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Effect of Doping Concentrations on the Sensitivity of PVA/AgNO3 Films to low x-ray doses

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ABSTRACT: The objective of the work is to study the effect of doping concentrations on the response of PVA/AgNO3 to low x-ray doses using optical densitometer and UV-visible spectrophotometer, The PVA/$AgNO_3$ Films were made through solvent casting technique with different concentrations of $AgNO_3$/PVA percentage and that is, [C_1=4%], [C_2=5%], [C_3=6%], [C_4=10%], [C_5=15%], [C_6=20%], [C_7=25%], then the films were exposed to different x-ray doses at diagnostic level, effect of concentrations and dose on the response of PVA- $AgNO_3$filmsstudied in terms of change in optical density which found that the optical density of PVA/$AgNO_3$ films with different concentrations of $AgNO_3$/PVA increase with radiation dose, the optical density of PVA/$AgNO_3$ films increase with increasing $AgNO_3$concentrations in PVA/$AgNO_3$ films, According to the change in optical density linearly with radiation dose and $AgNO_3$ concentrations PVA/$AgNO_3$ films provided a good dosimetric response.

KEY WORD: polyvinyl alcohol, X-ray Irradiation, UV spectroscopy, Optical Density. Chemical Radiation Dosimeter.

I. INTRODUCTION

Radiation Dosimetry is very important control of radiation practice [1]. Now a day's radio chromic film dosimeters are used widely for radiation dosimetry of different types. [2]. PVA films are easy to prepare and used for routine irradiation processes of food and medical equipment's [3]. For daily dose monitoring in radiation processing, the polymeric poly vinyl Alcohol dyed flexible films are considered to be the most common ones as dosimeters [4].because of their exceptional chemical and physical properties [5, 6]. Biocompatibility, stability to temperature variation, and non-toxicity [7, 8].Exposure of polymer materials to ionizing radiation produces changes in the microstructural properties, which affects the optical, the polymer materials [9].Dye dosimetry is based on the fact that ionizing radiations interact with matter and cause the color change of the dye. This property of color change of dye can be used for dosimetry as the decomposition of dye is linear with respect to the amount of dose absorbed [10, 11, 12,13]. The high energy ionizing radiations bring the radiolysis of the dye (decoloration or bleaching effect) which is used to measure the energy of the radiation incident on the chemical system [14, 15].The effect of x-ray or γ exposure on the silver/PVA composites film will be as color change to yellow due to presence of silver while the expected change on PVA will be as degradation of the PVA chain [16]. In this research we study the effect of doping concentrations on the response of PVA/AgNO3 to low dose x-rays using optical densitometer and UV-visible spectrophotometer.

II. LITERATURE REVIEW:

Many articles was published concern the use of Poly Vinyl Films as chemical gamma radiation dosimetry and the effect of dye concentrations all published articles show that film optical density increases strongly with increase of radiation dose as well as increase the concentrations of the dye. Radiation induced color bleaching of methyl red in polyvinyl butyral film dosimeter was reported by **Al-Zahrany AA, Rabaeh KA**, **Basfer AA** (2011). [11]. the use of polyvinyl chloride films dyed with methyl red in radiation dosimetry was reported by **M. Kattan and Y. Daher** [18].

ISSN: 2350-0328

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Vol. 6, Issue 3, March 2019

III. MATERIALS AND METHODS:

A. Materials:

1) Polyvinyl Alcohol (PVA): Polyvinyl alcohol powder was supplied by TECHNO PHARMCHEM (Mol. wt = 85000 to 124000 g/mol Degree of hydrolysis 86-89%).

2) Silver Nitrate Ag NO_3: Chemical compound (powder) sensitive to sun light in photographic films
3) X-ray Machine Unit:x-ray machine model PN563-55051-34 (Shimadzu) with filtration 1 mm AL, Max tube Voltage 150 KV, Frequency 50/60 Hz.
4) UV- Visible Spectrophotometer:UV –Visible Spectrophotometer model SED – SPEC- 48
5) Optical Densitometer:331 battery operated, B/W transmission densitometer, operated voltage 4-6volt DC – SN 033174.

B. Methods:

1)Preparation of PVA/$AgNO_3$ Films: The PVA Powder was supplied by TECHNO PHARMCHEM (Mol. wt = 85000 to 124000 g/mol Degree of hydrolysis 86-89%). The PVA/$AgNO_3$ Films weremadethrough solvent casting techniquewith seven concentrations of $AgNO_3$/PVA percentage and that is, [C1=4%], [C2=5%], [C3=6%], [C4=10%], [C5=15%], [C6=20%], [C7=25%], by dissolving each concentration of PVA powder in 100 ml distilled waterat room temperature on a beaker and The solutions were magnetically stirred at room temperature for 3 hours and then the PVA/$AgNO_3$ solutions poured in a petri-dish to form films by casting method in dark room. and left to dry at ambient temperature at least 2 days. Then films were peeled off in the petri-dish, cut into small films 2x2cm, loaded in sealed dark dental film envelope. The thickness of the films was controlled by the volume of PVA/AgNO3 solution [17].

2) Irradiation of PVA/$AgNO_3$ Films: The PVA/$AgNO_3$ films were irradiated with low x-ray doses in the range of diagnostic levels, [.15, 33, .59, .93, 1.34] mGy,the dose was controlled by the exposure factors Kvp and mAs, the range of exposure factors used between (40 – 120) Kvp and 10 mAs for x-ray machine.

IV. RESULTS

A. Optical Densitometer Measurement:

Table (1): the optical density measurement of PVA/AgNO3 films with different concentrations of AgNO3 irradiated with different doses.

Optical Density / **$AgNO_3$/PVA Concentrations**	OD .15mGy	OD .33 mGy	OD .59 mGy	OD .93 mGy	OD 1.34 mGy
4%	0.27	0.37	0.42	0.43	0.46
5%	0.28	0.38	0.43	0.44	0.47
6%	0.30	0.39	0.44	0.45	0.47
10%	0.38	0.41	0.45	0.46	0.48
15%	0.57	0.63	0.68	0.72	0.76
20%	0.62	0.67	0.72	0.83	0.95
25%	0.77	0.84	0.87	0.90	0.98

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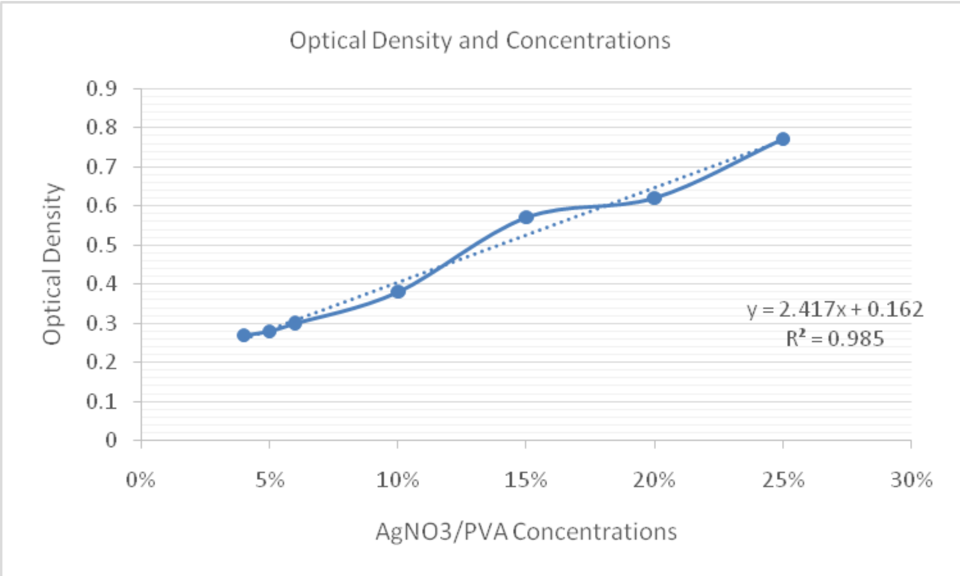

Figure (1) shows Correlation between AgNO3/PVA concentrations and optical density.

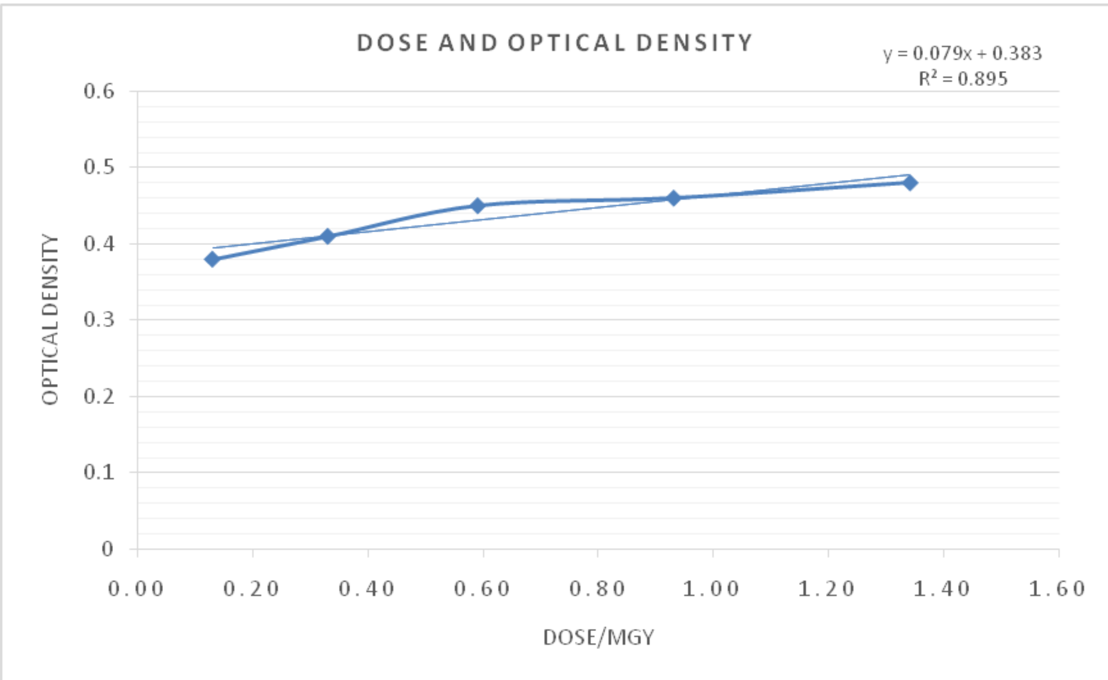

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Figure (2) shows Correlation between Radiation Dose and optical density.

ISSN: 2350-0328
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Vol. 6, Issue 3, March 2019

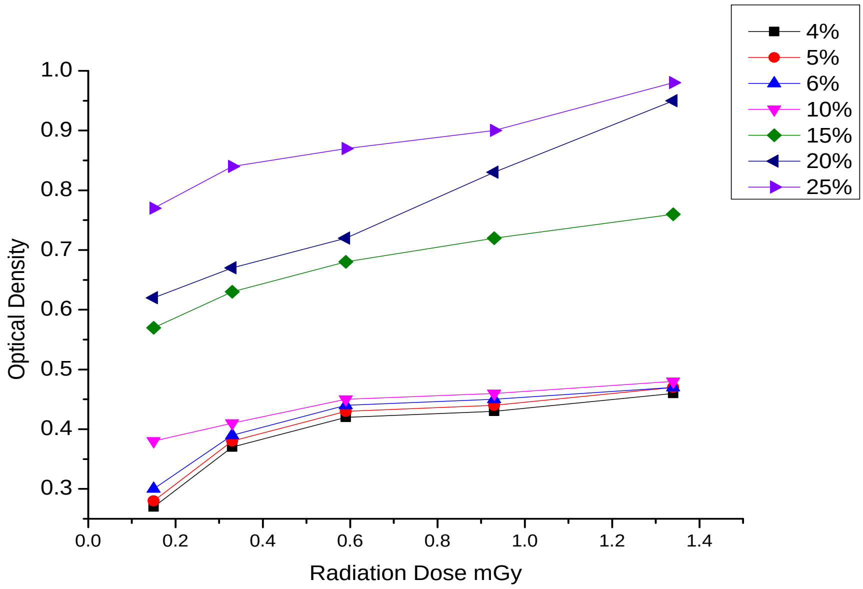

Figure (3) the effect of $AgNO_3$ Concentrations and Dose on the optical density of PVA- $AgNO_3$ films.

B. UV- Visible Spectroscopy Measurement:

The absorption spectra of irradiated PVA/$AgNO_3$films were measured in the wavelength range of 200-800nm, used un irradiated PVA/$AgNO_3$films as reference. The absorption spectra of PVA/$AgNO_3$films were recorded at different x-ray doses.

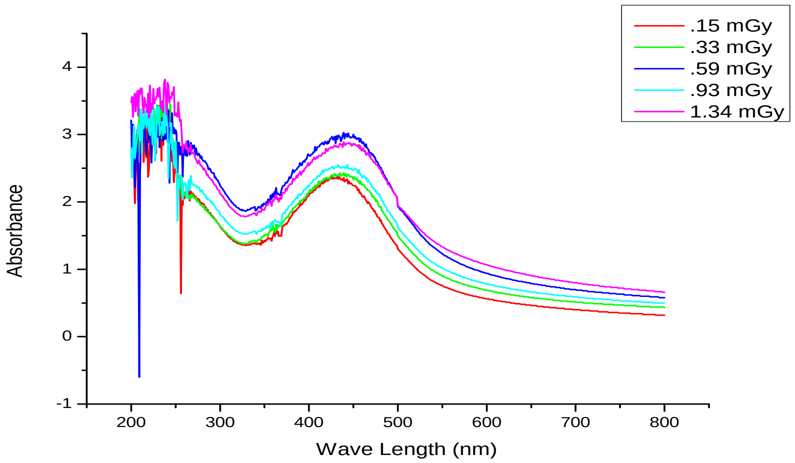

Figure (4) shows the UV spectrum of PVA/AgNO3 films with concentrations of 4% irradiated with different doses.

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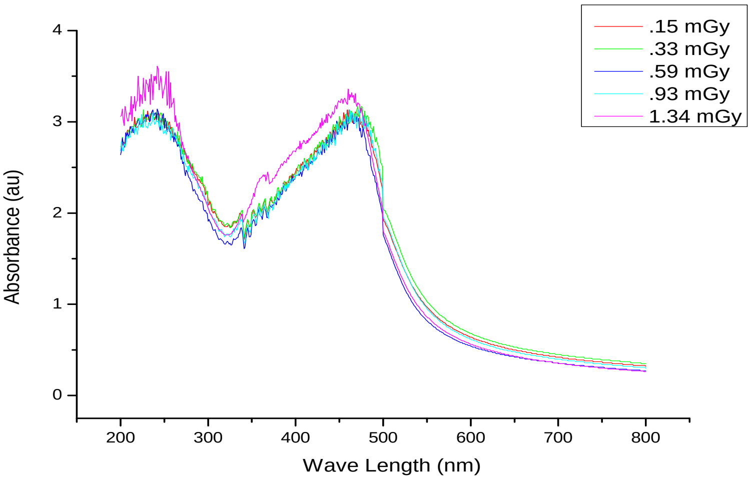

Figure (5) shows the UV spectrum of PVA/AgNO3 films with concentrations of 25% irradiated with different doses.

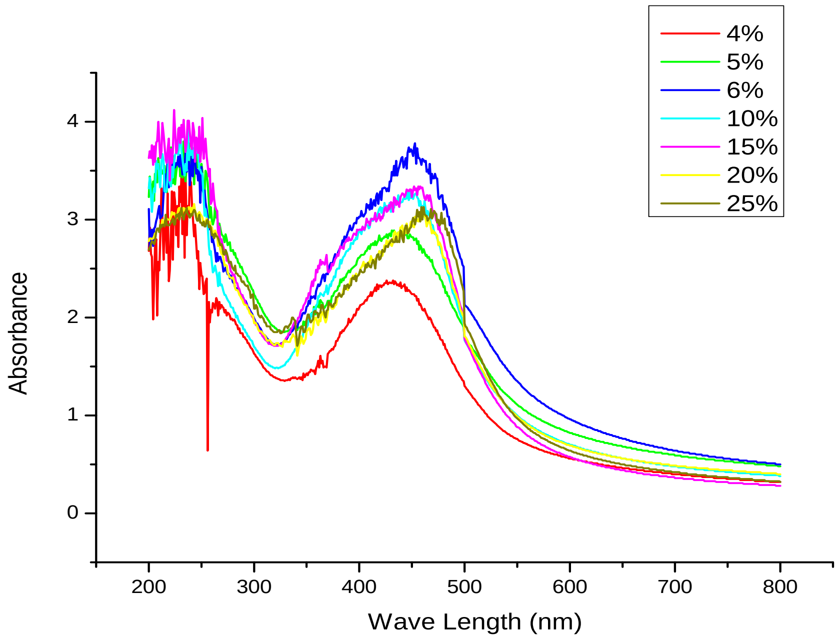

Figure (6) shows the UV spectrum of PVA/AgNO3 films with different concentrations irradiated with .15 mGy.

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Vol. 6, Issue 3, March 2019

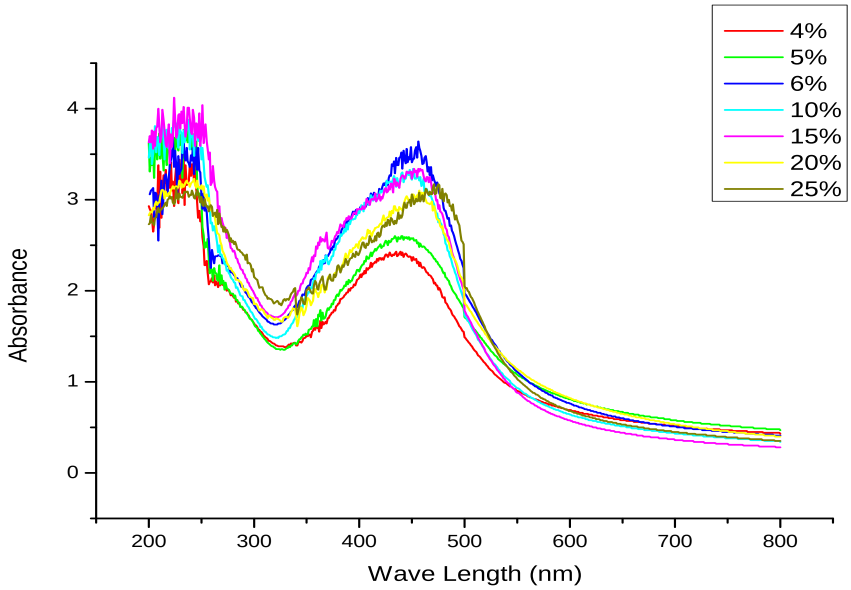

Figure (7) shows the UV spectrum of PVA/AgNO3 films with different concentrations irradiated with .33 mGy.

V. DISCUSSIONS

In this study the effect of doping concentrations on the response of PVA/$AgNO_3$ to low dose x-rays was studies using optical densitometer and UV-visible spectrophotometer, Effect of concentrations and dose for PVA- $AgNO_3$films showed that: increase $AgNO_3$ concentration increase the optical density of PVA/$AgNO_3$ films which provided good dosimetric response of PVA/$AgNO_3$ films to low dose x-ray. Based on the figure (1) the correlation between $AgNO_3$ concentrations and optical density showed linear response with (R^2 = .9578). Based on the figure (2) the Radiation dose and optical density showed linear response with (R^2 = .8954). Based on the figure (3) the optical density of the PVA/$AgNO_3$ films with different concentrations of $AgNO_3$/PVA increase gradually with radiation and the optical density of the PVA/$AgNO_3$ films increase gradually with increasing $AgNO_3$ concentrations. based on the absorption spectrum in the figures (4,5) shows the absorption spectra of AgNO3/PVA films with peak in the wave length 450 nm and all curves have the same trend but slightly different in their slopes depending on the amount of dose irradiated. based on the absorption spectrum in the figures (6,7) shows the absorption spectra of AgNO3/PVA films with peak in the wave length 450 nm and all curves have the same trend but slightly different in their slopes depending on the $AgNO_3$/PVA concentrations.

VI. CONCLUSION

-The optical density of PVA/$AgNO_3$ films with different concentrations of $AgNO_3$increase with radiation dose and $AgNO_3$/PVA concentrations.
- The irradiated films showed absorption peak at the wavelengths 450 nm and the intensity of peaks in proportional increment with radiation dose and $AgNO_3$/PVA concentrations.
- PVA/$AgNO_3$ films with different concentrations of $AgNO_3$ provided a good dosimetric response to low x-ray doses.

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