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Study the Effect of Pressure and time of Deposition on the Structure and Morphology of Gold Films Prepared Sputtering

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***Abstract**: In this paper, the preparation of films Au precipitated sputtering plasma on glass substrates and study the effect of parameters plasma glow discharge and of pressure gas and the time of deposition on the roughness and morphology of the films prepared through a screening X-ray diffraction (XRD) and testing atomic force microscopy (AFM) and electron microscopy scanner (SEM), and it found through analysis of the results marked increase of the thickness of the films as a result of increased pressure gas as well as an increase sputtering time certified the rest of the parameters.As a result of increased the thickness increasingly granular size and thereby increasing the surface roughness, increased more thickness leads to increased homogeneity of the films record.*
***Keywords**: Au films, plasma, sputtering, morphology, roughness.*

I. Introduction

A plasma is a quasi-neutral gas of charged and neutral particles which exhibits collective behavior [1].The glow discharge regime owes its name to the fact that the plasma is luminous, this luminosity arises because the electron energy and number density are high enough to generate visible light by excitation collisions. The glow discharge regime finds widespread industrial applications in lighting devices [2], and in the thin-film deposition and surface treatment [3-6].It can get a direct current (d.c.) glow discharges When a sufficiently high potential difference is applied between two electrodes laced in a gas, the latter will break down into positive ions and electrons , where acceleration The positive ions towards the cathode to produce secondary electrons in addition to some of the atoms sputtered from the surface of the cathode, while acceleration of electrons towards the anode to cause a series of collisions ionization and excitation, followed de-excitations emission of radiation, which gives a "glow" feature to discharge[7].

The d.c. glow at low pressure is one of the most familiar of gas discharges, largely because of the case with which it can be produced and maintained ,and because of it is distinctive appearance which depending on the pressure used , can be as shown in "Fig" 1, where the length of the discharge is consisted of several regions to which changed by change the electric field [8]. There are several parameters that affect the compositions and the microwave structure and surface morphology of thin films, including the growth of the grains and the method of its deployment on the surfaces of the films as well as the accumulation and coalescence each other and etc[9] .Where Jakub Siegel and others studied the effect of precipitation on the films prepared time was observed for the thickness of a linear dependence on time of deposition [10] E. Xenogiannopoulou Lama and others noted Through his studies gold films precipitated on the substrate of quartz increase the homogeneity of the films as a function of the thickness [11].

In this work was the study of the effect of some parameters of plasma glow discharge and pressure of work and the time of deposition on the structure and morphology of gold films prepared sputteringmanner and precipitated on glass substrate. And that of being a Great importance because of its broad spectrum of applications they are used in microelectromechanical systems and nanoelectromechanical systems, sensors , electronic textiles , or devices for surface-enhanced Raman scattering, etc.[12] .

1.1. Parameters plasma glow discharge.

There are several parameters which influence the operation of glow discharge as a technique for deposition of thin films sputtering,One of these parameters:

1.1.1 Pressure: increased pressure leads to an increase of the discharge current and low dark area in the length of the discharge thereby increasing the sputtering atoms [14].

1.1.2 The distance between the electrodes: The effect is similar to the effect of pressure [15], where the deposition rate decreases when increasing the distance between the electrodes, where at reducing the distance increases deposition rate becomes more heterogeneity [10].

1.1.3 The current – voltage independent: proportional sputtering rate with the current when there is constant voltages which represents an appropriate control coefficient, The voltage dependence is nonlinear , but for a certain range of applied voltages, depending on the gas and the target material, the glow-discharge sputtering may be operated in a linear range so that the sputtering rate is proportional to the product of current and voltage [14].

1.1.4 The time ofdeposition: Increasing time of the deposition lead to increase the sputtering rate , thereby increasing the thickness of the film [10,13]. There are also other influential parameters along glow discharge like the type of gas, which affects the color of the glow, as well as cathode material Whenever they send secondary electrons easily, the discharge can be self-sufficient more easily[11].

II. Practical Part

Been in this work deposition films gold Au high purity of 99.9% on the Substrate glass and different circumstances where the led to get a different thickness, using the method of plasma sputtering using SPC-12 system Compact Plasma Sputtering Coater origin (MTR Corporation, CA 94804, USA) , having appeared for the system and clean up all the parts and then appeared pillars of glass through cleaned several stages, where they were cleaned with water and washing powder and then placed in a glass container and flooded with distilled water and placed in a bath device ultrasound for a period of 15 minutes after the flood the alcohol ethyl (C_4H_8O) with a purity of 99.9% until used as extracted from alcohol and dried well using a special cleaning lens paper to be ready for use and can then precipitate films them.

The action steps in plasma sputtering system and through parameter glow discharge control (pressure and the time of deposition) with the installation of the rest of the parameters are as follows:2.1First was to determine the distance between the electrode by 2cm and install the substrate to be deposition of material on them, and then evacuated plasma chamber through a mechanical pump to a pressure of (1×10^{-2} mmHg) to be introduced Argon gas through pressureneedle valve to (2×10^{-2} mmHg) to be a working gas pressure of (1×10^{-2} mmHg)and during a specific period of time for the deposition of (110sec) were obtained onthe membrane thickness (210nm) either at the same conditions, but an increase of the allotted time for the deposition to (220sec) film Au output was the thickness of (230nm) ..

2.2 Then has re previous step but increased gas pressure Argon to (2×10^{-2} mmHg) for specific period of deposition b (110 sec) which led to an increase in film thickness to (270nm), either for a period of (220sec) get film with high thickness It is very (320nm).2.3For the same distance, but to increase the pressure to (4×10^{-2} mmHg) and time (110sec) was obtained membrane thickness (300nm) and time (220sec) produces a thick film (360nm).Is then the education and preservation of samples pending a necessary tests, where tests were conducted X-ray diffraction (XRD) using the device carries the following specifications (TYPE: XRD-6000, SHIMADZU, JAPANESE ORIGIN, TARGET: Cu Kα, WAVE LENTGTH: (1.5406) Ǻ, SPEED: (5) deg / min, VOLTAGE: (40) KV, CURRENT: (30) Ma, RANGE (2θ): 30-100 deg,) As well as an atomic force microscope measurements AFM microscope type (SPM-AA3000, contact, mod, Angestrom, Advanced inc, USA) The measurements of the electron microscope of the SEM Scanner Type(Type: INSPECT -550, Magnification: 300,000X, Accelerates Field: 10 KV, Company: FEI-Netherlands-Holland).

III. Results and Discussion

This work was conducted in several tests to determine the effects of increased pressure, as well as increase the time period for the deposition on the structure and morphology Au films prepared sputtering plasma glow discharge on the glass substrate. These tests represented by:

3.1X-ray diffraction (XRD):

"Fig"2 shows the X-ray diffraction pattern of Au thin films precipitated on glass substrates and different thicknesses (t = 210nm, t = 270nm), and through analysis shows compatibility with ICDD numbered card (00-004-0784) where he notes that the material of the installation Polycrystalline,type cubic with a sharp apex (111), and when increasing the thickness increases the growth of the peaks and increase the intensity so you look more distinct when the larger thickness.It has been a constant expense of the lattice of the film prepare for installation cubic of the equation (1) [16] have shown diffraction calculations of X-rays that fixed lattice have to adopt very few on the thickness of the film By increasing the film thickness is reduced slightly and this corresponds to the researcher.[10,13]

$$d_{hkl} = \frac{ao}{\sqrt{h^2 + k^2 + l^2}} \text{ ------------ } (1)$$

Where: (hkl): Miller. coefficients were calculated Average grain size to the prevailing direction (111) of the equation (2) and found that theAverage grain size increases with the thickness, which leads to increased surface roughness greater the thickness and therefore increasing the homogeneity of the film, and this corresponds to Researcher.[9.12]

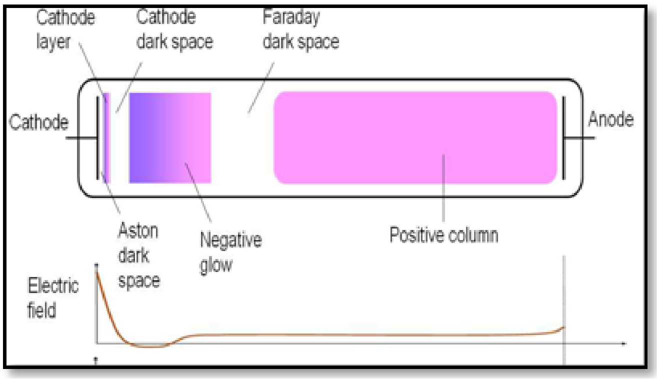
$$D_{av} = \frac{0.9\lambda}{B\cos\theta_B} \text{ -------------- } (2)$$

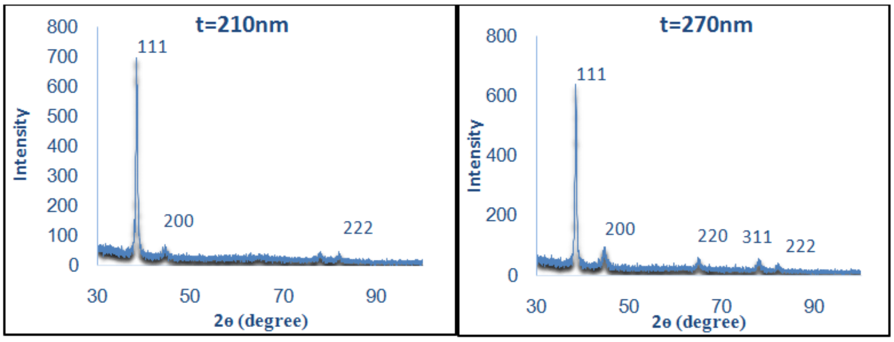
Where: B: display curved at the top and the middle of the measured radial units, λ: the wavelength of the beam falling, θ_B : Barak angle. As in "Table "1.

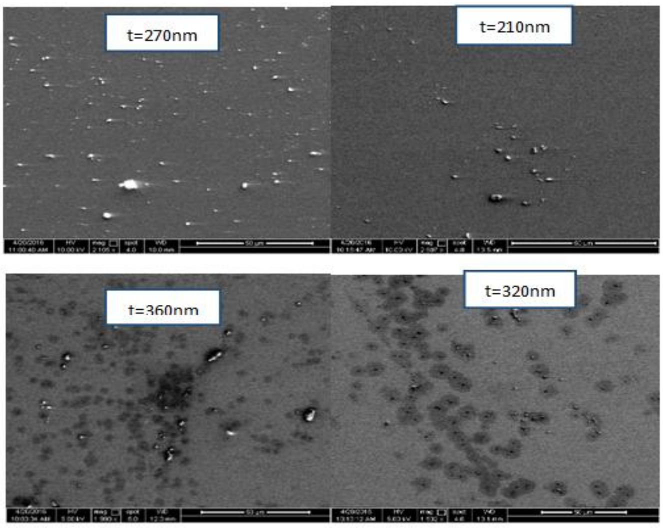
3.2 Morphology analysis

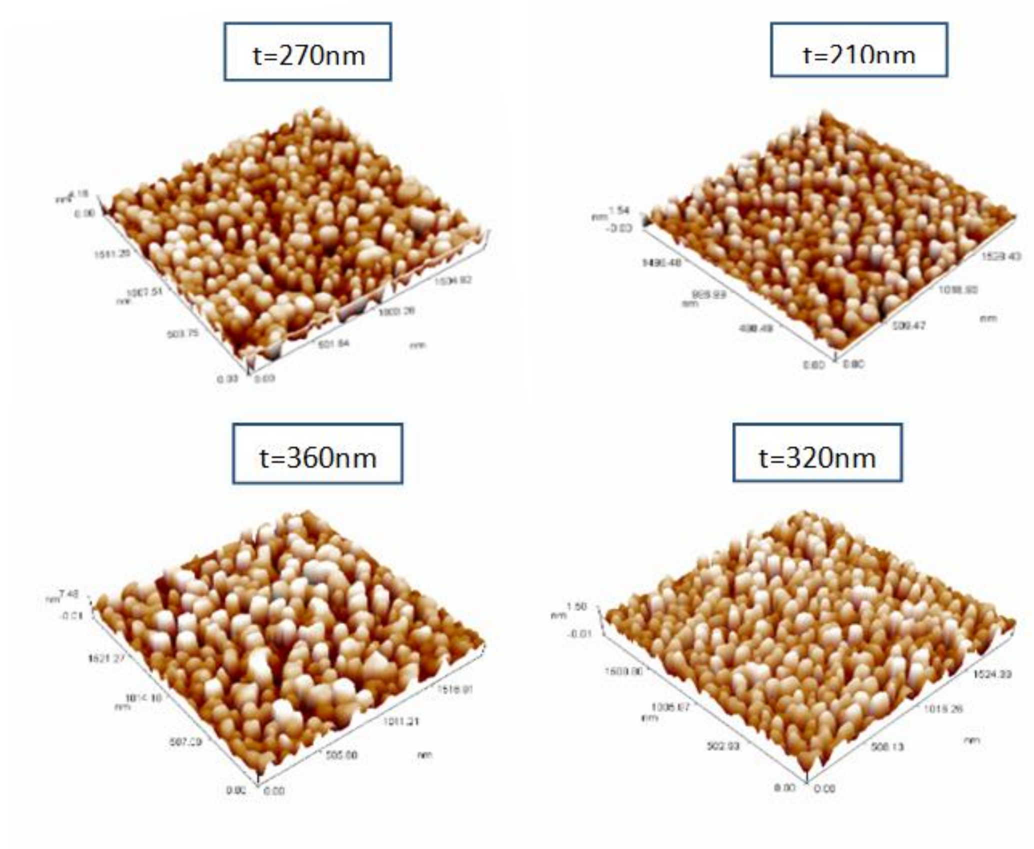
Fig"3 shows images SEM films Au precipitated on substrate glass and prepared sputtering in a manner different thickness where we note the presence of a separate granules "Islands" and increasingly these granules increase thickness thereby increasing collects made up larger particles and thus increase surface roughness This is consistent with the researcher[10]."Fig"4 shows the images AFM films Au prepared and various thickness where we note increasing the square root of the rate of surface roughness (RMS) with increasing thickness, as shown in "Table" 2, where the increase refers to the increase in surface roughness of the films and this confirms the resultsof examination of XRD, which refers to increase the granular size and thus surface roughness increase film thickness record, increasing the thickness of the top lead to increased homogeneity of the film and this corresponds to the researcher [9.12], and this roughness be the result of small-grained collected and that agglomerate to form large granules.

IV. Figures and Tables









Sample Au	2ɵ (deg)	2ɵ (deg) ICDD	d – value	hkl	a◦ (Å)	The average Grain size (Å)
Sample 1 t=210 nm	38.246	38.183	2.351	111	4.0754	19.86551
	44.386	44.391	2.039	200		
	81.808	81.721	1.176	222		
Sample 2 t=270 nm	38.261	38.183	2.350	111	4.0719	
	44.489	44.391	2.034	200		
	64.732	64.575	1.438	220		
	77.719	77.547	1.227	311		
	81.758	81.721	1.176	222		

Sample	*Root Mean Square (nm)*	*Roughness Average (nm)*
t=210nm	0.357	0.296
t=270nm	0.409	0.348
t=320nm	1.12	0.952
t=360nm	2.01	1.72

V. Conclusion

This study concludes adoption of roughness and structure of the surface "Morphology" Au films precipitated sputteringplasma glow discharge on parameter and conditions of discharge and of pressure gas and the time of deposition as a function of increasing thickness, which found an increase of surface roughness to increase film thickness, thereby increasing the homogeneity of the film and improve its qualities, which can be used these films for multiple purposes such as sensors , or devices for surface-enhanced Raman scattering,etc.

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