

Sudan University of Science and Technology

College of Graduate Studies



**Synthesis and Optimization of Polymer Film Detector
(PVACu₂O) in Radiation Therapy**

تصنيع و ضبط كواشف أفلام البوليمر (PVA\Cu₂O) في العلاج بالأشعة

**Thesis submitted for the fulfilment of PhD degree in
Medical Physics**

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Dedication

This work dedicated to:

Sole of my father & mother

My wife & my Childs

Everyone who seeks for knowledge

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Abstract

Ionizing radiation has been utilized in different medical fields such as diagnosis, treatment of diseases and scientific researches based on the induced effect that occur in different types of human cells; no doubt or debate, it could induce certain effect in many applicable medical materials and even the materials used for radiation measurement and detection.

In radiation therapy, for the high secured accuracy of radiation therapy dose should not exceed $\pm 5\%$ of the prescribed tumor dose. To achieve that goal, an effective tool should be used for analyzing and mapping the radiotherapy treatments for cancer patients. So polymer-gel and film dosimeters have been introduced and considered depending on physical and chemical changes that occur in the polymer after irradiation.

The aim of the current study was to synthesize polyvinyl alcohol cuprous oxide composite films (PVA/Cu₂O) for radiation detection depending on optical changes.

The method adapted from solving of 5% PVA in hot (80 °C) stirred water and after cooling to ambient temperature a 0.5 gram of Cu₂O dissolved and stirred for 2 hours. The films were made by casting in petri dishes contained 20 ml/each.

The peeled films were enveloped after drying and receiving radiation doses of 1, 2, 4, 6 ... 12 Gy. The analysis revealed a gradient change in color of films from light pink to dark brown with absorption peaks at 215 and 415 nm through entire doses which were increase as dose increment.

The optical density of films increases linearly and significantly ($R^2 = 0.9$) as the dose increases from 0.06 (arb. unit) at 1 Gy to 0.4 (a u) at 12 Gy with sensitivity at 0.06 mGy.

The energy band gap of the film decreased as the radiation dose increases from 3×10^{-12} to 2×10^{-12} eV.

Conclusively; the feasibility of utilizing PVA/Cu₂O composite films as radiation detector and personal dosimeter would be applicable in rural sectors and low economic countries.

الخلاصة

ان استخدم الاشعاع المؤين في المجالات الطبية المختلفة كتشخيص وعلاج الامراض بالاضافة للبحوث العلمية يقوم علي ما يحدثه من اثر في الخلايا الحية بمختلف انواعها. لاشك أن نفس هذا الاثر يمكن احداثه علي بعض المواد الطبية التطبيقية وحتى تلك التي تستخدم لقياس الاشعاع والكشف عنه.

في العلاج بالاشعة يجب الا تتعدي الجرعة العلاجية $\pm 5\%$ من تلك الموصوفة للورم. لتحقيق هذا الهدف يجب استخدام وسيلة فعالة لتحليل وتخطيط العلاج الاشعاعي لمرضي السرطان. عليه تم تجهيز مركبات البوليمر واعتبارها اعتمادا علي التغيرات الكيميائية والفيزيائية الناتجة لتعرضها للاشعاع.

هدفت هذه الدراسة الي اعداد افلام من مركب كحول البوليمر مضاف اليه اكسيد النحاسوز واستخدامها كاجهزة للكشف عن الاشعاع المؤين اعتمادا علي التغيرات المرئية التي يحدثها الاشعاع.

تم اعداد هذه الافلام باذابة 5% من مركب كحول البوليمر في ماء حار (80 درجة مئوية) وتحريك الخليط جيدا, اضافة 0.5 جرام من اكسيد النحاسوز لهذا الخليط بعد تبريده (درجة حرارة الغرفة) واعادة تحريكه لمدة ساعتين. تشكل هذه الافلام بصبب الخليط علي اطباق بتري بواقع 20 مل لكل. تسحب الافلام من كل طبق بعد تجفيف الخليط .

تم وضع الافلام داخل ظروف واقية ضد الضوء، ومن ثم تعريض هذه الافلام لجرعات اشعة قما تتراوح من 1,2,4,6 12 قراري.

أظهر تحليل هذه الافلام بعد تعرضها للاشعاع تغيير في لونها متدرج من اللون الوردي الفاتح الي البني الغامق مع ذروات امتصاص عند 215 و415 نانوميتر خلال كل الجرعات تزداد بازدياد مقدار الجرعة.

كما ان الكثافة الضوئية لهذه الافلام تزداد خطيا وبوضوح ($R^2 = 0.9$) عند ازدياد الجرعة من 0.06 (وحدة مطلقة) عند 1 قراري الي 0.4 (وحدة مطلقة) عند 12 قراري مع حساسية عند 0.06 .

ايضا فاصل حزمة الطاقة للفلم يقل بازدياد الجرعة الاشعاعية من 3×10^{-12} الي 2×10^{-12} الكترون فولت

خلصت هذه الدراسة الي ان افلام مركب البوليمر مع اكسيد النحاسوز يمكن استخدامها ككواشف اشعاعية او كجهاز قياس شخصي للجرعة الاشعاعية في المناطق الريفية والبلدان النامية.