

Sudan University of Science and Technology

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Measurement of Radiotherapy Entrance and Exit Doses Using Synthesized Poly Vinyl Alcohol with Silver Nitrate Film Compare to Thermo Luminance Dosimeter

**قياس جرعة المدخل و المخرج في العلاج بالاشعة بواسطة افلام مصنعة من بولي فينيل الكحول المطعم بالفضة
مقارنة مع كاشف الوميض الحراري**

A thesis submitted for fulfillment of PhD degree in Medical Physics

BY

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DEDICATION

To the Soule of my father Abdallah Ismail who was sincerely encourage and fostered me throughout my study-hood, I dedicate the benefits of this humble work. To the Soule of my sister Hawa Abdallah Ismail, Allah rewards them with paradise.

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Abstract: This research has been prepared at radiation and Isotopes center- Khartoum (RICK) in order to measure the entrance and exit dose in radiotherapy using films compose of Poly Vinyl Alcohol grafted with Silver Nitrate.

The PVA solutions were made by dissolving PVA in distilled water at temperature of 80 °C on a beaker. The solution was magnetically stirred throughout at that temperature for 3 hours, After cooling to room temperature, we took the PVA solution into dark room and hybridized with silver nitrate and stirred for 2h. Then the PVA /AgNO₃ solution spread into a specially made glass caster, 10 cm in diameter and left to dry at ambient temperature in dark room for at least 3 days to remove water. Then films will be peeled off the glass caster and cut into small films 2x2cm, and loaded in sealed dark plastic packs (dental film envelope).

Then the films together with TLD were irradiated with γ -ray from Co⁶⁰ radiotherapy machine and receiving doses in the range of 1, 2, 4... 12 and 15 Gy) at entrance and exit beam of a solid phantom in a build up region (0.5 cm).

The result showed a color changes from white to light yellow, golden, brown and dark brown according to the dose that received to each film. The characterization of films by UV-visible spectroscopy showed an absorption peaks at 200 and 410 nm, and the absorption peak increase following the increment of applied radiation dose in a linear form based on the following equations: $y = 0.993x + 0.6624$, $y = 0.111x + 0.1024$, for entrance and exit doses respectively, where y refers to the absorption in (au) and x refers to the dose in Gray (Gy) with a correlation coefficient of $R^2 = 0.99$. And the optical density showed great and significant relation with the applied dose in a form of linear proportional relation based on the following equations:

$y = 0.0404x + 0.1171$, $y = 0.0312x + 0.0996$ for both entrance and exit doses respectively, where y refers to optical density and x refers to the applied dose in Gy with a correlation coefficient of $R^2 = 0.98$.

Also the PVA/AgNO₃ composite films were exposed together with TLD in Co⁶⁰ radiotherapy machine using field size 10x10 SSD 100cm. The results of optical density and UV visible spectroscopy analysis indicated that there are a good compatible with the TLD result.

Also there is applicable relationship ($R^2 = 0.63$) between the dose and the attenuation coefficient μ of phantom based to the following equation: $y = 0.083e^{-0.09x}$, where y refers to Attenuation coefficient μ and x refers to radiation absorption in Gy.

مستخلص

تم اعداد هذا البحث بالمركز القومي للعلاج بالأشعة بهدف قياس جرعة المدخل والمخرج الإشعاعية بواسطة أفلام مركبة من فينولات الكحول المتعدد الجزيئات المطعمة بالفضة.

تم تصنيع الافلام بواسطة اذابة فينولات الكحول المتعدد الجزيئات في ماء مقطر بواسطة محرك مغنطيسي تحت ضبط درجة الحرارة 80 درجة مئوية و استخدام تقنية الشد السطحي بعد تطعيمها بالفضة وتركها في الغرفة المظلمة لمدة ثلاثة ايام بعد وضعها في طبق زجاجي . بعد ذلك تم وضع الافلام في ظرف بلاستيكي مظلم لكي يمنع وصول الضوء الي داخل الفلم.

تم قياس جرعات المدخل و المخرج على نموذج بشري حيث كانت الجرعات الاشعاعية المعطاه هي: 1، 2، 4، 6، . . . 15 غراي بواسطة جهاز الكوبالت-60 و وضعت الأفلام بين سكين (0.5 سم) من المواد الشبيهة للجسم البشري مصحوبة بي بلورات كاشف الاشعة TLDs .

كانت النتائج من عملية الاستشعاع هي تغير لون الافلام من الابيض الى اللون الاصفر ثم الاصفر الغامض ثم اللون البني . حيث تم تأكيد قراءة الجرعات عند المدخل والمخرج بواسطة كاشف الاشعة TLD . و تم توصيف الافلام بعد الاستشعاع بواسطة مطياف الاشعة فوق البنفسجية و مقياس الكثافة الضوئية . اوضحت النتائج الاتي: اوضحت الافلام معامل امتصاصية عند المدى 200 و 410 نانومتر حيث كانت ذات علاقة طردية خطية وفق المعادلات التالية:

$y = 0.993x + 0.6624$, $y = 0.111x + 0.1024$ لكل من الجرعه الداخلة والخارجة علي التوالي حيث y تمثل الامتصاصية و x تمثل الجرعه المطبقة ومعامل ارتباط كان مقداره $R^2 = 0.99$ وكذلك اظهرت دراسة الكثافة الضوئية مع الجرعه الاشعاعية المطبقة علاقة خطيه بناءا علي العلاقة الرياضية الخطيه الاتيه: $y = 0.0312x + 0.0996$, $y = 0.0404x + 0.1171$ و ذات دلالة معنوية (R^2) قدرها 0.98 لتوضح امكانية استخدام هذه الافلام لقياس الجرعات الشخصية.

كذلك اظهرت الدراسة ان هنالك توافق كبير بين نتائج الكثافة الضوئية الماخوذة بواسطة الافلام ونتائج الجرعة الاشعاعية الماخوذة بواسطة كاشف الوميض الحراري مما يؤكد امكانية استخدام هذه الافلام في قياس الجرعات الاشعاعية.

كما امكن تحديد معامل التوهين الخطي لمادة الفانتوم و كان مقداره 0.1 . حيث كانت العلاقة بين الجرعة المطبقة و الممتصة علاقة أسية وفقا للمعادلة الاتية: $y = 0.083e^{-0.09x}$ حيث y يشير الي معامل التوهين و x يشير الي الجرعه المطبقة بالغراي بدلالة معنوية قدرها ($R^2 = 0.63$) .

Table of Contents

Contents	Page
Acknowledgment	I
Dedications	Ii
Abstract	Iii
الخلاصة	V
Table of contains	Vi
List of tables	Vii
List of figures	Viii
List of abbreviations	Xi
Chapter one	
1.1 Introduction	2
1.2 Problem of the study	4
1.6 Objectives of the study	5
1.15 Thesis outline	5
Chapter two	
2.1 theoretical background	7
2.2 previous study	30
Chapter three	
3.1 Tools and equipments	45
3.2 Method	52
Chapter four	
4.1 Results	57
Chapter five	
5.1 Discussion	63
5.2 Conclusion	66
5.3 Recommendation	68
References	69
Appendices	76

List of Tables

Table	Page
2.1 The properties of different ionizing radiation	8
2.2 The common sources of ionizing radiation. (Smith, 2000)	9
2.3 The different types of γ -radiation interactions with mater. (Siegbahn, 1965).	18

List of Figures

Figure	Page
2.1 Decay scheme of ^{60}Co radioisotope which ends by Nicle-60 stable. Another frequently used γ -ray source is cesium-137, a fission product from nuclear reactors. The energy of the emitted photon is 662 keV and the half-life is 30.17 years. Nuclear reactors themselves are potential sources of γ -rays	11
2.2 Schematic diagram of photoelectric absorption of γ -radiation resulting in ejection of orbital electron from L shell leading to ionization process of an atom.	13
2.3 Schematic diagram of Compton scattering for γ -radiation resulting in ionization and scattering of the incident photon with less energy	14
2.4 Schematic diagram of Pair Production process for γ -radiation being interfered in the nucleus field and orbital electron to produce triplet particles.	16
2.5 shows the expected irradiation results of the organic molecules, where R. and S. are free radicals and M and N are molecular products.	19
2.6 shows the schemes for grafting process for polymer A with monomer B using γ -radiation.	22
2.7 Schematically illustrates the sequence of direct electronic transitions from the initial state i to the final state f , or by an indirect process in which the intermediate state k is populated by scattering and relaxation of “hot” electrons, which are photo-excited in the substrate.	27
2.8 Schemes for UV-visible spectroscopy principle and steps of taking the spectra.	29
2.9 optical absorption spectra of Ag-PVA film annealed at 120C^0 at different duration.	31

2.10 Absorption spectra of primary Ag colloid(a), corresponding Ag-PVA nanocomposite film (b), and colloid obtained after dissolution of Ag-PVA nanocomposite film(c).	32
2.11 the UV/VIS optical absorption spectra after IT 2 h for film of AgNO₃ filled with PVA system.	33
2.12 the UV/VIS optical absorption spectra after IT 4 h for film of AgNO₃ filled with PVA system	33
2.13 the UV/VIS optical absorption spectra after IT 6 h for film of AgNO₃ filled with PVA system.	34
2.14 shows the color change of PANI nanoparticles polymerized by radiatio doping at different doses in PVA blend for 28.6%-AniHCl monomer. The picture of the un-irradiated film was taken on a white background	37
2.15 shows the colour change to golden yellow of irradiated PVA/AgNO₃ composites due to reduction of AgNO₃ to Ag+ nanoparticles induced by γ-rays. The picture of the un-irradiated film was taken on a white background	38
2.16 shows absorption spectra of unirradiated and irradiated MO-PVA films to different absorbed doses	39
2.17 shows the gamma radiation – induced formation of Ag on SiO₂ at various radiationdoses: (a) 0 kGy, (b) 0.12 kGy, (c) 0.24 kGy, (d) 0.36kGy, (e) 0.54 kGy, (f) 0.66 kGy, and (g) 0.78 kGy	41
2.18 Shows the UV/VIS absorption spectra for films of CrF₃-filled PVA system before UV- irradiation.	43
2.19 shows the UV/VIS absorption spectra for films of CrF₃-filled PVA system after UV- irradiation	43
3.1 Chemical structure of poly(vinyl alcohol) (PVA) monomer	45
3.2 The chemical structure of the silver nitrate compound.	47
3.3 shown the cobalt-60 machine that used to irradiate the films	48
3.4 shown the UV spectrometer (Camspec M350) used in this	49

research	
3.5 shown the optical densitometer that we used in this work from PTW (densix)	50
3.6 shown the TLD reader system (PCL3 from PTW) used in this research	52
3.7 shown the dissolving PVA/AgNO ₃ in distilled water using magnetic stirrer and hotplate	53
3.8 shown the ⁶⁰ Co machine and the films positioning for irradiation	54
4.1 shows the change in the measured parameters for the studied samples due to amount of doses	57
4.2 shows the UV-spectrum for PVA\AgNO ₃ film receiving γ -radiation dose 1-15 Gy as entrance applied dose	57
4.3 shows the UV-spectrum for PVA\AgNO ₃ film receiving γ -radiation dose 1-15 Gy as exit dose.	58
4.4 show the correlation between the applied γ -radiation doses 1-15 Gy and the absorption coefficient at entrance and exit doses	58
4.5 shows the correlation between dose in Gy and the relevant optical density in (a. u).	59
4.6 showed the correlation between the applied doses (given dose) in Gy and TLD reading in Gy for entrance and exit dose.	60
4.7 shows the correlation between TLD Dose reading in Gy and the relevant optical density in (a. u).	60
4.8 shows the correlation between the absorption in Gy and the attenuation coefficient μ	61

List of Abbreviation

Prefix	Meaning
DSC	Differential scanning calorimetry
ESTRO	European society for radiotherapy & oncology
FTIR	Fourier-transform infrared
FWHM	Full width at half maximum
ICRU	International Commission of Radiation Units
IR	Infrared
OD	Optical density
PVA	Polyvinyl alcohol
SEM	Scanning electron microscopy
TLD	thermo-luminescencedosimeter
UV	Ultra violet
XRD	X-ray diffraction