the M1 light current equal to 0.24. From the M4 specimen, there is an increase in the light current. The value of the light current at radiation increased for one day at the same intensity to the 0.31 and this value continued to improve when irradiated for three days, as the value rose to 0.45. (1-2-3) The time of inertia decreased from (2.3) to (1.2) and this time of inertia at irradiation for three days is evidence of many disruptions that have led to an increase in the total value of the detector resistance resulting in an increase in the time of inertia.

Keywords: Tin Oxide, vacuum evaporation system, Thin films SnO₂.

1. INTRODUCTION

The term thin membrane is used to describe several thin layers of deposition from the material's atoms and is of a small thickness of about (1 μ m) Thin membrane technology has made a significant contribution to the semiconductor study and has been interested in it since the early nineteenth century, giving a clear idea of many of its physical and chemical properties, which differ from those of its constituent substances in their volumetric state (Bulk) [1, 2].

Thin membranes are deposited on a solid base of silicon or glass and are defined by baseline rules. Base type depends on the deposited material and the nature of the study [3].

Thin membranes have been used instead of many parts of electronic circuits that give similar qualities but more efficiently such as Rectifiers, Capacitors, Digital Computer, Transistors, and Photographic imaging devices [4].

Tin oxide is found in nature in the form of metallic tin stone. The stone has a variable color from yellow to black and is characterized by glitter. It is fusible to the temperature of 1620 oC. Tin oxide is characterized by having a relatively large energy gap as in metal oxides. Chemically, vacant oxygen sites are responsible for the transmission of electrons [5]. Tin oxide is a chemically inert and mechanically solid compound that is a half-conveyor with an energy gap n type (3.7-4 ev) and possesses optical transparency in the visible field as it possesses an untaxed structure so it is more stable [6,7].

2. Experimental Part

The thin membrane of the SnO₂ material was prepared using the method of thermal fumigation in the vacuum where a high discharge system (8) was used to discharge the chamber from the air and the tin powder was fumigated by placing the material to be vaporized in the Bout basin of the tungsten material and under very low pressure less than (10-2 Torr) and up to (10-9

Torr). The sedimentation process was carried out on the bases of n-type silicon with 111 of dimensions (1×1 cm). The material used was heated to melting point by passing a high-intensity electric current and thus evaporating the material and depositing on the base the component of the thin membrane. The glass floors (Slide) were placed after being cleaned with ion distilled water and ethanol alcohol and dried with filtration paper. They are then placed with electric heater for 15 minutes and with temperature ($100 \text{ }^\circ\text{C}$) and checked to ensure cleanliness. A pure tin was used as small metal balls and placed in the degeneration boat. After low pressure, appropriate voltage was shed on both ends of the boat. After the deposition process, the deposited samples were placed in the oven at a temperature of ($450 \text{ }^\circ\text{C}$) for (40 minutes) and the door of the oven was opened to enter oxygen. After the tin is oxidized, the electrodes are deposited in a spiral pulsating form, after which a wire made of high purity aluminum is suspended on a cord of spiral tungsten for the purpose of deposition of the rear pole on the entire silicon slide, after completing the suspension of the wire the chamber is closed until the pressure reaches (2.2×10^{-4} mbar) and shine voltage on both ends of the aluminum smelting tangent wire and deposit on silicon and glass slides. For the deposition of the front poles, masks are made by encasing the membrane with cellophane and making a hole in the center of the cover size (1mm).

The membrane was irradiated by exposing it to a single energy source (Co 60) (1.17-1.33 Mev) with a half-life of (5.3 year). The exposure of the membrane to the radioactive source was with time periods and a radiation dose of ($3\text{h} \times 14\text{Gy}$), ($1\text{d} \times 14\text{Gy}$), ($3\text{d} \times 14\text{Gy}$) for an appropriate radiation dose of improved radiation properties.

A study of electrical properties (I-V) has been conducted on these models of voltage current properties for all samples before and after irradiation of front and reverse biases in lighting and darkness.

An examination was carried out using the atomic force microscope (XRD) whereby the crystal structure of the models was identified. The BRAC equation for X-ray diffraction was used to calculate the distance between atoms given to the $n\lambda=2d\sin$ relationship [8].

3. Results and discussion

3.1 X-Ray-diffraction results

The composition of the proscribed membrane before and after radiation was studied with camma rays and figure (1) shows the X-ray spectrum of tin oxide deposited on glass bases using the vacuum thermal deposition method to identify the nature of the crystal structure of the SnO₂/Si membranes and by examining the pure membrane with XRD shows that the membrane (SnO₂/Si) Pure unirradiated multi-crystalline type and possesses cubic installation. The growth is preferred by directional (111) as well as levels (102), (150) at the angles of neutrality 28.5014,44.2498, $2\Theta= 59.1840$ respectively which are consistent with (Ahmed et al., 2020) [9], and using standard cartels (JSDC Card) numbered (00-016-0737) where a high degree of crystallization was shown after the neglect of the crystal orientation of the silicon and after the irradiation process for three hours reduced the value of the top to (60 a.u) at the $\Theta=59.18402$ directional angle (105) This indicates that the summit decreased because the degree of crystallization decreased with irradiation and after irradiation for a full day, the summit's value increased to (480 a.u) indicating crystal growth at the $\Theta=59.18402$ angle with the summit disappearing at the $2\Theta=44.24982$ directional angle (102). After the irradiation process lasts for three days, the relative intensity value increases to (60 a.u) at the $2\Theta=25.87862$ angles directionally (-120) and the directional $2\Theta=44.24982$ (102) with the relative intensity value increased at the $2\Theta=59.1840$ angle to (340 a.u) due to the occurrence of crystal growth that increased the value of crystallization.

Figure 1 shows the X-ray diffraction chart of radioactive, deposited and oxidizing models at $450 \text{ }^\circ\text{C}$ air temperature and at oxidizing times (30 min). The effect of irradiation is observed by the relative intensity value of (111), (150), (102) (-120) where intensity increases as irradiation time increases. Thus, crystal growth is affected by irradiation time, but relative intensity decreases at (102) where crystallization is weaker at this level [10].

An important characteristic was obtained from the XRD scheme, namely the distance between the crystal levels calculated using the BRAC Act and compared with the d values of the standard card and was almost identical.

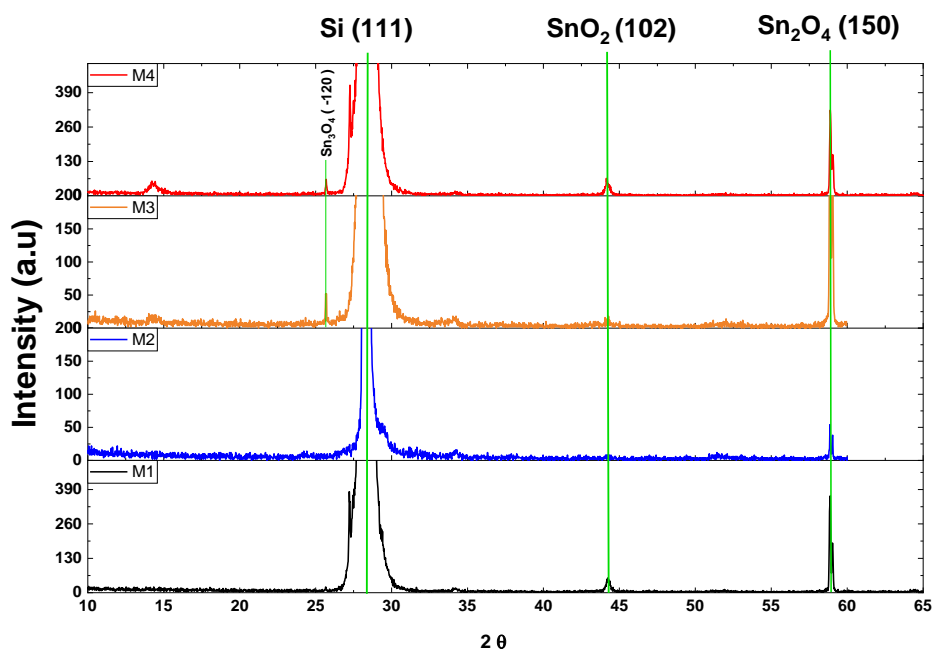


Figure (1) X-ray diffraction chart for pure (M1) and irradiated (M2,M3,M4) models

3.2 (I-V) Characterization in lighting and darkness.

Figure (2) shows the characteristics of I-V in the case of frontal and reverse bias in the dark of the pure sample. The results show the existence of a type (n-n +) bi-crystal properties and show the passing current in the forward bias of great value compared with the reverse bias current.

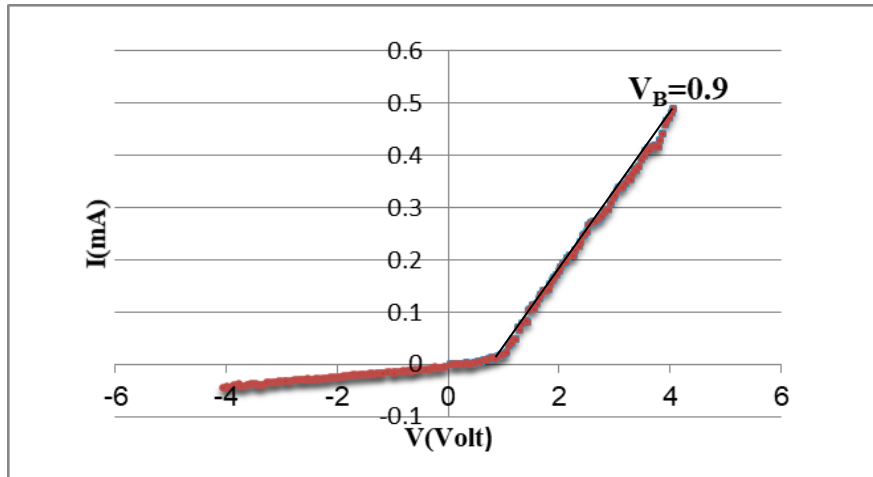


Figure (2) Characteristics (I-V) in darkness of pure, unirradiated sample.

When studying electrical properties with the reverse bias of the four reagents at light by shedding different capabilities (100,200 mw/cm²) as in figure (3) shedding different capabilities

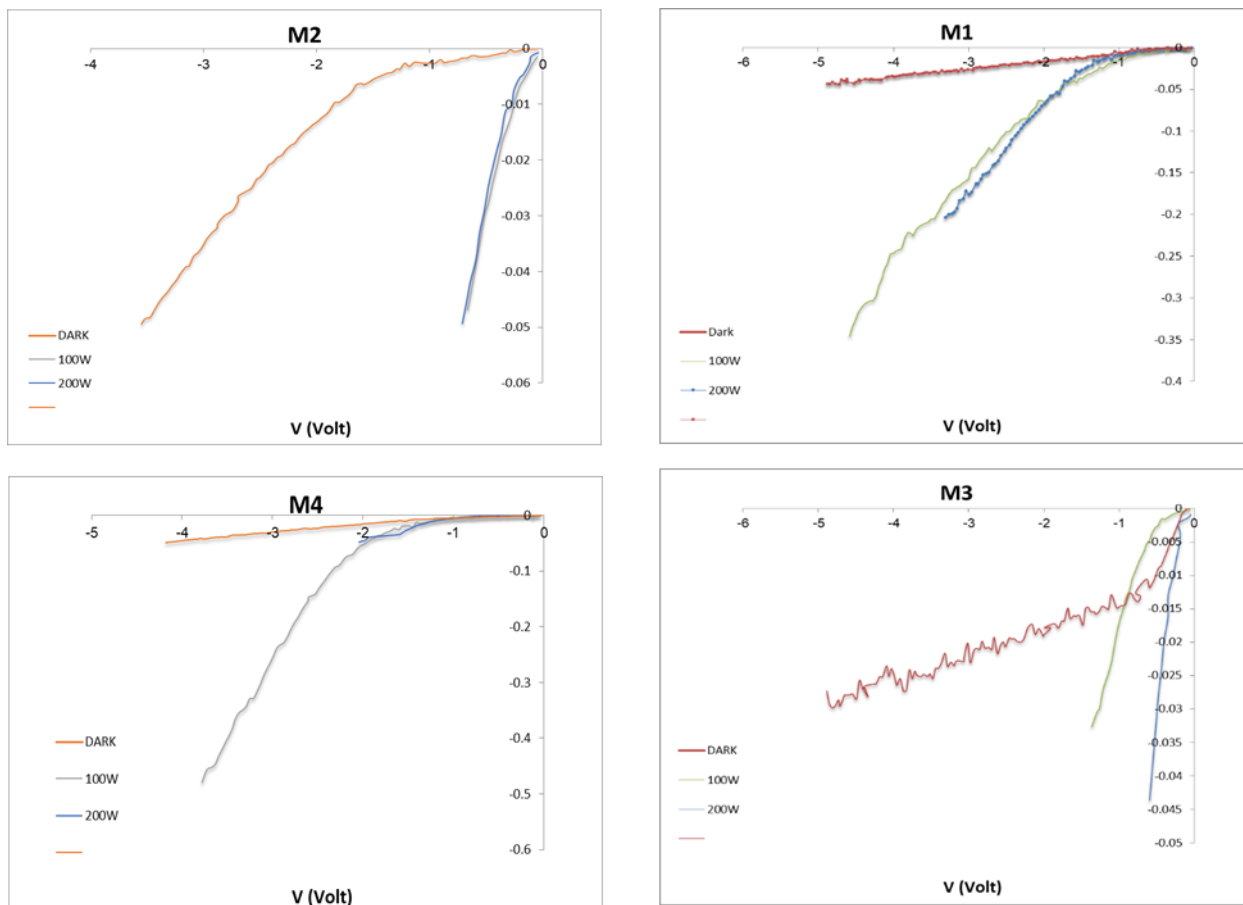


Figure (3) Reverse bias of the four pure unirradiated M1 and irradiated reagents M2, M3, M4

Results from figure (3) of the M1 sample show that we have a light current equal to 0.24 and the M4 sample shows that we have an increase in the light current as the light current value at radiation increased for one day at the same intensity to 0.31 and that this value continued to improve at irradiation for three days as the value rose to 0.45 and this may be due to the generation of new levels and some defects.

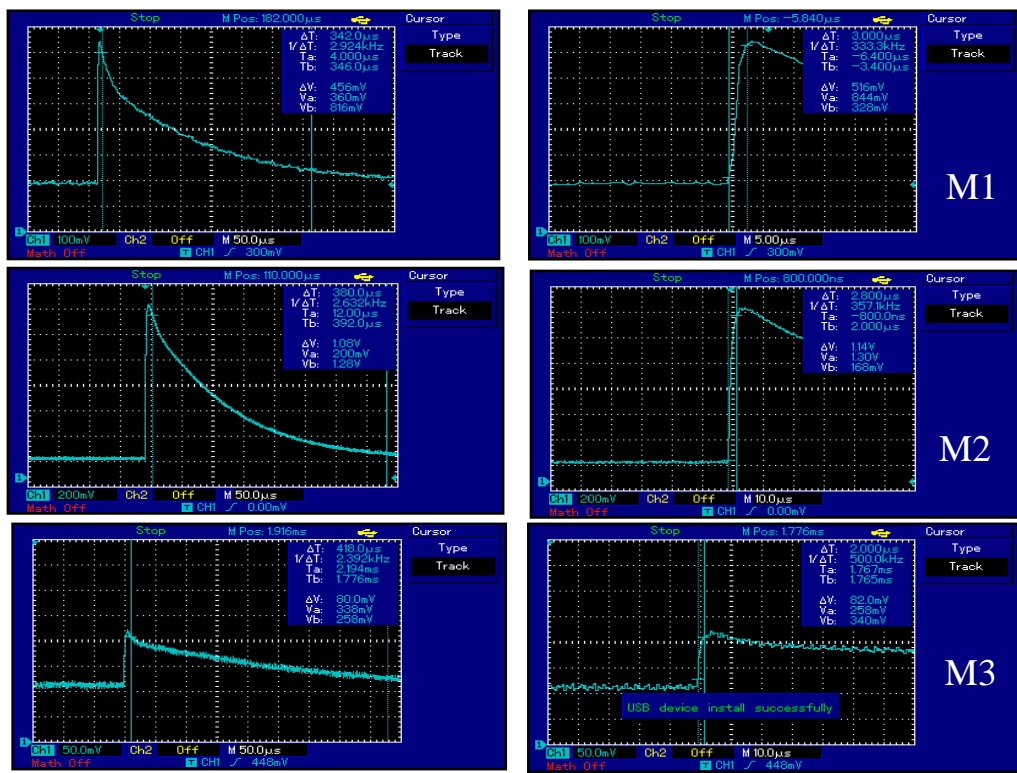
3.3 Response Time

One of the most widely used methods for estimating the carrier lifetime is the open circuit voltage decay [11]. A pulsed laser with a wavelength of) 900 nm (, a width of (2 μ s) and a pulse difference of)120 μ s([12], was used. A)10 V(power supply was used, and a load resistance of(674 \times 102 Ω) was used. The rise time was measured between)10% to 90%(. The relaxation time was set between 90% and 30%.

The results of the fourth examination showed an increase in the light current and this was supported by an increase in the response time according to Table No. (2). The results showed a decrease in the time of rise, where the time value decreased to (1-2-3), while the time of descending decreased from (2.3) to (1.2), and the exception to this is the inactivity time of three days, and this is evidence of the presence of many disorders that led To increase the value of the total resistance of the detector, which led to an increase in the deactivation time as shown in Figure (4). The rise time of each gear detector is shown compared to its inactivity time, and this is identical to the voltage detectors [13].

Table No. 4 Pure sample response time and irradiated samples

Samples	On time	Off time	I _s (μ A)	Φ_b (V)	η
M1	3 μ s	234 μ s	2.3	0.394	6.4
M2	2 μ s	190 μ s	1.9	0.399	5
M3	1.2 μ s	340 μ s	1.1	0.411	6.3



inactivity Time

Rise Time

Shape (4) Response time for M1 samples: before irradiation, M2: irradiated for a full day, M3: irradiated for three days

The results of the ideal factor calculated from slope curve mile showed between voltage V and $\ln(I/I_s)$ the binary has a factor equal to (6.4) and this is identical to the researcher. (Ahmed et al., 2020) When irradiated for one day the results showed an improvement in the ideal factor value and this was the result of new levels created by irradiation that led to ease in the reengineering stream, when irradiated for three days, the results showed a rise in the ideal factor value as in figure (5). This matched the hypothesis that we imposed by generating crystal defects that led to the acquisition of electrons and the denial of passage.

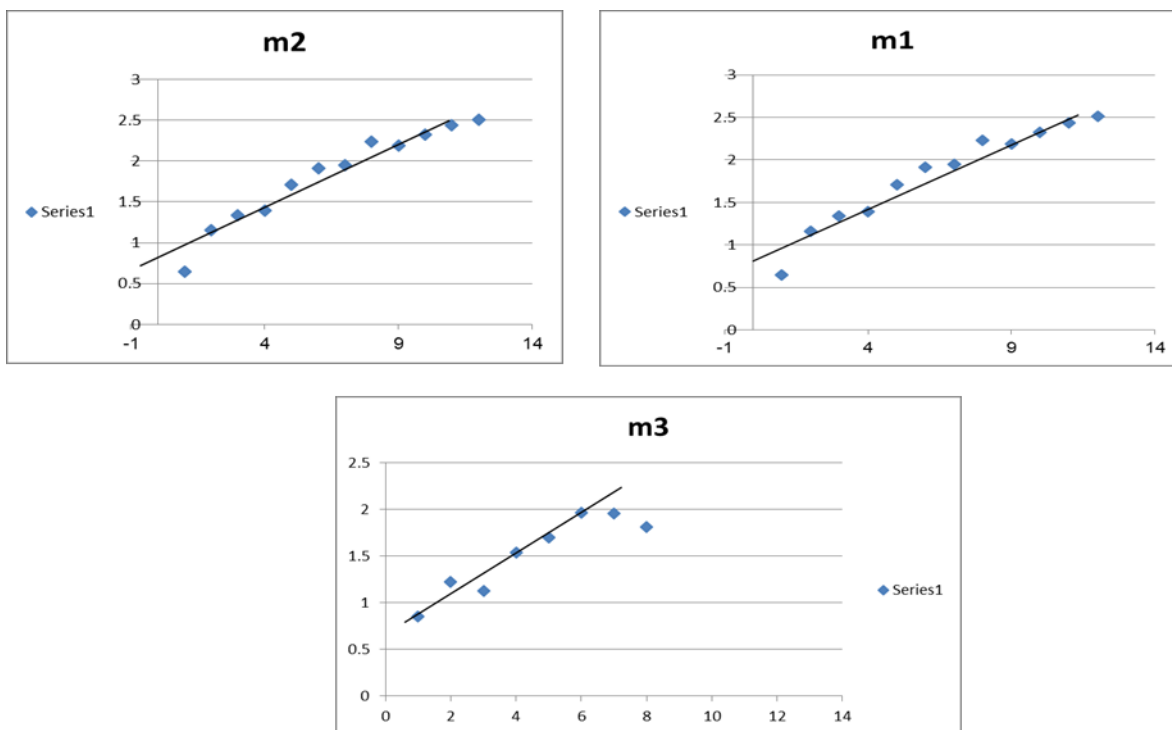


Figure (5) Perfect factor for M1 samples: before irradiation, M2: irradiated for a full day, M3: irradiated for three days

4. Conclusion

Results showed that the pure, unirradiated (SnO₂) membrane has a multi-crystallized composition, and irradiation has improved the value of the light current. The return time of the prepared membranes decreases when irradiated for one day and then increases when irradiated for three days. The value of the barrier voltage increases gradually by increasing the irradiation time with an improvement in the value of the ideal factor when irradiated for a full day.

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