بسم الله الرحمن الرحيم

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Ain Shams University College of Women for Arts, Science and Education

Physics Department

Preparation and characterization of vanadium pentoxide by spray pyrolysis technique

Thesis

Submitted to Physics department

College of Women for Arts, Science and Education

Ain shams university

In partial fulfillment of M. Sc. Degree in:

(Solid state physics)

Presented by

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وقل اعملوا

فسيرى الله عملكم ورسوله والمؤمنون

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Abstract

A chemical spray pyrolysis technique was used to deposit a vanadium pentoxide (V_2O_5) thin films on glass substrate with a deposition temperature ranged from 300°C to 500°C in step of 50°C. From ammonium Meta vanadate aqua precursor solution molarity of (0.1 M) was used as a source of vanadium.

The effect of deposition temperature on structure, morphological, electrical conductivity and optical properties was analyzed at constant deposition time, solution molarities and the distance between spray nozzle and substrate.

X-ray diffraction patterns shown that an orthorhombic cubic structure with growth along (001) plane.

With increasing the substrate temperature, the electrical conductivity was increased, and the scanning electron microscopy clarified that the crystalline of V_2O_5 thin films was effectively modified.

The optical results revealed that energy band gap of V_2O_5 films deposited at 400°C, 450°C and 500°C is 2.38 eV for direct allowed transition. Based on the observed results the V_2O_5 phase can be well controlled by altering the substrate temperature. All prepared thin films up to 400°C show transparency in both visible and near IR region.

The effect of deposition time (5 min to 20 min) in step of (5 min) on the electrical and optical properties of V_2O_5 prepared at 450°C deposition temperature was studied. The results showed that, the conductivity increased with increasing the deposition time.

The highest conductivity values (9.5×10^9) Ω^{-1} cm^{-1} was obtained for the sample prepared at deposition time of 20 min.

It can be seen that transmission and reflection of the film deposited for 5 min has the highest value that can be attributed to the thickness effect of the prepared samples.

Keywords: V_2O_5, XRD, Morphological, Optical, Electrical properties, Deposition temperature, deposition time, Crystallinity and grain growth.

Introduction

Among the transitions metal oxide semiconductors, vanadium pentoxide, particularly in thin-film structure, takes concerned widely through many years because of its varied range of uses [1, 9]. Multi-valance layered construction characterized by wide-ranging band-gap, respectable stability of chemical and thermal properties. The outstanding thermo-electric feature that is the character which sort a vanadium pentoxide (V_2O_5) hopeful material for micro-electronics, electro-chemical, and optic-electronic devices [2-5].

Recent researches studies have pointed out that with the application of electrical signal [40],[34]. Nano fibers made up of vanadium oxide can act as vicarious muscles that can contract [9].

Many techniques such as pulsed laser deposition(PLD) [10] gives a brief overview of the progress that it has made starting with control of deposition parameters such as a deposition temperature [36,37],[32,33].Sol-gel spin coating [11] where that an orthorhombic structured thin film is transformed to β-(V_2O_5) nanorods by subsequent annealing at 500 °C.

The as-deposited (V_2O_5) thin films were produced by thermal evaporation technique [12] without intentional substrate heating present an amorphous structure. After thermal treatment for (1h) at atmospheric environment conditions the films show a predominant (001) plane reflection of the orthorhombic (V_2O_5) phase. Direct current radio frequency (DC/RF) sputtering [13] was studied the influence of ambient atmospheres on the structure, optical properties, and morphology of the thin films after annealing.

The characterization and the transition behaviors in the annealing process were investigated by the dominant sequence clustering (DSC). The results demonstrated that (V_2O_5) films underwent four different transition behaviors during post-deposition annealing due to the different oxygen proportion of ambient. Electron beam evaporation technique [14] showed that SEM micrographs perceived the prepared films were nearly homogeneous with densely