Synthesis and Study the Properties of a Solar Cell of Gold Nanoparticles Prepared in a Simple Chemical Way

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Abstract

The aim of this study is to prepare gold nanoparticles by a simple chemical method at a temperature of 70°C. The solution was dried on glass basest by Casting method, the rate of five drops per sample At a temperature 100 C. Then the structural and optical properties have been confirmed by X-ray diffraction, scanning electron microscopy (SEM) and Transmission Electron microscope (TEM), Fourier Transform Infrared Spectroscopy (FTIR) and spectrum.

Key Words: Gold Nanoparticles, TEM, Chemical Method.

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Introduction

The thin gold films are utilized in the micro-electronic devices as layers of protection for inner surfaces of micro-wave waveguide resonators, electrical contacts, coatings, and so on (Roya Herizchi *et al* 2014). Gold NPs show high catalytic activities in several of the chemical procedures, such as oxidation of methanol, CO, hydrocarbons, and other compounds. (M. Haruta *et al*, 1993; M. Okumura *et al*, 1997; M. Haruta, 1997) Moreover, in the past years, the nano-structured materials that have been based upon the gold became an object of detailed researches for purposes of the modern medicine. (Chi-Ming *et al*, 1992; H. Wang *et al*, 2006; N.G. Khlebtsov *et al*, 2005; K. Bali T *et al*, 1993). Gold NPs are fundamentally representing the complexes of the dimethyl-gold (III) with the b-diketonates as well as their derivations, (Sujay B *et al*, 2016) carboxylates, (A. Bessonov *et al*, 2007) salitsilaldiminates, (R.G. Parkhomenkoa A *et al*, 2013) in addition to the complexes that include the tri-methylphosphine. (M. Jubber *et al*, 1989). And Gold has a particular importance as a metal that is used for the technology and research, as a result of its chemical inertness, the high work function, high conductivity, large atomic mass, and preferable optical characteristics for specific applications. None-the-less, the chemical inertness, which is translated as well into poor adhesion and high surface and bulk diffusivity. The likelihood to realize the ultra-thin gold films on the glass substrates as well as understanding their optical behaviors is of a high technological significance, for example, for the transparent electrical contacts, nano-plasmonic devices and optical meta-materials. In those situations, there is a necessity for minimizing the spurious optical absorption and (sometimes) electrical resistivity of low-frequency.

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In that context, it has been significant as well being capable of using the traditional approaches of the metal deposition for obtaining the films of high-quality on the common transparent substrates, like the glass. Lately, the ultra-thin (less than 10nm) gold films of high-quality on Si (Pattier *et al*, 2008) and glass (H.M. Stec *et al*, 2011) the surfaces that are activated by the mercapto-silanes have been reported. The concept for the deposition of the gold on the activated surfaces that have been terminated by the SH-groups results from researches of adsorbing alkane-thiol mono-layers on the surfaces of gold (M.D. Porter *et al*,1987) and it has been explored, for example, (H.WANG *et al*, 2006) to deposit rather thick films (70 nm). (D.J. Dunaway *et al*, 1994) have stated scanning-force microscopy researches of ultra-thin (<10nm) Au films on Si and oxidized Si with the use of a variety of the silane mono-layers. (D.J. Dunaway *et al*, 1994) (R.A. Hatton *et al*, 2003).

Experimental Work

The gold solution was prepared from dissolving (1 gram) gold chlorides with distilled water, then the green tea solution was gradually added to the solution until a golden yellow solution was obtained as shown in the figure (1), then part of the solution was deposited on slides of glass and silicon. The results of the work were confirmed using X-ray diffraction of the prepared samples.

Fig. 1. The target solution

Result and Discussion

Figure 2 illustrates XRD patterns for Nanoparticle gold thin films on the glass substrate its can be seen in Figure (2). The patterns of an XRD for Nanoparticle gold It may be seen that the films can be defined as poly-crystalline materials. Figure2 revels It contains three peaks at 38.11, 44.16 and 64.46 diffraction angles corresponding to 111, 200 and 220 and planes that were compared to the standard XRD date file JCPDS file number 00-004-0784. Through the use of Debye Scherrer's relation, crystallite size can be calculated (Scherrer P 1918).

$$G_s = \frac{0.9\,\lambda}{\beta\cos(\theta)} \quad (1)$$

θ represents the angle of diffraction, λ represents the x-ray wave-length and β represents FWHM.
Equations (2&3) can be used for the evaluation of the density of the disarrangement δ and strain η (R. T. Collins *et al*, 1997; Alia A. Shehab *et al*, 2018), as can be seen in table (1).

$$\eta = \frac{\beta\cos\theta}{4} \quad (2)$$

$$\delta = \frac{1}{G_s{}^2} \quad (3)$$

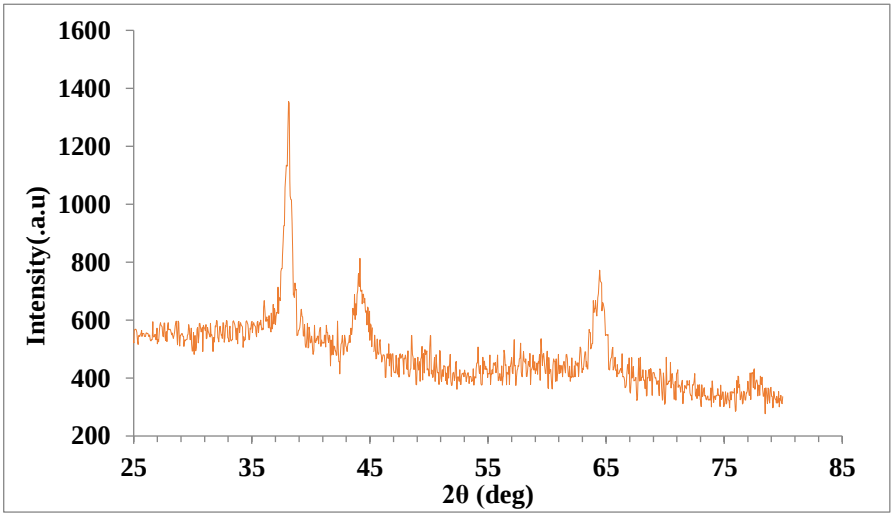

Fig. 2. XRD patterns for Nanoparticle gold thin films

Table 1

The density of the disarrangement δ and strain η				
Sample	**2 theta (deg)**	G_s **(nm)**	**η (lines^{-2}.m^{-4})**	**δ10^{17}(lines.m^{-2})**
Au	38.11	61.69	6.11	.017
	44.16	23.79	15.85	0.297
	64.46	13.15	28.67	1.76

Figure 3 exposes 3-D AFM photos and chart division of gold nanoparticle's film. It's entirely wrapped with gold nano-structure, which is spread regularly on surface, As the results of the examination showed the average grain size, roughness and RMS of surface roughness (62.71, 2.26 and 2.71) nm Respectively. As the results are close to the results of X-ray diffraction.

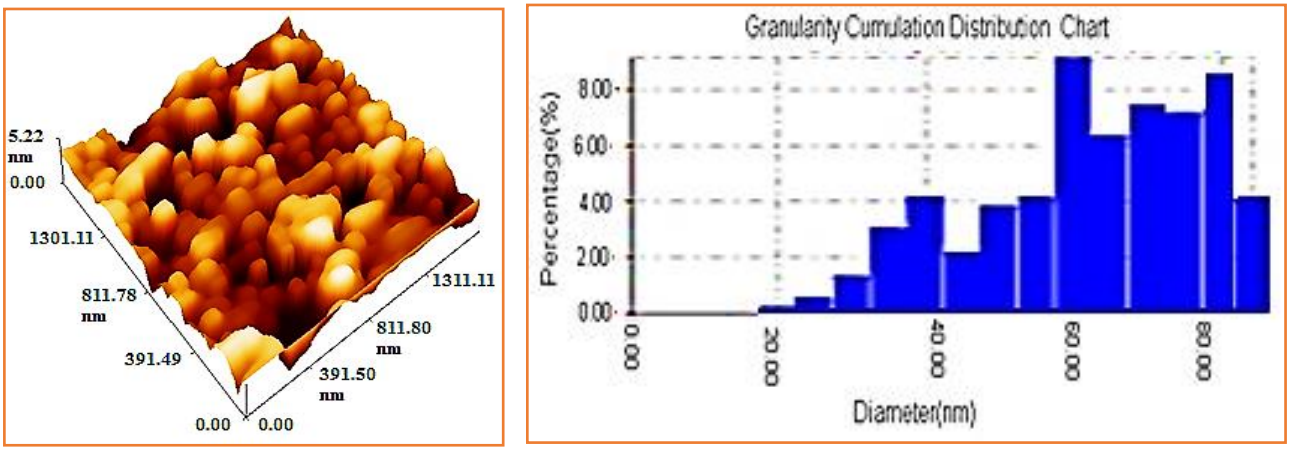

Fig. 3. 3-D AFM photos and chart of the nano-granola

The SEM of gold nanoparticle's has been shown in Fig. 4. We observe the completion of the formation of nanoscale gold, which shows the fine structure and clumping of particles into spherical shapes with nanoscale diameters ranging from 22 - 39 nm.

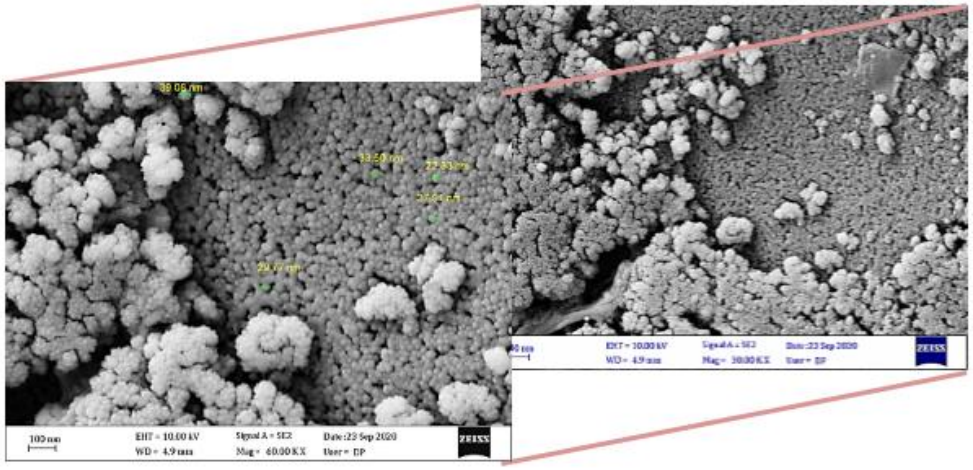

Fig. 4. The SEM of gold nanoparticle's

Figure (5) shows ratio of 1 : 1 elements suggested the existence of gold in those films. However, the results of the XRD suggest that those films dominantly contain gold. There have not been any peaks that are associated with other element in EDS spectra, which has revealed pure Au formation in the prepared thin films.

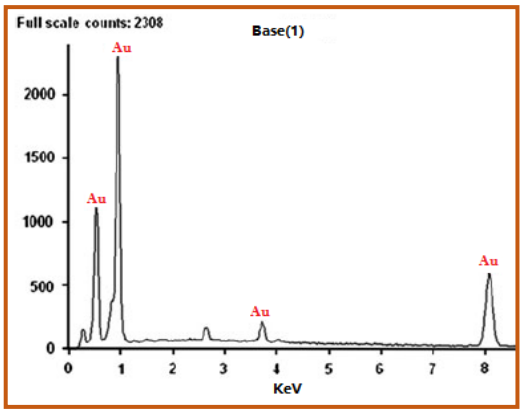

Fig. 5. Ratio of 1: 1 elements in target solution

FTIR spectroscopy has been conducted for the determination of the potential functional groups which are responsible for the gold nanoparticle's. Figure6 illustrates the spectra of Au that have been obtained from green tea extract. The spectra appearing at 500 – 3500cm^{-1} indicates. Figure 6 clearly has highlighted the assembly of the MUA on Au surface. The peaks about (1080.33, 1620.38, 1952.68, 2926.31 and 3488.11) cm^{-1} which refer to asymmetrical and symmetrical–CH group stretching. The characteristic peaks that correspond to the O–H acid group appear at 3,488cm^{-1} (with and without ligand-capped).

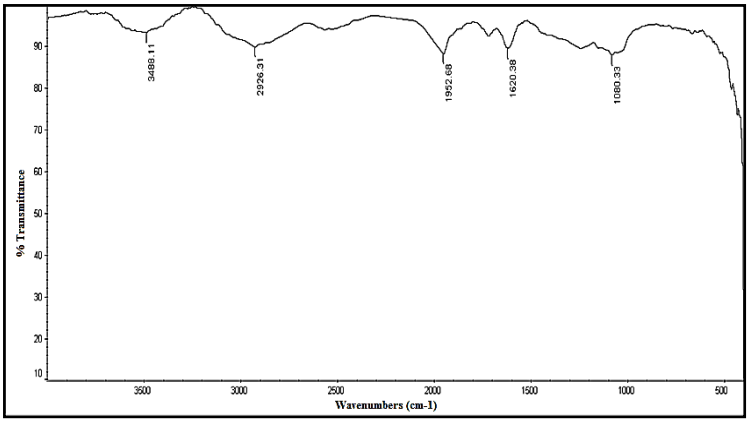

Fig. 6. FTIR spectroscopy

Figure (7) shows UV–Visible spectrum of those Au. UV-Visible Spectroscopy Study. UV-Vis Spectroscopy demonstrates The existence of Out of existence Au. Results have shown that there was not any clear peak for the green tea extract after dissolving the gold chloride, and the peak appeared at 546 nm It has been additionally confirmed by other characterization types that this peak is an indication of the monodisperse spherical shape gold formation. The reaction happens in 3 minutes with clear change in the color.

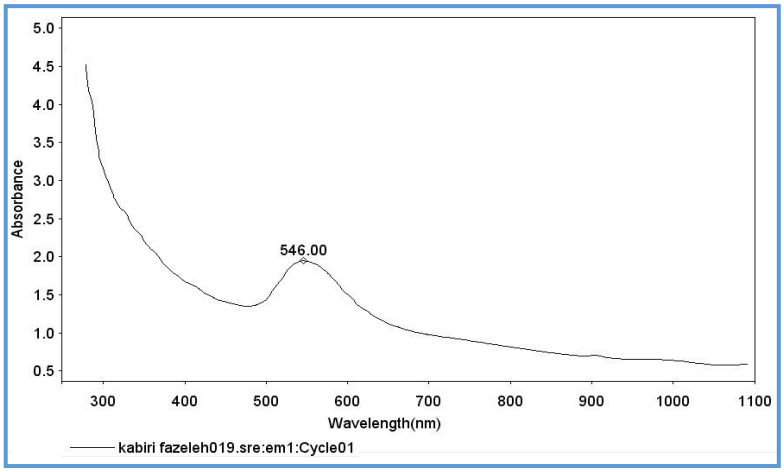

Fig. 7. UV–Visible spectrum

Figure 8 exhibits the (I-V) curve under the illumination in which the photo-current has been produced. The efficiency of the conversion of the solar energy into electric current (η) has been

determined by eq. (4, 5) (Suha. A. Fadaam *et al*, 2018), after the calculation of the following parameters, Isc short circuit current density, Voc open circuit voltage, and FF fill factor The table (2) show the value of efficiency the solar cell Which was prepared on a silicon wafer, has obtained the efficiency is (4.06%).

$$\eta = \frac{P_m}{P_{in}} \times 100\% = \frac{I_m V_m}{P_{in}} \times 100\% \qquad (4)$$

$$F.F = \frac{I_m V_m}{I_{sc} V_{ov}} \qquad (5)$$

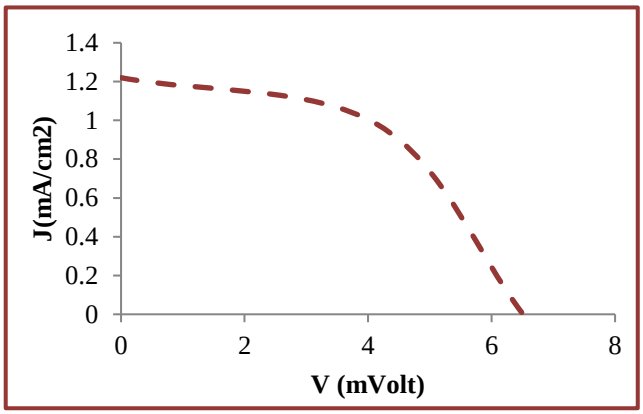

Fig. 8. The (I-V) curve

Table 2. The value of efficiency the solar cell

The value of efficiency the solar cell						
Sample	J_{sc} (mA/cm²)	V_{ov}(mV)	J_m (mA/cm²)	V_m (mV)	F.F%	η%
Au	6.51	1.22	4.16	0.977	0.51	4.06

Conclusion

The nanoparticle gold was successfully prepared by a simple chemical method using gold chloride with the addition of green tea and it has been confirmed by XRD and EDX, then the characteristics of solar cell have been studied and the efficiency rate was obtained by depositing on silicon chips at a rate of 4 066%.

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