Open Access **Baghdad Science Journal** **P-ISSN: 2078-8665**
2020, 17(4):1169-1176 **E-ISSN: 2411-7986**

DOI: http://dx.doi.org/10.21123/bsj.2020.17.4.1169

In Vitro Cytotoxicity Study of Pt Nanoparticles Decorated TiO_2 Nanotube Array

Shaymaa R.Baqer*[1] ***Abdulkareem M.Ali Alsammarraie*[2]** ***Mahasin Alias*[1]**
***Mohammad M.F.Al-Halbosiy*[3]** ***Amaal S. Sadiq*[1]**

[1]Department of Chemistry, College of Science for Women, University of Baghdad, Baghdad Iraq
[2]Department of Chemistry, College of Science, University of Baghdad, Baghdad-Iraq,
[3]Biotechnology Research Center, Al-Nahrain University, Baghdad-Iraq,
*Corresponding author: *shyma0213@gmail.com, karim.alsamuraee@gmail.com, mahasinfa_chem@csw.uobaghdad.edu.iq , ma8jed@yahoo.com, amaalsameer74@gmail.com
*ORCID ID: https://orcid.org/0000-0002-7150-165X, https://orcid.org/0000-0002-3983-1608 , https://orcid.org/0000-0002-3375-1797 , https://orcid.org/0000-0003-1373-4188 , https://orcid.org/0000-0002-5664-4767

Received 16/7/2019, Accepted 8/1/2020, Published 1/12/2020

Abstract

Titanium dioxide nanotubes were synthesized by anodizing Ti sheets in the ethylene glycol solution and were covered in Pt nanoparticles onto the surface of TiO_2NTs using electrodeposition method from using five derivatives of Mannich base Pt complexes which have been used as precursor of platinum. The mean size, shape, elemental composition of the titanium dioxide nanotubes and platinum deposited on the template were evaluated by different techniques such as field emission scanning electron microscope (FE-SEM), transmission electron microscopy (TEM), X-ray diffraction pattern (XRD), and energy dispersive X-ray (EDX) technique. From all these analyses, the TiO_2NTs prepared and Ptnanoparticles deposited on it were identified. The diagnoses proved that all the Pt nanoparticles have a size less than 50 nm. The MCF-7 cancer cell lines and WRL68 normal cell lines were treated with concentration 800, 400,200,100, 50, 25, 12.5µg\ml of TiO_2NTs and Pt\$TiO_2$NTs(1) and (2) for 48hours using MTT assay.IC_{50} and inhibition rate were calculated. The result shows that the Pt\$TiO_2$NTs have more inhibition effect on cancer cell lines than TiO_2NTs array.

Key words: Electrochemical deposition, Platinum nanoparticles**,** Titanium dioxide nanotubes

Introduction:

Most recent research on titanium dioxide nanotubes interested in the doping or deposition of metal ions like chromium, iron, cobalt, nickel ,copper, palladium, platinum, sliver, and zirconium (1) and like boron ,carbon, nitrogen and fluoride as non-metal in addition to using the metal oxides such as manganese dioxide had increased its applications in several fields (2). Among the varied nanostructured oxide materials, special attention has been directed toward TiO_2 nanotubes as result of developing some feature like low-cost and it has a large surface area compared to the volume(3). The titanium nanotubes are used as catalysts in accumulation boiling, photocatalysis (4), electrochromic device (5), resistant to corrosion (6), H_2 gas generation(7), solar cells (8), sensors, memory device (9), catalyst support (10), wastewater. Conjointly consistent with several researchers, the titanium oxide nanotubes could have been employed in drug-eluting stents and for the native unleash of antibiotics, drug delivery in cancer and tumor therapy. It is also widely used in dental implants and bones (11). Using titanium nanotubes in nanomedicine has a promising future in treating many diseases because improving cell adhesion, growth and differentiation (12,13), as well as its use in drug delivery. Later findings proved the strong relation between the cell responses and nanotube dimensions(14).Some of methods used to improve the performance of TiO_2NTs are to load nanotubes with some antibiotics such as vancomycin(15) or decorate the surface of TiO_2NTs with different nanoparticles such as gold(16) and sliver(17). Platinum medicine is still one of the most important treatments for

cancer, one of the most effective materials in the treatment of human cancers in particular (18).
Platinum nanoparticles have many properties that can be used in practical applications, including the manufacture of electronics and internal electrodes (19), durable proton exchange membrane fuel cells and biology and biochemistry applications (20). In this study five Mannich base Pt(IV) complexes were used as a source of platinum instead of platinum salt ($H_2PtCl_6.6H_2O$) because the ligand prevents the aggregation of Pt nanoparticles when decorated on the surface of nanotubes. In this research titanium nanotubes were prepared and different sizes of Pt nanoparticles deposited on the surface of titanium nanotubes using different deposition times 3minutes when using PtL_1,PtL_2,PtL_3 and PtL_5 and 6 minutes when use PtL_4.at the fixed concentration to show the effect of the size and density of platinum nanoparticles and their effect on inhibition of cancer cells compared to nanotubes alone by using MTT method in 620nm.This research aims to synthesis pt nanoparticles of different size from Mannich base platinum complexes as a source of platinum after deposition on TiO_2NTs and study the cytotoxic effect of these nanomaterials on breast cancer cell lines.

Material and Methods

All chemicals were purchased from commercial sources $H_2PtCl_6.6H_2O$ (99.9%), S-(1-(benzothiazole-2-ylamino) methyl]-H-benzimidazole-2-yl)4- nitrobenzothioate (L_1),S-(1-(Pyrazine-2-carboxamido) methyl)-1-H-benzoimidazole-2-yl)4- nitrobenzothiolate(L_2), N-((2-((Morpholinomethyl)thiol)-1H-benzomidazol-yl)methyl) pyrazine-2-carboxamide (L_3), 2-(Morpholin-N-methyl)mercapto-1H-benzimidazole (L_4), S-(1-Morpholinomethyl)-1-benzoimidazol-2-yl)4-nitrobenzothioate (L_5).NH_4F (99.5%), ethylene glycol 99.8% and Ti, Pt foil (99.6,99.99%) and thickness 0.25mm. Solvents and reagents were used as received. The nanostructures were characterized by SEM, TEM, XRD, EDX, FT-IR. Transmission Electron microcopy (TEM) was recorded on Philips CM (10).EDS .Atomic weight and atomic number of all prepared nanoparticles were carried out by energy dispersive X-ray spectroscopy (EDS) XFlah6-10 Detector –Bruker. X-ray diffraction was measured using Shimadzu ray 6000.

Preparation of Complexes

Preparation of TrichloroS - (1 -(benzothiazole - 2 –ylamino) methyl]- H -benzimidazole-2-yl)4-nitrobenzothioate Patinum (IV). Chloride.0.5hydrate (PtL_1), Trichloro S-(1-((pyrazine-2-carboxamido) methyl)-1-H-benzoimidazole-2-yl) 4-nitrobenzothioate Palatinum (IV) .Chloride Ethanol (PtL_2) , Trichloro N-((2-((Morpholinomethyl)thiol)-1H-benzomidazol-yl)methyl) pyrazine-2-carboxamide) Platinum (IV). Chloro. Hydrate (PtL_3,). Dichlorobis (2-(Morpholin-N-methyl)mercapto-1H-benzimidazole) Platinum(IV).Dichloride .Hydrate (PtL_4). Dichloro Bis S-(1-Morpholinomethyl)-1-benzoimidazol-2-yl)4-nitrobenzothioate Platinum (IV). Dichloride.Dihydrate (PtL_5). The Pt complexes were prepared according to the literature (21, 22)
The Mannich bases reaction occurs in ethanol with platinum salt , 1:1 and 1:2 molar ratio for L_1,L_2,L_3 and L_4,L_5 respectively. The mixture was then refluxed for (3 hours.); the color solid complexes were formed, and then filtered, washed with ethanol and dried in dissector

.

Preparation of TiO_2 Nanotubes

Titanium dioxide nanotubes was prepared according to the literature (8) .Titanium foils were cut into the suitable size (1×2 cm^2). A direct current power supply (matrix E3612A) was utilized as the voltage source for the anodization. The anodization process was executed in a homemade plexiglass cell with two electrode arrays; titanium foil as the working electrode and Pt mesh utilized as the counter electrode in constant potential at 25^0C. The distance between the substrates and the counter-electrode was approximately 1.5 cm. Degreased by sonication in detergent, deionized (DI) water, ethanol and acetone respectively for 10 minutes dried in an oven at 100 °C for 15 minutes. For the anodization process, the electrolyte used was 0.5 wt% ammonium fluoride (NH_4F), (99.5%) in anhydrous ethylene glycol (99.8% of purity at room temperature. The anodized substrate was then soaked in a water bath at 40 °C for 20 mintes to remove the organic electrolyte. The anodization was performed for one hour at 40 V. After the occurrence of the anode, annealing in the oven with a temperature at 550^0C was done (8).

Preparation of PtNPs/TiO_2NTs

Platinum nanoparticles were deposited onto the annealed TiO_2 by using an electrochemical (reduction) method at a constant potential in a typical two-electrode system with the prepared TiO_2 nanotube as the working electrode, Pt sheet as the counter electrode. The electrolyte solution was prepared by dissolving the 2mM from five complexes PtL_1, PtL_2, PtL_3, PtL_4 and PtL_5 in 100

ml mixture solvent (dimethyl formamide DMF, ethanol, deionized water (1:1:1)). Electrodeposition time was set at 3 minutes, while the PtL_4 at 6minutes while the electrodeposition voltage was fixed at 7 V and pH=5.5. The prepared Pt modified TiO_2NTs was washed several times with deionized water for 3 minutes to remove the residue of the solutions that are not deposited above the template, and then dried in air.

Cytotoxic Assays

Cytotoxicity effect of TiO2NTs and PtNPs when deposition on TiO2NTs on MCF-7 and WRL68 cancer cell line, and normal cell lines were done in a sterile area using the biosafety conditions of the airflow cabinet, MCF-7, WRL68 cell lines used in this study were equipped from Biotechnology Center/Al-Nahrain University. The cells were cultured in (MEM) modified eagles medium with serum ((100 U\ml) of antibiotic, ((100 µg)) of streptomycin/ml in incubator with (5% CO_2 at 37 °C). The survival or death of cells were determined using (3-(4,5- dimethylthiazole-2-yl)-2,5-diphenyl Tetrazolium bromide ((MTT)) which is diagnosed by using spectrophotometer. Plated in 96-well sterilized microliter-plates at a density of (1×105 cells/well). After twenty-four hours, Cells were treated with different concentrations of prepared compounds starting from the lowest concentration and incubated in (5% CO_2) atmosphere with high humidity. After forty eight hours of compounds exposure, the cells were incubated with (0.5 mg/ml, MTT) distilled water for another four hours at thirty-seven degrees.10% of salt (sodium dodecyl sulphate) then incubated for two hours. Absorption was measured at the wave length 620 nm on a multi-well ELISA plate reader (23).

Results and Discussion

Hitachi S-4160 Field emission scanning electron microscope (FE-SEM) was utilized to diagnose the surface morphology of TiO_2 nanotubes template **Fig. 1(**A,B,C,D,E,F). Template was scratched with a steel blade so as to observe the nanotubes of the side, as shown in **Fig. 1** (A1,B1,C1,D1,E1,F1). The process of anodizing led to the arrangement of nanotubes vertically. Generally, the nanotubes had lengths in the range 3 - 5 µm, and average diameters 83 nm, range from (51.8-95.7) .There were no differences when compared the observed morphology of the annealed crystalline nanotubes and transmission electron microscopy **Fig. 2**. TiO_2NTs may serve as the active sites or platform to deposit nanocrystals and able to promote unidirectional charge transport due to the one dimensional feature of the nanotubes. The aggregated Pt nanoparticles formed for (PtL_4) were larger than the other particles upon electrodeposition at 6minutes as depicted as in **Fig. 1** (B, B1). While other which observed in **Fig. 1** (C,C1,D,D1,F,F1,E,E1), the Pt nanoparticles were dispersed uniformly on the tube mouth of the TiO_2NTs at 7V, 2 mM and 3minutes, some Pt nanoparticles were found to have embedded into the TiO_2NTs. However, Pt nanoparticles prepared at 7 V, 2 mM for 6 minutes, became larger than Pt synthesized at 3minutes (24). The EDX unmistakably demonstrates that Pt, Ti and O are the major elements of composition which assures the existence of Pt decorated on TiO_2NTs substrate as appear in **Fig. 3**.

Baghdad Science Journal
P-ISSN: 2078-8665
E-ISSN: 2411-7986

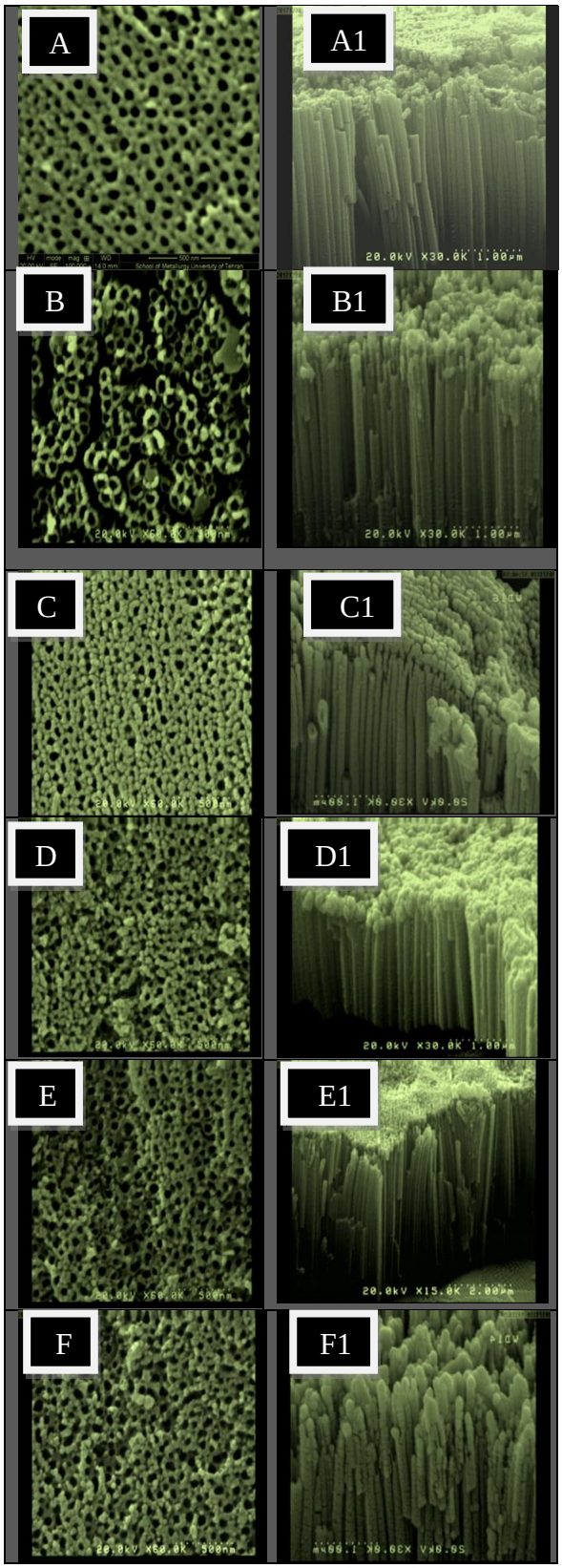

Figure 1 . FE-SEM images: A, A1 TiO_2NTs surface and cross section; B, B1 ,C ,C1 ,D ,D1 ,E ,E1 ,F ,F1 Pt/TiO_2 NTs surface and cross section B ,B1 at 7 Vol.,2mM 6 minutes C ,C1 ,D ,D1 ,E ,E1 ,F ,F1 at 7V, 2mM at 3 minutes

Field emission scanning electron microscope (FE-SEM) was supported by transmission electron microscope (TEM) technique and similar results have been shown .TEM images of the TiO_2NTs and Pt/TiO_2NTs are summarized in **Fig. 2**. both scans, show similar results in size and shape of nanotubes in average diameter (83nm) and nanoparticles (less than 50 nm) and deposition of platinum nanoparticles on the internal and external walls of TiO_2NTs, **Fig. 2 a and b.**

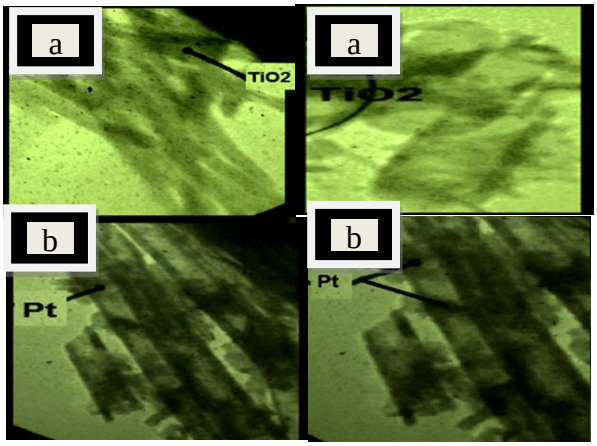

Figure 2. (a) TEM images of TiO_2NTs; and (b) Pt/TiO_2NTs

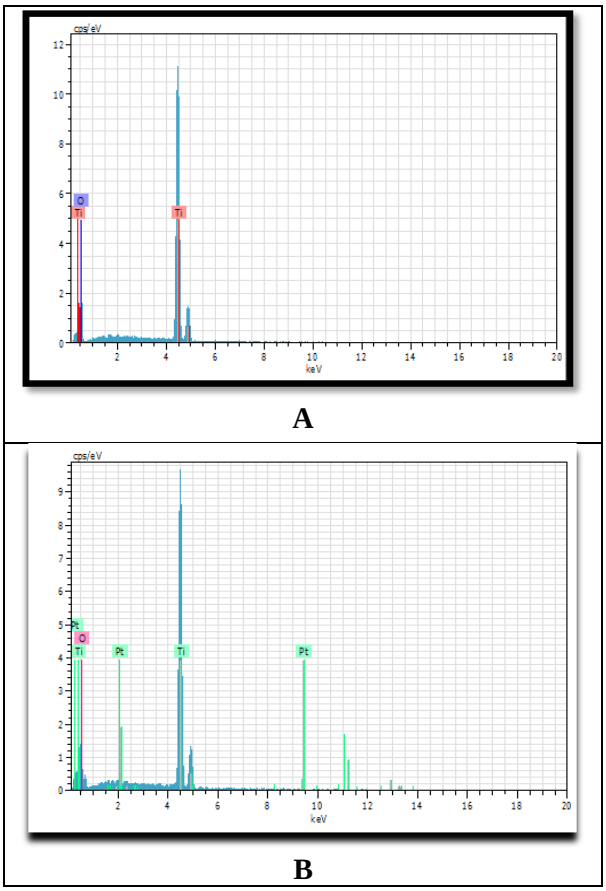

Figure 3. EDX (A) TiO_2NTs template, (B)$Pt_{1,2,3,4,5}$\$TiO_2$NTs

XRD analysis was used to confirm the crystal phases of TiO_2 nanotubes and the Pt-nanoparticles. The results are shown in Fig. 4, when the sample was heated at 550^0C, only anatase phase was detected (25). The XRD patterns of TiO_2 nanotubes and Pt/TiO_2NTs prepared at 2mM. Plain TiO2NTs were polycrystalline in nature with the existence of hexagonal structure and anatase phase , the XRD pattern exhibited the presence of titanium(JCPDS No. 44-1294), anatase (JCPDS No. 21-1272), diffraction peaks of TiO2 2θ=25.44, 38.20, 48.29, 54.22, 55.30, 62.82, 70.48 and 75.58o can be attributed to the (101), (004), (200), (105), (211), (204), (220) and (215) lattice planes of anatase TiO_2, respectively (25). Crystallite size value of TiO_2 was calculated 59.6 nm. A comparison of XRD patterns/Pt samples was shown in Fig.4,only anatase phase of TiO_2 was observed for all samples , because of the high intensity of the TiO2 peaks and overlapped with Pt nanoparticels peak (due to the large TiO2 crystallite size) compared with XRD of the sample(26).

The crystallite size of the TiO2 nanotubes can be calculated by applying Debye–Scherrer's equation as below (27):

$$D = \frac{0.94\lambda}{\beta \cos\theta}$$

where

D= Represents the mean size of crystalline

λ =Represents the wavelength of X-ray

β= Represents the line broadening in radians

Θ= Represents the Bragg angle

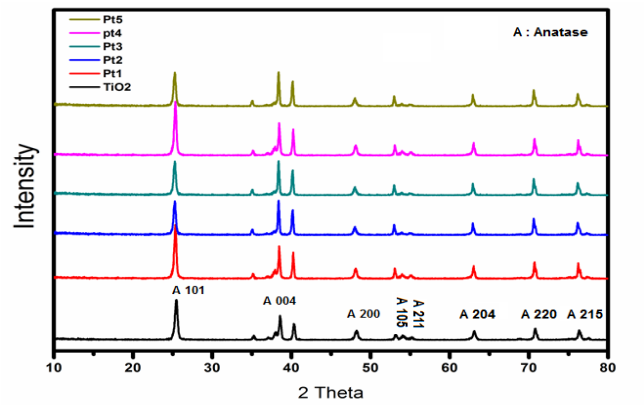

Figure 4. X-ray diffraction pattern of synthesized TiO_2NTs and other Pt nanoparticles decorated on it

Interpretation of Cytotoxic Assay Results

Cells toxicity was evaluated by (3-(4,5-dimethylthiazole-2-yl)-2,5-diphenyl Tetrazolium bromide ((MTT)) method. Cultured MCF-7 were treated with TiO_2NTs and Pt\$TiO_2$NTs at concentration (800, 400, 200, 100, 50, 25 and 12.5µg/ml) for 48 hours. **Table 1** shows the statistical results, and the value of IC_{50} for MCF-7 cancer cell lines and WRL68 normal cell lines. According to IC_{50} test, the concentration of Pt \$TiO_2$NT that was required for 50% inhibition of MCF-7 and WRL68 cell inhibition was calculated. All data were expressed as means±standard deviations (SD). The statistical analysis was performed using Independent Samples Test (2-tailed (t-test)) at confidence levels of 95%.

The results in **Table 1** when deposited the Pt nanoparticles have different grain size on the surface of titanium nanotubes to modify it, and when we compare the values of IC_{50} for the three compounds Pt\$TiO_2$NTs (1), Pt\$TiO_2$NTs (2), and TiO_2NTs, the following are concluded:

1-The nanomaterial Pt\$TiO_2$NTs (1) has platinum of particle size between 22-32 nm which has an inhibitory effect more than platinum of a particle size between 30-45 nm on MCF-7 cell line.

2-When comparing values IC_{50} of the three nanomaterials Pt\$TiO_2$NTs (1), Pt\$TiO_2$NTs (2) and TiO_2NTs, it has been observed that the modification of the titanium-nanotubes surface by different nanoparticles size of platinum, which has a particle size of less than 50 nm, has toxicity against MCF-7 higher than titanium nanotubes alone Pt\$TiO_2$NTs(1)>Pt\$TiO_2$NTs (2)> TiO_2NTs.

3-When comparing values IC_{50} for the two cell lines MCF-7 and WRL68 of the three nanomaterials Pt\$TiO_2$NTs (1), Pt\$TiO_2$NTs (2) and TiO_2NT, it was observed that the toxicity of these nanomaterials towards cancer cells were much higher than that of normal cell lines **Fig.5**.

Table 1. Statistical data and IC_{50} Values of Pt\$TiO_2$NTs(1), Pt\$TiO_2$NTs(2) and TiO_2NTs on cancer (MCF-7) cell lines and normal (WRL68) cell lines in time of exposure 48 hrs

Conc. μg\ml	*(Inhibition rate%(means ±standard deviation± SD)*					
	Pt\$TiO_2$NT(1) MCF-7	*Pt\$TiO_2$NT(1) WRL68*	*Pt\$TiO_2$NT(2) MCF-7*	*Pt\$TiO_2$NT(2) WRL68*	*TiO_2NT MCF-7*	*TiO2NT WRL68*
800	72.40±0.172975	29.22±.091198	59.56±0.502162	37.22±0.217785	49.20±0.136163	34.40±.0577697
400	66.56±0.167097	8.66±0.445073	52.15±0.469597	9.50±0.430155	43.38±.0122317	12.89±0.867106
200	51.97±0.132842	5.63±0.235530	48.80±0.912652	5.40±0.460815	30.97±0.884123	8.84±0.511783
100	37.97±0.136704	4.40±0.330807	39.70±0.302108	5.30±0.484152	20.94±0.051394	7.30±0.237557
50	20.85±0.597523	4.32±0.000577	22.30±0.389295	3.34±0.401623	15.80±0.705143	5.98±0.256689
25	15.34±0.154717	3.13±0.262543	11.26±0.267275	3.13±0.421099	10.50±.0.45254	4.30±0.436534
12.5	8.22±0.240563	3.08±0.896177	5.13±0.008737	3.08±0.125819	7.03±.0417440	3.00±0.325140
IC_{50}	191	431	156	450	212	406

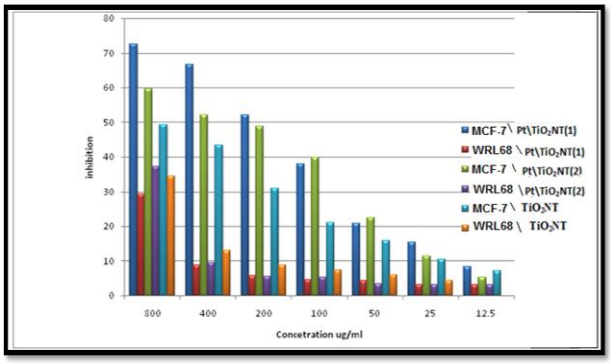

Figure 5: The percentage inhibition rate in MCF-7 cell line after treatment withTiO_2NTs, Pt\$TiO_2$NTs (1) and Pt\$TiO_2$NTs(2) , 48 hrs compared to normal WRL68 cell line

The viability of the cell depends on the environment or the dominant medium in order to achieve the best response, including cell adhesion or migration and proliferation. Biological effectiveness depends largely on several factors, the most important of which are chemical and physical properties, including surface area, particle size shape and purity of the phase in addition to the concentration of nanoparticles (28, 29).

Therefore a number of reasons have been suggested to inhibit the growth of cancer cell lines, including the Pt-high surface density of nanoparticles which was found to be incompatible with MCF-7 cell adhesion and proliferation (28,29). Therefore, it is important and desirable to find an optimal surface density of Pt nanoparticles to be decorated on TiO_2NTs including the nanoparticle and nanotube diameters that effectively kill bacteria, cancer cells and remains favorable to the normal cells.

The reason may be releasing platinum nanoparticles from Pt/TiO_2NTs and the breakdown of DNA (30), or maybe attributed to inhibition of cancer cells incorporated the nanostructure into the cells; form aggregates in the cells and inhibit migration and proliferation of cancer cells (31).

Conclusions:

Electrodeposition was applied to synthesize Pt\TiO2NTs. The regular crystalline with single-phase formation (anatase). The experiential methods Powder XRD, FE-SEM, TEM, EDX analytical techniques confirmed the presence of TiO_2 NTs in anatase phase and Pt nanoparticles decorated on it. In vitro cytotoxicity test has been carried out using the MTT assay method in wave length 620 nm. The study proved that the toxicity of the titanium nanotubes toward cancer cell lines (MCF-7) increased by deposition platinum nanoparticles on it. Also from IC_{50} Value proved that these prepared nanomaterials have very low toxicity toward normal cell lines.

Acknowledgments

The authors express their gratefulness to the College of Science for Women \ University of Baghdad and College of Science- University of Baghdad, for providing them with the opportunity to carry out this work**.**

Authors' declaration:

- Conflicts of Interest: None.
- We hereby confirm that all the Figures and Tables in the manuscript are mine ours. Besides, the Figures and images, which are not mine ours, have been given the permission for re-publication attached with the manuscript.
- The author has signed an animal welfare statement.
- Ethical Clearance: The project was approved by the local ethical committee in University of Baghdad.

References:

1. Indira K, Mudali U K, Nishimura T , Rajendran N. A review on TiO_2nanotubes influence of anodization parameter, formation mechanism, properties, corrosion behavior, and biomedical applications. J. of bio-tribo-corrosion. 2015; 1(4):1-28.
2. Zhu Q , Hu H , Li G , Zhu C ,Yu Y. TiO_2 nanotube arrays grafted with MnO_2 nanosheets as high-performance anode for lithium ion battery. Electrochimi. Acta. 2015; 156: 252-260.
3. Roy P, Berger S ,Schmuki P. TiO_2 nanotubes .synthesis and applications. Angew. Chem. Int. Edition, 2011; 50(13):2904-2939.
4. Sheng J, Chen Y ,Tong H, Guo Y. Preparation and photocatalytic properties of KH-550 modified nano-TiO2\graphene composites. Rev.Envirron Risk Assess Remediat.2017; 1(2):62-68.
5. Pablos C, Marugan J ,van Grieken R, Dunlop P, Hamilton J, Dionysiou D, et al. Electrochemical enhancement of photocatalytie disinfection on aligned TiO_2 and nitrogen doped TiO_2 nanotubes .Mol.2017; 2(704):1-15.
6. Bahgat M , Farghali A A , Mustafa A F , Khedr M , Mohassab-Ahmed M Y. Electrical magenetic and corrosion resistance properties of TiO2nanotubes filled with $NiFe_2O_4$ quantum dots and Ni-Fenanoalloy. Appl.Nanosci. 2013; 3(3):241-249.
7. Liu Z , Pesic B , Raja K S, Rangaraju R R, Misra M. Hydrogen generation under sunlight by self ordered TiO2nanotube arrays. Int.J.of Hydrogen Energ.2009; 34(8):3250-3257.
8. Ayal A K, Zainal Z, Lim H N, Talib Z A, Lim Y C, Chang S K , et al. Electrochemical deposition of CdSe-sensitized TiO2nanotube arrays with enhanced photoelectrochemical performance for solar cell application .J. Mater.Sci.:Mater.Electron.2016; 27(5):5204-5210.
9. Perillo P , Rodríguez D. TiO2 nanotubes membrane flexible sensor for low-temperature H2S detection. Chemosensors. 2016; 4(15): 1-10
10. Chen X ,Wu N, Zhang G, Feng S, Xu K, Liu W, et al. Functionalized TiO2 nanotubes as three-dimensional support for loading Au@Pdnanoparticles, facile preparation and enhanced materials for electrochemical sensor.Int.J.Electrochem.Sci.2017;12:593-609.
11. Oh S, Daraio C, Chen L-H, Pisanic TR, Fiñones RR, Jin S. Significantly accelerated osteoblast cell growth on aligned TiO_2 nanotubes. J Biomed Mater Res, Part A. 2006; 78A (1):97–103.
12. Oliveira W F, Arruda I R., Silva G M., Machado G, Coelho L C, Correia M T. Functionalization of titanium dioxide nanotubes with biomolecules for biomedical applications. Mater Sci Eng: C. 2017; 81: 597-606.
13. Nasr R, Hasanzadeh H, Khaleghian A, Moshtaghian A, Emadi A, Moshfegh S. Induction of apoptosis and inhibition of invasion in gastric cancer cells by titanium dioxide nanoparticles. Oman med.J. 2018; 33(2): 111-117.
14. Khoee M H, Khoee S , Lotfi M. Synthesis of titanium dioxide nanotubes with liposomal covers for carrying and extended release of 5-FU as anticancer drug in the treatment of HeLa cells. Anal. biochem . 2019; 572: 16-24.
15. Zhang H, Sun Y, Tian A, Xue XX, Wang L, Alquhali A, et al. Improved antibacterial activity and biocompatibility on vancomycin-loaded TiO2 nanotubes: in vivo and in vitro studies. Int J Nanomed. 2013; 8:4379-4389.
16. Yang T, Qian S, Qiao Y, Liu X. Cytocompatibility and antibacterial activity of titania nanotubes incorporated with gold nanoparticles. Colloids Surf. B. 2016; 145:597–606.
17. Mei S, Wang H, Wang W, Tong L, Pan H, Ruan C, et al. Antibacterial effects and biocompatibility of titanium surfaces with graded silver incorporation in titania nanotubes. Biomaterials. 2014; 35(14):4255–4265.
18. Bendale Y, Bendale V, Paul S. Evaluation of cytotoxic activity of platinum nanoparticles against normal and cancer cells and its cancer potential through induction of apoptosis. Integr .Med.Res.2017; 6(2):141-148.
19. Stepanov A L, Golubev A N, Nikitin S I, Osin Y N. Areview on the fabraction and properties of platinum nanoparticles .Rev.Adv.Mater.Sci.2014; 38(2):160-175.
20. Mohammadi H, Abedi A, Akbarzadeh A ,Mokhtari M J, Shahmabadi H E, Mehrabi M R et al. Evaluation of synthesized platinum nanoparticles on the MCF-7 and HepG-2 cancer cell lines.Int.NanoLett. 2013; 3(28):1-5.
21. Alias M, Bakir Sh R. Synthesis,Physico-Chemical characterization ,and cytotoxicity assay of Mannich base derivatives with heavy metal ions on RAW264.7 cell line.JGPT.2017;12(9):302-313.
22. Alias M , Bakir Sh R. Synthesis,spectroscopic characterization and in vitro cytotoxicity assay of morpholine Mannich base derivatives of benzimidazole with some heavy metals .ANJS.2018; 21(3):50-60.
23. Freshney R I. Culture of animal cells: a manual of basic technique and specialized applications. John Wiley & Sons; 2015.
24. nanotube arrays modified with nanoparticles of platinum group metals (Pt, Pd, Ru): enhancement on photoelectrochemical performance. J. of Nanoparticle Res. 2019; 21(2): 29, doi:10.1007/s11051-018-4443-8.
25. Vera-Jimenez A M, Melgoza-Aleman R M, Valladares-Cisneros M G, Cuevas-Arteaga C. Synthesis and mechanical\electrochemical characterization of TiO2nanotubular structures obtained at high voltage.J.of. Nanomater. 2015; 2015, Article ID 624073:1-12.
26. Kittisakmontree P, Pongthawornsakun B, Yoshida H, Fujita S I, Arai M , Panpranot J.The liquid phase hydrogenation of I-heptyne over Pd-Au\TiO2catalysts prepared by the combination of incipient wetness impregnation and deposition-precipitation .J.Catal. 2013; 297: 155-164.
27. Tsai W B, Kao J Y, Wu T M ,Cheng W T.Dispersion of titanium oxide nanoparticles in

aqueous solution with anionic stabilizer via ultrasonic wave. J.Nanoparticles .2016;Article ID,6539581.
28. Chellappa M, Anjaneyulu U, Manivasagam G, Vijayalakshmi U. Preparation and evaluation of the cytotoxic nature of TiO_2 nanoparticles by direct contact method. Int. J. Nanomed. 2015; 10 (Suppl 1: Challenges in bio.res.: 31–41.
29. Rahimnejad S, Torbati M B. Synthesis of Hydroxyapatite/Ag/TiO2 Nanotubes and Evaluation of Their Anticancer Activity on Breast Cancer Cell Line MCF-7. JCHR .2016; 6(3):1–10.
30. Waters DJ, Shen S, Glickman LT, Cooley DM, Bostwick DG, Qian J, et al. Prostate cancer risk and DNA damage: translational significance of selenium supplementation in a canine model. Carcinogenesis. 2005 Apr 7;26(7):1256-62.
31. Latha T S, Reddy M C, Muthukonda S, Srikanth V V, Lomada D.In vitro and in vivo evaluation of anti-cancer activity :shape-dependent properties of TiO_2nanostructures.Materi Sci Eng C.2017;78:969-977.

دراسة السمية الخلوية خارج جسم الكائن الحي لجسيمات البلاتين النانوية المزخرفة لصفائف الانابيب النانوية للتيتانيوم ثنائي الاوكسيد

شيماء رجب باقر[1] عبد الكريم محمد علي السامرائي[2] محاسن الياس[1] محمد محمود فرحان[1]
الحلبوسي[3] امال سمير صادق[1]

[1]قسم الكيمياء،كلية العلوم للبنات،جامعة بغداد،بغداد، العراق
[2]قسم الكيمياء،كلية العلوم ، جامعة بغداد، بغداد، العراق
[3]مركز بحوث التقنيات الاحيائية ،جامعة النهرين ،بغداد ، العراق

الخلاصة:

تم تحضير الانابيب النانوية لثاني اوكسيد التيتانيوم بأنودة صفائح التيتانيوم في محلول الاثيلين كلايكول و تمت تغطيتة سطحها بجسيمات البلاتين النانوية بطريقة الترسيب الكهربائي بأستخدام خمس مشتقات من معقدات البلاتين لقواعد مانخ التي استخدمت كمصدر او بأدء للبلاتين .تم تقييم متوسط الحجم والشكل وتركيب العناصر لانابيب التيتانيوم داي اوكسيد النانوية وجسيمات البلاتين المترسبة عليها بتقنيات مختلفة مثل المجهر الالكتروني الماسح (FE-SEM) ، المجهر الإلكتروني النافذ (TEM) ، نمط حيود الأشعة السينية (XRD) و الأشعة السينية المشتتة للطاقة (EDX). من كل هذه الفحوصات ، تم تشخيص TiO_2NTs وجسيمات البلاتين النانوية المودعة عليها وقد اثبتت الدراسة ان جميع جسيمات البلاتين النانوية ذات حجم أقل من 50 نانومتر. تم معاملة خطوط الخلايا السرطانية MCF-7 وخطوط الخلايا الطبيعية WRL68 بتركيز 800 ، 400 ، 200 ، 50 ، 25 ، 12.5 ميكروجرام / مل من TiO_2NTs و(2)،(1) Pt \ TiO2NTs لمدة 48 ساعة باستخدام اختبار MTT. بالاضافة الى ذلك تم حساب IC_{50} ومعدل التثبيط لهم. تظهر النتيجة أن Pt \ TiO_2NTs لها تأثير تثبيط أكبر على خطوط الخلايا السرطانية من صفيف TiO_2NTs.

الكلمات المفتاحية: الترسيب الكهروكيميائي ، جسيمات البلاتين النانوية، الانابيب النانوية لثنائي اوكسيد التيتانيوم