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Characterization and antibacterial of Gold Nanoparticles Prepared by Electrolysis method

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Abstract. In this study gold nanoparticles (AuNPs) was prepared by electrolysis method Au thin film which was deposited on a glass substrate by drop-casting technique structural, optical and topographic characteristic of prepared nanoparticles were examined by UV-VIS absorption, TEM electron microscopy, AFM atomic microscopy, and XRD diffraction. Antibacterial activity of nanoparticles has been investigated against many pathogenic bacteria, including Escherichia coli, Staphylococcus aureus, bacillus and Pseudomonas aeruginosa using a well-spread method, and the results showed that nanoparticles have an inhibitory effect against all types of pathogenic bacteria For diseases. And 30 and 25 mm) for aerosols, E. coli, Bacillus subtilis, Staphylococcus aureus and Staphylococcus aureus, respectively.

Keywords. Nanoparticles, Antibacterial, thin film, gold nanoparticles, TEM.

1. Introduction

Nanotechnology has been used in many important areas such as physical, medical, engineering and chemical applications. New techniques have been developed to detect and control atoms and molecules. Metallic nanoparticles have gained attention in many applications such as biotechnology, cosmetics and electronics [1]. These nanoparticles include iron oxide, nanoparticles and other nanoparticles in different shapes and sizes, which have been widely used and designed and modified for use in medicine and biomedical applications [2]. Biomedical properties of nanoparticles have emerged in recent decades, from surface modification through the biological adhesion of certain molecules to fine-tuned optical properties to diagnostic protocols according to molecular composition, among others [3]. The widespread use of antibacterial chemical agents created selective pressure to support high rates of antibiotic resistance [4].

The need to develop new antibacterial substances has emerged because new strains of existing antibiotic-resistant bacteria have become a public health problem [5]. In this context, it is necessary to assemble or obtain compounds such as nanoparticles with antimicrobial properties, and we have promising applications in combating the ever-increasing number of antibiotic-resistant pathogenic bacteria that pose a continuing threat to human and animal health [6]. The realization of this research is the invention of small-sized gold NPs with concentration by electrolysis method. The concentration of

Au NPs 150 ml was used to examine an anti-bacterial mechanism against four types of human pathogenic bacteria. Inhibition zone was studied by a good agar method of diffusion .

2. Experimental work

In this work, a glass (20 x 20) mm2 with a thickness of 1 mm was used. Gas substrates were cleaned with methanol and deionized water in the ultrasound bath to obtain a clean surface. AuNPs were prepared by electrolysis cell as shown in Figure 1. The poles of this cell are the molybdenum plate as a positive electrode and the gold plate as a negative electrode. Water was used with hydrochloric hydrochloride in a ratio of about 8: 1 as an electrolyte liquid. The applied voltage was 6 volts. Falling casting method was used to deposit the golden nanoparticles into the glass samples. Then the annealing process is applied at 175 ° C for 60 minutes. For samples. Thickness film was found to be around ($2x10^2$ ±10 nm). Thickness of the films was measured using Fizeau Interferometer method. Crystal structure was studied at the following operation conditions: source Cu-Kα radiation of wavelength λ = 1.54 Å, current intensity = 20.0 mA, scanning speed = 5 cm/min by XRD 6100 Shimadzu. Optical transmittance measurements were recorded with UV/Visible 1800 spectrophotometer. The energy bandgap was specified from the transmittance (T) in the wavelength (200 nm to 1000 nm). Shape and gold size were studied by AFM and XRD (AA 3000 Scanning Probe Microscope).

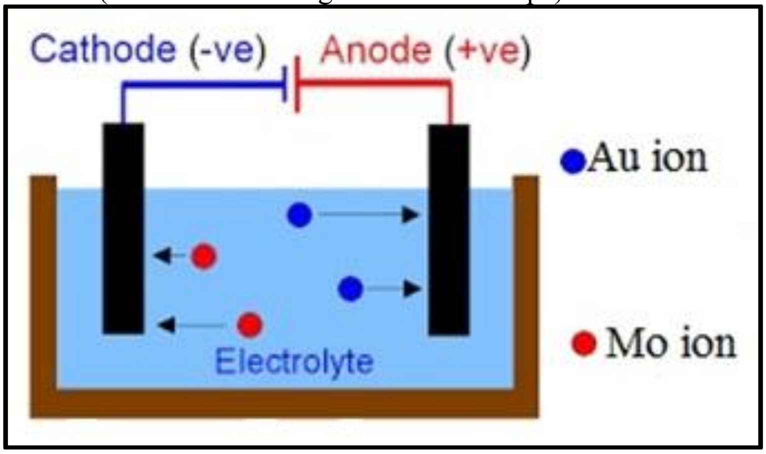


Figure 1. Electrolysis cell.

Anti-microbial activity of gold nanoparticles (AuNPs) against pathogenic micro-organisms was determined utilizing (W.D.M) well dispersion technique under oxygen consuming condition.

1- Inhibitory movement against all pathogenic miniaturized scale creatures was tried on Muller-Hinton agar.
2- Agar plates were vaccinated with (1.5 × 108 (CFU)/mL for microorganisms and 1.5×10^6 (CFU)/mL for shape and yeast, contrasted and 0.5 mcFarl and standard cylinder) with every pointer small scale life forms in the wake of developing them in a supplement stock.
3- Wells adjoin 6mm were cut in Mueller-Hinton agar plate and 150 µL of AuNPs was included into each well.
4- All plates were hatched at room temperature 37 ˚C inside 24 hrs-48hrs for microscopic organisms and 30 ˚C inside 72 hrs for yeast and shape then the action was controlled by the distance across of the restraint zone around the wells, the zone of leeway on agar plates was utilized as a pointer of bioactive capability of the AuNPs.

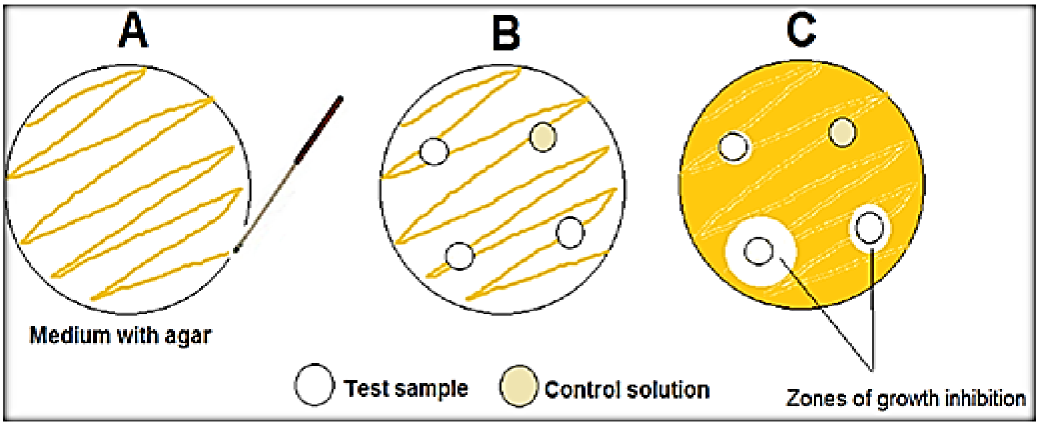


Figure 2. The clearance zone of agar plates.

3. Results and discussions

X-ray diffraction pattern of a gold thin film on a glass substrate shows in figure 3. We can see that the film is a multifaceted structure that focuses on the cube. From Fig. 3, four peaks can be seen at the diffraction angle of 38.18, 44.26, 64.48 and 77.52 corresponding to the aircraft (111),(200), (220) and(311) respectively, which were agreed with the card XRD (ASTM No. 00-004-0784). It is compatible with literature [7].

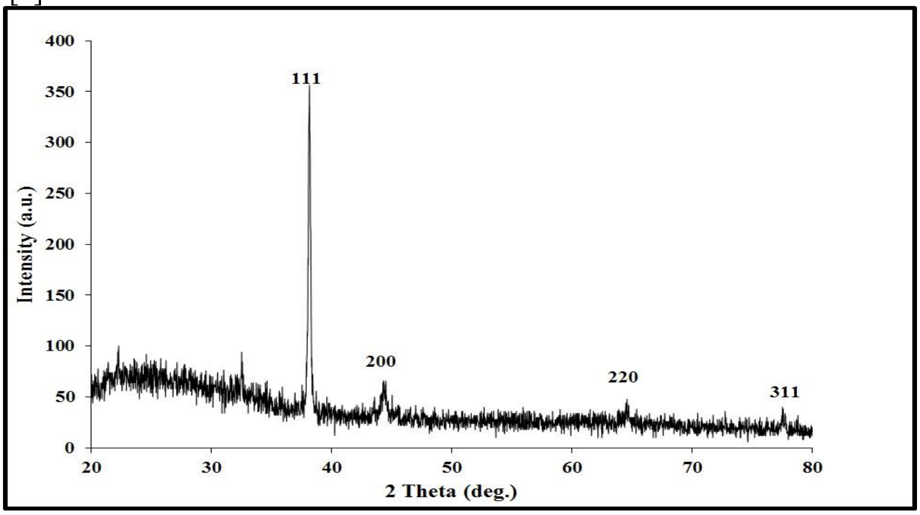


Figure 3. X-ray spectra of Au thin film.

From Scherrer's equation it was found that the crystallite size [8]:

$$G_S = \frac{0.9\lambda}{\beta \cos\theta}$$

where θ, λ and β are the diffraction angle, the X ray wavelength, and the FWHM respectively. While equations 2 and 3 were used to calculate the dislocation density δ and the micro-strain η [9] (Table 1) :

$$\delta = \frac{1}{G_S{}^2}$$

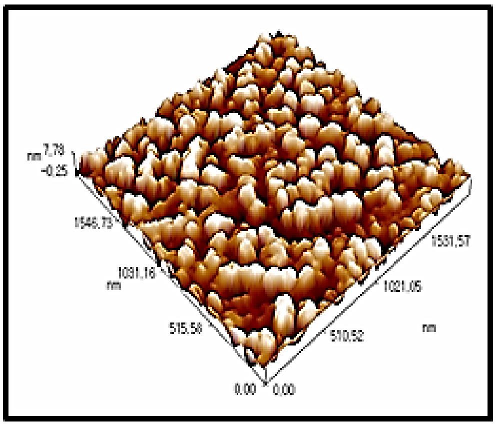
$$\eta = \frac{\beta \cos\theta}{4}$$

Table 1. Crystallite size G_S, micro strain η and dislocation density δ of the Au thin.

Sample	Theta (deg.)	(hkl)	G_S (nm)	η X10^{-4}	δ X10^{14} (lines/m^2)

Au	38.14	111	44.19	7.790	5.120
	44.26	200	53.25	6.463	3.525
	64.48	220	56.21	6.123	3.164
	77.52	311	56.23	6.121	3.162

Figure 4 shows the distribution map of 3D images and the granular accumulation of the film for gold which deposited on a glass. It is completely wrapped with a nanostructure that is regularly diffuse over the glass. Table 2 shows the grain rate, roughness density and RMS of the high Au film.



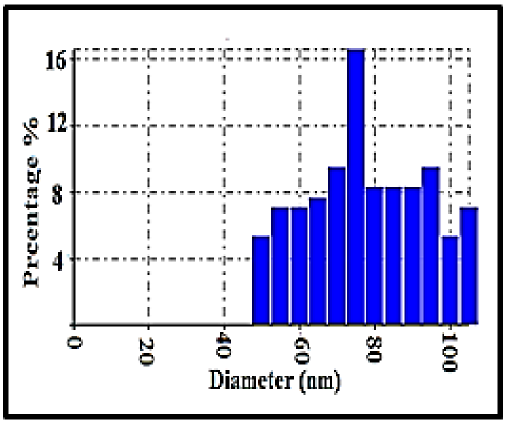


Figure 4. Atomic microscopy and Granularity chart distribution chart of Au thin.

Table 2. Grain rate, roughness density and (RMS) for Au thin film.

Sample	Average grain (nm)	Roughness density(nm)	RMS(nm)
Au	75.46	1.69	2

Figure TEM of Au NPS is shown in Figure 5. The image proved that the formation of Au nanoparticles is approximately spherical and has a diameter of about 16 nm prepared by electrolysis.

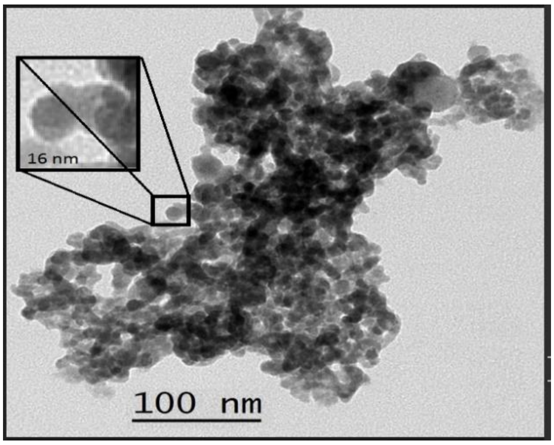


Figure 5. TEM micrograph image of Au particles prepared by electrolysis method.

Figure (6) shows the Au thin film and the relation between the transmittance and the wavelengths. It can be seen that the increasing transmittance sharply until it reaches the highest value at 300 nm, then decreases slightly and then begins to increase gradually until it reaches the highest value at 500 nm.

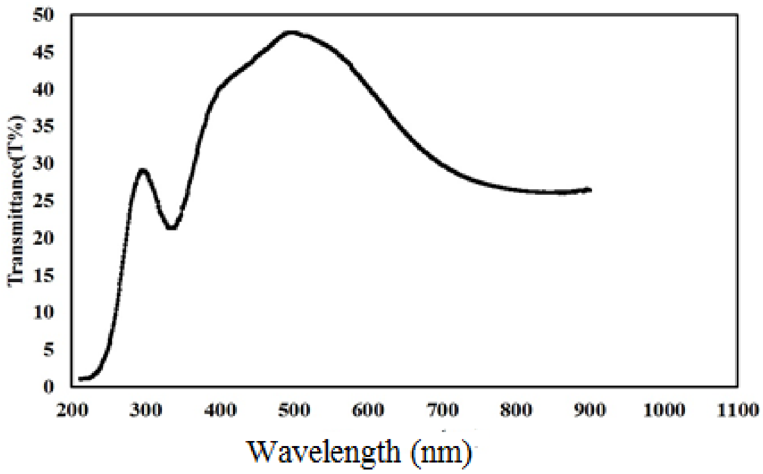


Figure 6. Optical transmittance of Au thin film.

The optical energy gap of Au was calculated by the relation [10]:

$$\alpha h\upsilon = C(h\upsilon - Eg)^m$$

Where C, υ ,h and α is a constant, transition frequency, plank constant and the absorption coefficient respectively, Eg is the optical energy gap and the exponent n describe the number of transition m= 0.5 for indirect band. Fig.6 shows that band gap of gold thin film which it is prepared and deposited on a glass. The measurement was from the square plot $(\alpha h\upsilon)^2$ toward the energy of photon by extrapolating the linear curve part VS. the photon energy. The energy gap of Au thin film is found to be around 4.6 eV.

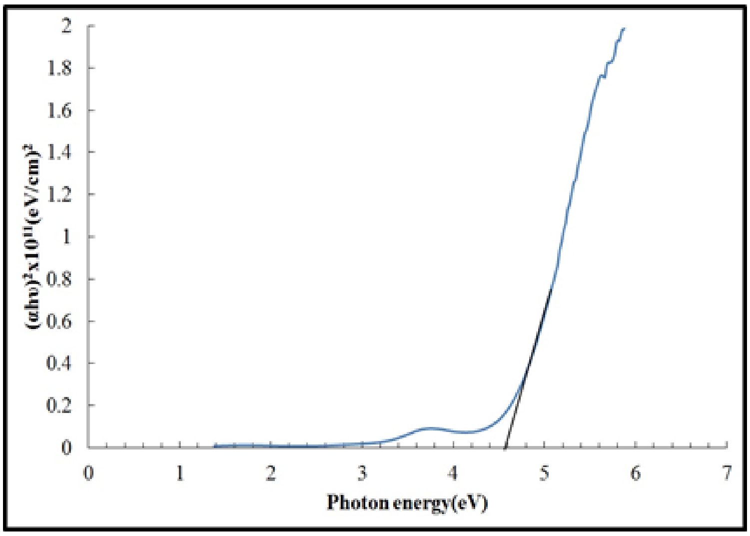


Figure 7. Plot $\alpha h\nu^2$ versus hν curve of Au thin film.

The most important applications of nanotechnology is in medicine as antibiotics only eliminate a small number of pathogenic bacteria while the nanoparticles eliminate different type of pathogens [11]. Gold nanoparticles (AuNPs) were known to have solid antibacterial exercises. The antibacterial movement of various centralization of arrangements containing Gold nano-particles exhibited that both gram positive microscopic organisms were hindered. The most extreme antibacterial action in 150µL/mL centralization of the integrated Au NPs was (26, 27 and 30 and 25) mm for gram-negative microorganisms like E.coli, Pseudomonas aeruginosa and gram-positive microbes like Bacillus subtilis, Staphylococci aureus separately. B. subtilis shows most noteworthy antibacterial action for AuNPs than other microbes. Figure 8 illustrates the effect of gold nanoparticles on pathogenic bacteria using method of disk diffusion. Diameter of the reflection zone is about ten mm around the different disc. The maximum effect of nanoparticles is about 30 mm on thin film bacilli, as shown in Table3.

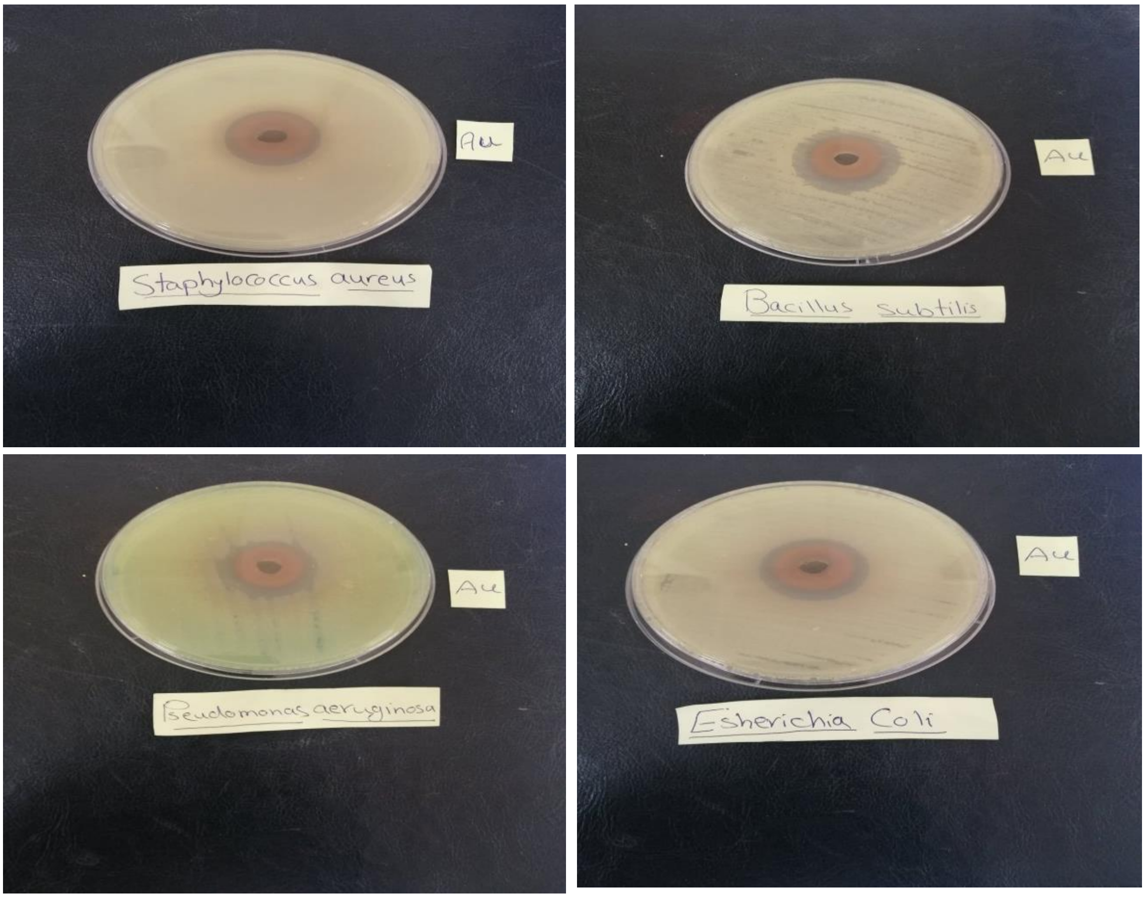


Figure 8. The inhibition zone caused by AuNPs is prepared in a electrolysis method prepared against pathogenic bacteria.

Table 3. Antibacterial Activity of Au Nps against bacteria.

material	Escherichia coli	Staphylococcus aureus	Bacillus subtilis	Pseudomonas aeruginosa
Au	26 (mm)	25 (mm)	30 (mm)	27 (mm)

4. Conclusion

The work demonstrates how the thin film was prepared by electrolysis. Simple, easy and fast way to install nanostructures. The film's behavior as shown in figures prove that the film has a good visual transition with good crystallization. Also, this study concluded that gold nanoparticles with a concentration of 150 L / ml have significant activity and potential effect in reducing the growth of pathogenic bacteria in practical applications.

5. Acknowledgements

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