Effect of Aluminum Oxide Nanoparticles Films Thickness on Optical Properties

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Abstract:
The aluminum oxide (Al_2O_3) nanoparticles thin films has been prepared via UV-irradiation methods using metal salts (aluminum nitrate $Al(NO_3)_3$) with different thickness (150 , 200, 300 , and 400) and measuring structural and optical properties.

The structure of the (Al_2O_3) nanoparticles thin films was tested with X-Ray showed that have six main diffraction features corresponding to (111), (311), (222), (400), (511) and (440) planes . The results of atomic force microscopy (AFM) indicated that all films have grain size about 25.97-65nm .

The optical band gap energy was decreased by the increase of thickness from (5.19-4.68) eV then used aluminum oxide as gas sensor.

Keywords: X-Ray, AFM, Optical Properties.

1. Introduction

Aluminum oxide (Al_2O_3) is a multifunctional material used as polycrystalline material. The transparent conductive oxide widely used in various applications, such as solar cells. optoelectronics [1,2] significant p-type of Al_2O_3 efforts through chemical and electrochemical deposition of compound (especially semiconductor)

AL_2O_3 is a semiconductor that process optical properties which in all deposition techniques used AL_2O_3, films are polycrystalline where the grain boundary, and the effect on the barrier high were studied [3].

Structural properties of undoped AL_2O_3 films deposited by spray pyrolysis at temperatures 395k have been studied by so many researches.

2.Materials and Methods

The AL_2O_3 were prepared by Al $(NO_3)_3$ dissolved in water from an aqueous solution of (0.1M), While the cell contains a quartz tube as a jacket for immersion UV- source in the solution, the reactor is cooled by ice bath to avoid the rising in temperature as a result of the UV- irradiation.

Then using spray polyrises system as explain in points:

1-Substrate temperature of about (400k)

2-Spray rate 5sec/1min

3-Air pressure (2N/M2)

This films of nano AL_2O_3 prepared by using each of spray nozzle and substrate after cleaning and heating on electrical heater for (30min) before spraying process so the glass substrate is nearly at the same temperature as the electric heater.

Each spraying period lasts for about (15sec) following spraying, the film has smooth surface free from pinholes using weighting methods and electronic balance. The thin film was estimated by using the equation:

$$t_{(nm)}= m$$

3. Results and Discussion:

1-Structral properties

I. X-Ray peaks appeared in (2Θ) at 20 from 80 degrees

The pattern has six main diffraction features corresponding to (111), (311), (222), (400), (511) and (440) planes and all the three peaks can be indexed to standard cubic phase of Al_2O_3 (JCPDS card No. 870598,870720 and 893722). No reflection peaks corresponding to nitrate ions and other impurities were noted in this pattern, indicating the high purity of the final product as illustrated in figure (1). The different peak intensity profile was characteristic of cubic structure of Al_2O_3 This result is somewhat consistent with the [4].
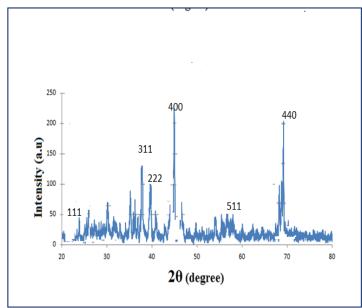

Fig. (1): Illustrate the X-Ray of Aluminum Oxide nanoparticles.

II. Atomic Force Microscopy (AFM) Figure (2) show the atomic force microscope results for AL_2O_3 which had been prepared in UV-irradiation with different thickness, one can observe that the particle size was variated from 25.97 - 65 nm.
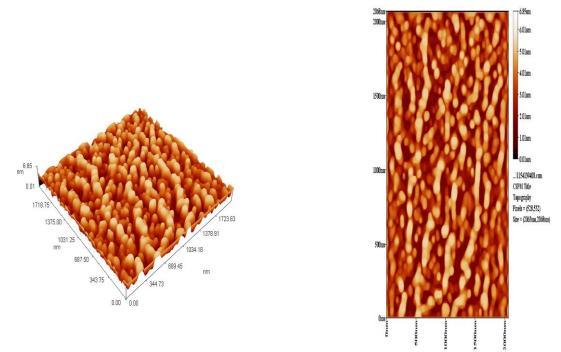
1-Structral properties

Fig. 2: illustrated the AFM results for Al_2O_3 nanoparticles.

3-Optical Results

Figure (3) showed the absorbance spectra of (Al$_2$O$_3$) nanoparticles with wavelength range (200-800) nm is represented so, the absorbance with the increase of the thickness [5,6].
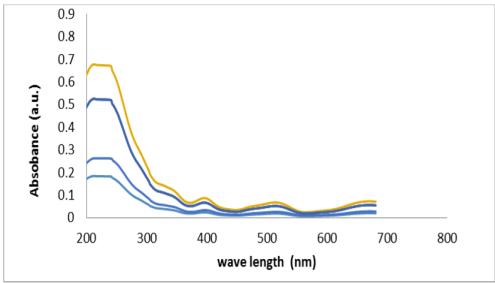

Fig. (3) Absorption Spectrum, of Al$_2$O$_3$ nanoparticles.

4- Calculate the Energy Gap

To find the values of energy gap by drawing curves between $(\alpha h v)^{1/2}$ as function of energy (hv). Then tacking touch line from $(\alpha h v)^{1/2} = 0$ this values represent Eq as shown in figure (4) from results we showed that values of energy gaps decreased with increasing nana silver percent this refers to intermediate levels which contains when added materials which increasing electrons charge [7] .
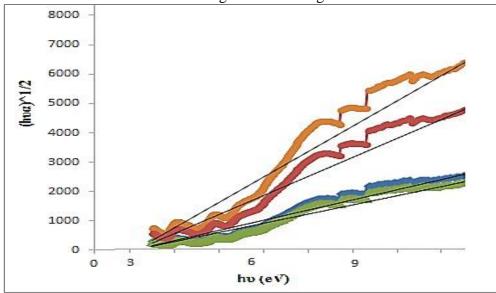

Fig. (4) showed values of energy gap.

where values of energy gap equal to (5.19-4.68) eV from different thickness.

5.Thin films of Al$_2$O$_3$ nanoparticles used as gas sensors

Using Al$_2$O$_3$ nanoparticles as sensor sensitivity before and after the deposition of catalysts is shown in figure (5) for understanding the effect of the platinum coating on sensitivity of Al$_2$O$_3$ nanoparticles to ammonium gas (NH3). From results appeared that increasing in the thickness of the depletion layer increased each of the resistance and sensitivity of Al$_2$O$_3$.
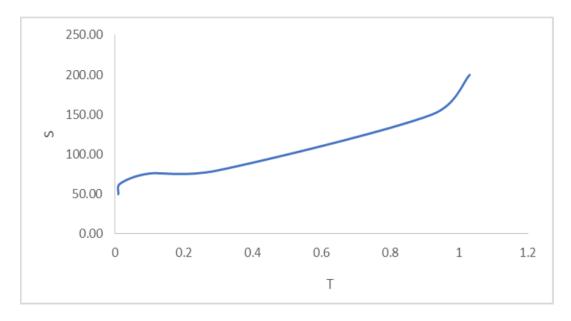
Fig. (5) Sensor sensitivity of the Al_2O_3 on NH_3 gas

From the result in figure (5) the resistance and sensor sensitivity to NH3 as increased linearly with increasing temperature.

4. Conclusion:

1. The UV-irradiation methods for prepared nanoparticles consider as an environmentally friendly method.

2. The grain size of aluminum oxide nanoparticle about 25.97 - 65nm increased with increasing thickness of thin films.

3. The absorbance of (Al_2O_3) nanoparticle increases have higher absorbance in the UV region.

4.Energy gaps of nanoparticles increased energy gaps with thickness from 4.68 to 5.19 eV.

5.The gas sensitivity is proportional with the thickness of films so the aluminum oxide nanoparticles consider a good gas sensors for NH3 gas .

5.References

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