The effect of anode temperature on the Optical characteristic of Se films prepared by direct current planar magnetron sputtering

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Abstract

This work describes, selenium (Se) films were deposited on clean glass substrates by dc planar magnetron sputtering technique.The dependence of sputtering deposition rate of Se film deposited on pressure and DC power has been studied. The optimum argon pressure has range ($4x10^{-1}$ -$8x10^{-2}$)mbar. The optical properties such as absorption coefficient (α) was determined using the absorbance and transmission measurement from UnicoUV-2102 PC spectrophotometer, at normal incidence of light in the wavelength range of 200-850 nm. And also we calculated optical constants(refractive index (n), dielectric constant ($\varepsilon_{i,r}$), and Extinction coefficient (κ) for selenium films.

Keywords
Optical characteristic
planar magnetron sputtering

Article info
Received: Mar. 2010
Accepted: Apr. 2010
Published: Dec. 2010

تاثير درجة حرارية الانود على الخصائص البصرية للا غشية السيلنيوم المحضرة بطريقة الترذيذ المغناطيس المستمر

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خلاصة

في هذا العمل تم تحضير اغشية السيلينيوم بتقنية الترذيذ المغناطيس المستمر على قواعد نظيفة من الزجاج واعتماد معدل ترسيب اغشية السيلينيوم على الضغط والقدرة المسلطة حيث كان الضغط المناسب لتوليد البلازما من اجل ترسيب الاغشية ضمن المدى mbar($4x10^{-1}$ -$8x10^{-2}$).كما تم حساب الخصائص البصرية مثل معامل الامتصاص الذي حسب من خلال قياسات الامتصاصية والنفاذية باستخدام جهاز UnicoUV-2102 PC spectrophotometerضمن مدى الاطوال الموجية من (200-850 nm) وكذلك تم حساب الثوابت البصرية للاغشية السيلينيوم(معامل الانكسار (n) ،ثابت العزل الحقيقي والخيالي $\varepsilon_{i,r}$ ومعامل الخمود (k)).

Introduction

Selenium as a major element in the group of chalcogens is found in a wide range of materials being used in many industrial fields such as photo elements, solar technology, metal coatings as well as lubricants and pharmaceuticals [1] Chalcogenides glasses based on chalcogen elements S, Se and Te, have a Kerr non-linearity 100 times larger than silica, making them excellent and unique for ultra fast all optical devices. They have low phonon energy, high photosensitivity, and easy fabrication and processing, good chemical durability and special second/third order optical non-linearity to their high refractive index. High non-linearity optical process in these glasses provides the key functions for frequency conversion, all-optical switching (AOS) and is used as all-optical processing devices. Chalcogenide glass fibers transmit in IR region. These glasses are used for fabricating active devices, such as infrared transmitting optical fiber, optical amplifiers, infrared lasers, blue laser diodes and efficient femto second switches[2–4]**.**The study of chalcogenide glasses has increased in last decades because of their application in the fields of fiber optics, xerography and novel memory devices [5]. The interest in the optical properties of amorphous semiconductors and glasses has been stimulated also by their possible applications as switching elements and optical transmission media, as well as by their use as passivating materials for integrated circuits[6]. During the past several years there has been considerable work done on the growth of thin film for solar cells by rf diode sputtering as an alternative to the glow discharge decomposition of silane [7]. R.F. sputtering is an attractive process when scaling up becomes a consideration, the tendancy being that the larger the area the more uniform i s the final film. Over the last decade the use of planar magnetron sputtering [8] has opened up new areas for application of sputtering However, the use of a plasma-based method such as magnetron sputtering can have significant advantages including the use of low energy particle bombardment to achieve lower growth temperatures and the use of excited state species to improve the doping control during growth. DC planar magnetron Sputtering is a widely used technique in thin film pound layer in the surface of the target. In order to processing to deposit compound thin films [9]. Such obtain controlled film properties, such as stoichiometry films may be sputtered from alloy targets.

Aim of the work

The aim of our work is prepared selenium thin films by DC planar Magnetron Sputtering and study the optical characteristics of the selenium thin film.

Experiments

Se thin films were grown on glass substrate by direct current (DC)-magnetron sputtering Se target, using high pure Ar gas (99.99%) as working gas. The base pressure of the chamber was $2x10^{-5}$ mbar and the growth pressure was maintained at $8x10^{-2}$mbar. The target to the substrate was 6 cm in the on-axis geometry. All the glass substrates were ultrasonically cleaned in acetone, ethanol for ten minutes, respectively, and air blower dry. The deposition time was 10 min, and sputtering power was 1608.9W.where discharge voltage equal to 310 V while discharge current was 5.19 mA.

Results and discussion

1. The optical properties of the films

From absorption spectrum of Selenium films grown on glass substrate the optical properties which involve the absorption coefficient, the optical energy gap (E_g^{opt}) and optical constants such as [refractiveindex(n),extinction coefficient (k),the real part (ε_r), and the imaginary part (ε_i) of dielectric constant] where studied the effect of the heat treatment on optical properties of selenium films which prepared by DC planar Magnetron sputtering.

2. The Absorbance Spectrum

The absorbance spectrum of selenium films at room temperature and heat treatment for different annealing temperature (333 and 333)ºK have been determined by UV-Visible absorbance spectrum in the spectral range (530 -850) nm on glass substrate. Fig.(1) shows decrease with increased the annealing temperature. The behavior of the absorption spectra is opposite completely to that of the transmittance spectra.

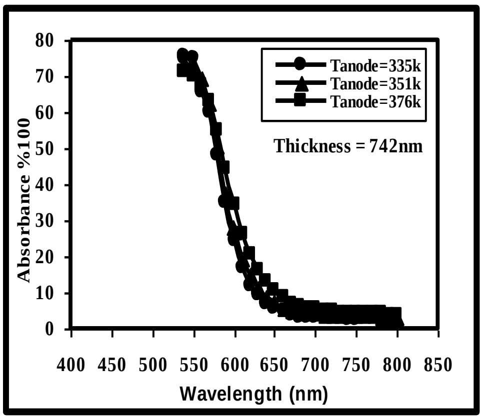

Fig.1.The absorbance spectra for Selenium films

3. The Optical Energy Gap Measurement

The direct optical energy gaps value (E_g^{opt}) for selenium films have been determined. A plot of $(\alpha h\upsilon)^2$ versus hυ for selenium with different annealing temperatures is shown in Fig.(2).The plot is linear indicating the direct band gap of the films. Extrapolation of the linear of the line to the hυ axis gives the band gap.The value of the optical energy gap decreases with increase of annealing temperature for all sample due to the growth of the crystallites .

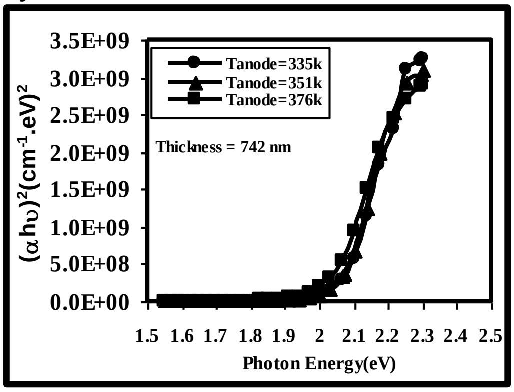

Fig.2. The plot of $(\alpha h\upsilon)^2$ vs. hυ for selenium films

4 Absorption coefficient

The absorption coefficient (α) of selenium films for the as prepared and annealed films at 333K and 353k are illustrated in Fig.(3).From this figure, Se films exhibits a strong absorption of photos at the short wavelength region within (530-580)nm. The values of α are nearly agreed with the results of Kotkata[10].

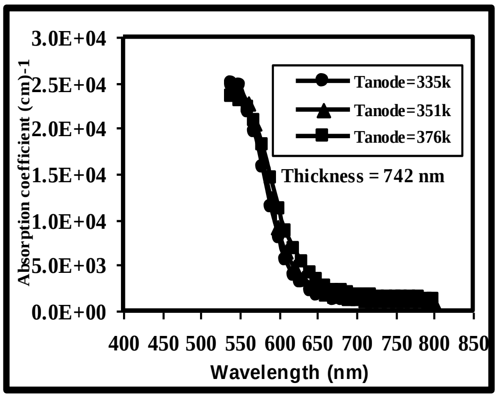

Fig.3. The absorbance coefficient for selenium thin films

5. Refractive Index

The variation of the refractive index as a function of the wavelength for Se thin films at different annealing temperatures is shown in Fig.(4), which indicate that the refractive index increases with the increasing of annealing temperature due to the increase of the compactness of the after the heat treatment simultaneously with the increase of the crystallite size. It is found from this fig.(4).That the refractive index decreases with the increasing annealing temperature

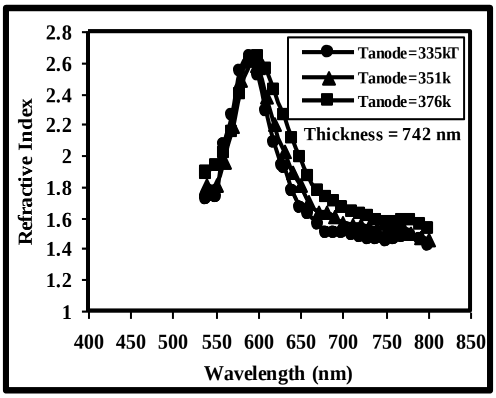

Fig.4. the Refractive index versus wavelength of incident radiation for selenium thin films.

6. Extinction Coefficient

The relation between the extinction coefficient and wavelength for selenium films deposited at different annealing temperatures is shown in Fig.(5).From this figure we can see that the extinction coefficient (k) takes the similar behavior of the corresponding absorption coefficient as shown in Fig.(3).This is attributed to the same reason mentioned previously in the absorption coefficient

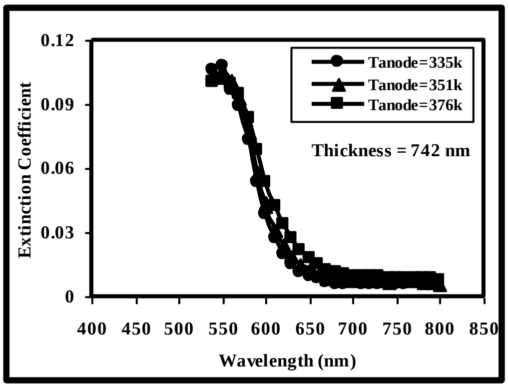

Fig.5.The Extinction coefficient versus wavelength of incident radiation for selenium thin films.

7. The Dielectric Constants

The variation of the real (ε_r) and imaginary (ε_i) parts of the dielectric constant values versus wavelength in the range 530 – 850nm at different annealing temperatures (R.T, 333 and 353)K is shown in Figs.(7 and 8). The behavior of ε_r is similar to that of refractive index because the smaller value of k^2 compared with n^2, while ε_i is mainly depends on the k values, which are related to the variation of absorption coefficient. It is found that ε_r decrease with increasing of annealing temperatures, while ε_i increase with increasing of annealing temperatures.

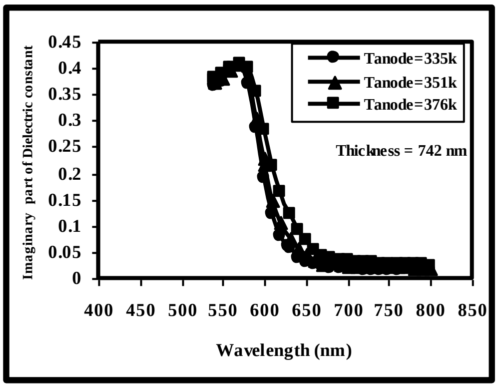

Fig.6 Real dielectric constant for selenium films

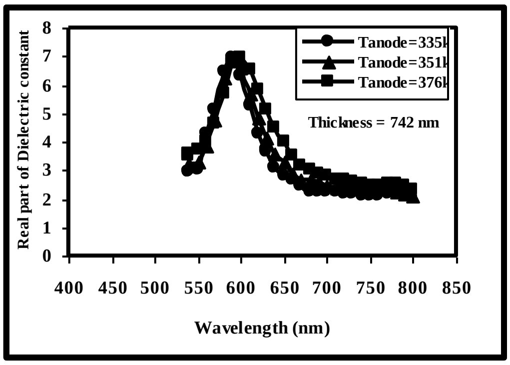

Fig.7. Imaginary dielectric constant for selenium films

Conclusions

The thin films of Selenium deposited by DC planar magnetron sputtering technique have been characterized using optical measurements and deductions to obtain such optical and solid state properties as the T-R-A spectra, optical band gap energy, extinction coefficient, refractive index, and real and imaginary dielectric constant. The variations of optical properties with incident photon energy wavelength have been studied. All the films exhibit high Absorbance (~ 0.70 – 0.90), low reflectance in the visible near infrared region from ~ 500 nm to 850 nm, thus making the films suitable for optoelectronic devices, for instance as window layers in solar cells. The films show a direct transition. Variations in the optical constants with wavelength are found to be oscillatory in nature, which are attributed to the particular structure of the films and their thickness.

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