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Characterization of table sugar dosimeter for gamma-radiation dosimetery

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ABSTRACT

The electrical conductivity and optical absorbtion of the table sugar solution are discussed. Attention is focused predominantly upon the effect of high-energy radiation (gamma-ray) .the result from experiments relevant to dosimetry, such as behavior resetting, dose response, dose rate, stability and reproducibility are described. The observed change in both the electrical conductivity and the optical properties suggest that sugar solution may be considered as effective samples for room temperature real time gamma –radiation dosimetry.

Keywords : Gamma-ray, dose-response, dose rate, Electrical conductivity, optical absorption, fading .

INTRODUCTION

Irradiation of solid with high energy radiation, like gamma-rays, electrons or neutrons expected to affect their physical properties. Studies on the changes in characterizations of ferroelectric table sugar irradiated with ionizing radiation yield valuable information regarding the electronic processes in these materials. To be applied in radiation dosimetry they must present preferentially linear response in the dose range to be measured .It is necessary to determine its dosimetric properties such as lower and upper limits of useful dose range ;dose rate, stability, fading and reproducibility before and after irradiation and environmental conditions effects[1,2,3,4] Sugar has showed good results as dosimeter using electron spin resonance technique [5] but the high cost of the equipment is a serious handicap for large –scale routine application .The other techniques that have been used to reduce the cost are lyoluminscence and chemiluminescence [6,7].This study ,that was undertaken in order to characterize the aqueous sugar solution as a dosimeter in the dose range (1-320)kGy (1-160)kGy respectively. Make use of easy methods based on the measurement of electrical conductivity and optical absorption of sugar solution for routine dosimetry process control.

MATERIALS AND METHODS

The table sugar was purchased from local market and was used without chemical treatment .sugar was irradiated in the solid form, with Cs-137 gamma radiation in the dose range (1-320)

kGy at dose rate of 0.50 Gy/min. To establish electron equilibrium during irradiation, sugar samples were irradiated in air inside container of 3mm wall thickness to achieve equilibrium for secondary electrons [8].

The gamma-irradiated sugar was dissolved in distilled water immediately after irradiation at room temperature, in this way aqueous solutions with different concentration of (10-80)%w/w were prepared. The electrical conductivity measurement were performed using a conventional conductimeter it supplied from (HANNA instruments) .The device has been used to measure the absorptive of the samples at the wavelengths rang (450-570) nm. It is supplied from (Helios Alpha, England).The gamma –irradiated sugar table was dissolved in distilled water immediately after irradiation at room temperature, in this way aqueous solution with concentration of 10%(w/w) prepared .The measurements were made a constant temperature of 25 ^{o}C .

RESULTS AND DISCUSSION

Electrical properties

Concentration effect

The effect of concentration on the electrical conductivity of table sugar solutions are shown fig.1 The behavior of electrical conductivity of sugar solution with concentration is remain constant. sugar contain $C_6H_{12}O_6$,which form non electrolysis when dissolved in water ,most which become no ions so the electrical conductivity remain constant with increase concentration.

Dose response

Fig.2 shows typical plots of the electric al conductivity for as-deposited and gamma-irradiation sugar solution .From this figure it is evident that the electrical conductivity is sensitive to the radiation influence in the dose range1-320 kGy. These data indicate a linear response of electrical conductivity to dose of a gamma radiation .the slope of the curves was plotted as a function of sugar solution concentration is shown in fig.3.

Dose rate effect

In order to investigate the effect of dose rate on the dose rate on the electrical conductivity of sugar solution 20%w/w ,set of samples has been Irradiated to 8 kGy at two different dose rate one of them 0.0011 mGy /minute and the other 0.56kGy/minute we see that the electric conductivity increases approximately by 13% when the dose rate is 0.56 Gy/min ,see Table (1).

Table (1) Effect of dose rate on the Electrical conductivity of sugar solution irradiated to (20) kGy..

Dose rate	Electrical conductivity µs/cm
0.0012mGy / minut	29
0.56 Gy / minute	33

Fading

All material that show a low fading in the stored glow at room temperature are characterized by their good stability. As for those with high fading, they are unstable that is why attention should be paid to these characteristics when material are used to measure radiation doses.

In Fig(4).the post irradiation fading of electrical conductivity at room temperature is shown. The result demonstrated a very small decrease of electrical conductivity response during the next 30 days. This is well within the accepted rate of fading of standard TL phosphor [8]

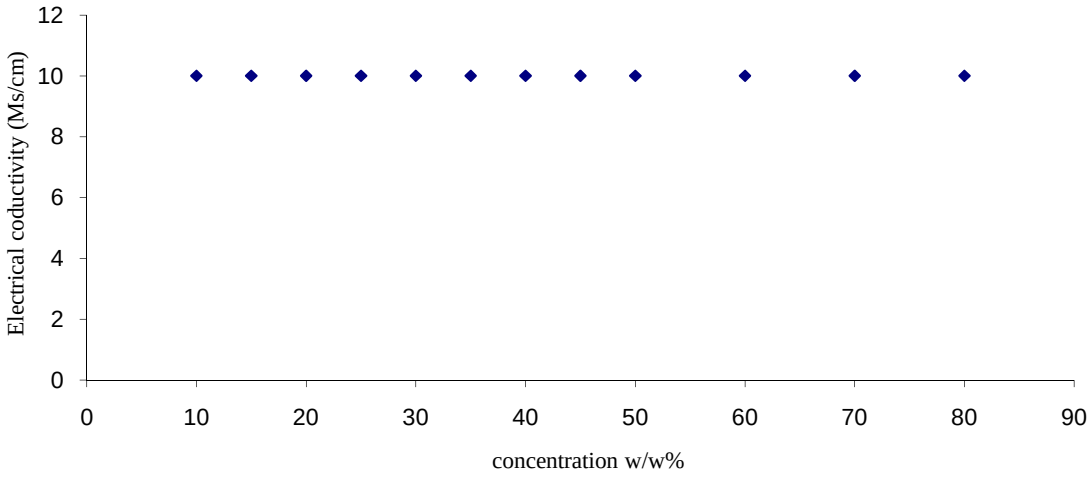


Fig. 1 The effect concentration on the electrical conductivity of sugar solution

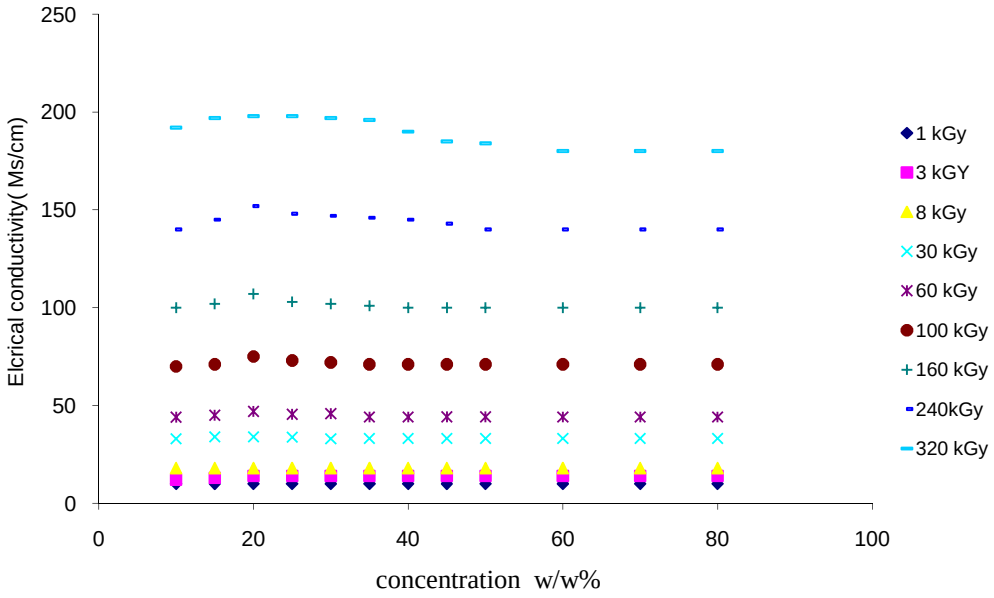


Fig. 2 Electrical conductivity plotted against concentration of water solution of irradiated solid sugar in the dose range 1-320 kGy.

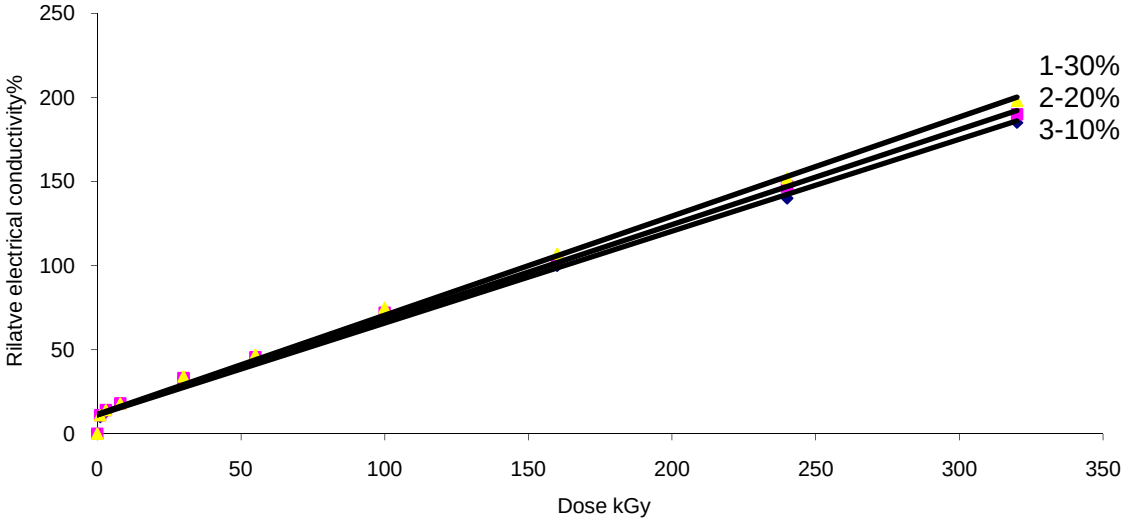


Fig.3 Relative electrical conductivity of water solution of irradiated solid sugar plotted with absorbed dose for the concentration between 10%-30%.

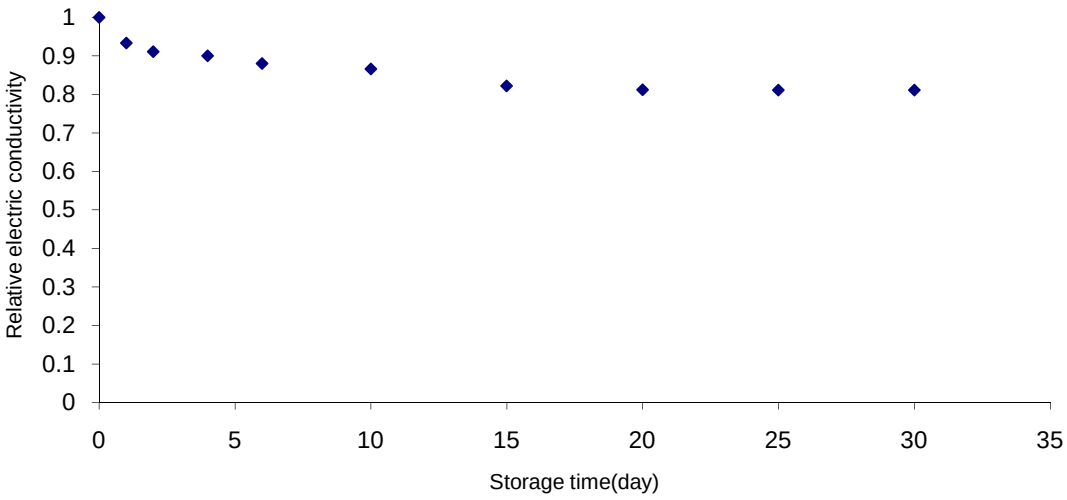


Fig. 4 Fading of electrical conductivity of water solution after storage at 25 ^{o}C post-irradiated solid sugar with 30 kGy.

Optical properties

The optical properties of material are important, as they provide information on the electric band structures, localized states and types of optical transitions. Typical optical absorption spectra plots against wavelength of water solution sugar samples of irradiated solid salt in the dose range (1-160)kGy are shown in Fig(6).From this it is evident that the optical absorption spectral distribution is sensitive to the radiation influence at the wavelength 470 (nm) . In Fig (7) shows the increase in the normalized absorbance intensity with increase the radiation dose. It is clear from this figure that the dose response curve is linear in the range from (1-160) kGy .The linear part of the dose-response curve can be used as a good means for gamma dosimetry in the stated range.

In order to investigate the effect of exposure dose rate on the optical absorption of solution salt samples set of sample has been irradiated to 10 kGy at two different source one of them 0.0011mG/min and the other source 0.56 Gy/min we see that effect of dose rate very small , see Table(2)

Table (2) Effect of dose rate on the Electrical conductivity of sugar solution irradiated to (20) kGy..

Dose rate	Absorbance at 470 nm (arb.unit)
0.0012mGy / minut	0.0507
0.56 Gy / minute	0.0506

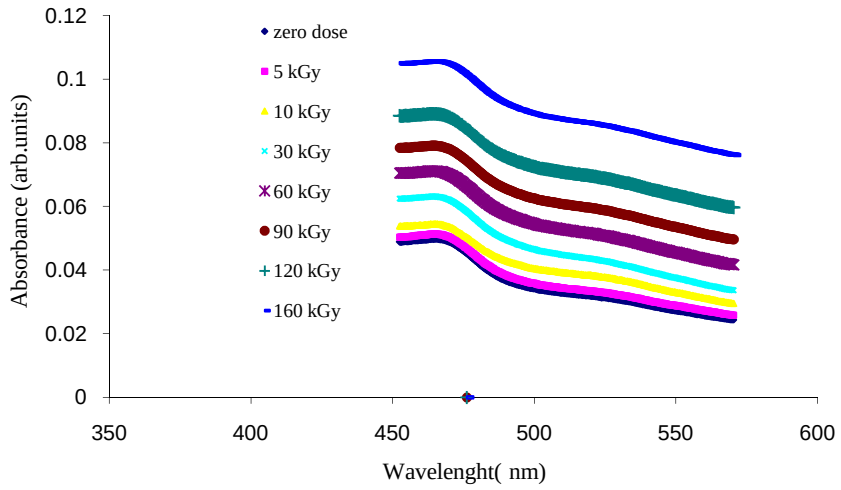
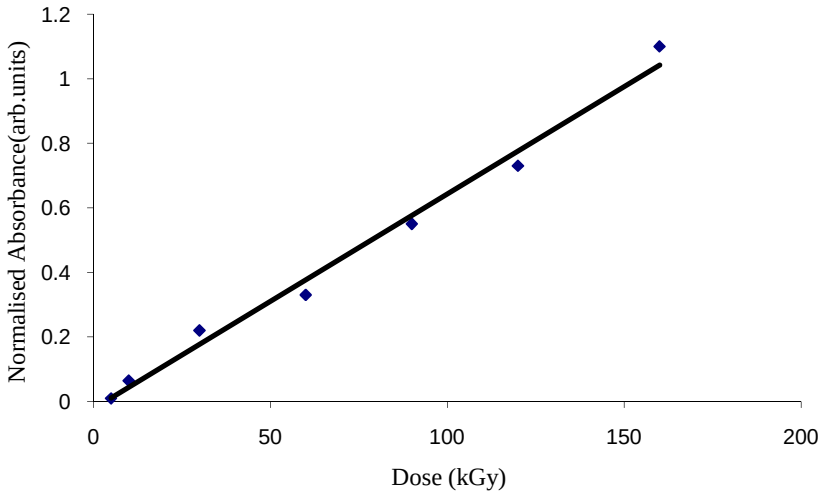


Fig.5 Optical absorbance of water solution of irradiated solid sugar in the dose range (0-160) kGy.



ı ,470 nm.

Fig. 6 Dose response curve of the table sugar irradiated with gamma-radiation ,470 nm.

Reproducibility

The evaluation of overall variation coefficient for absorbance of irradiated of solution salt by using the equation CV%=σ/D×100%. For each sample calculate the mean read –out value D, and the standard deviation σ of the 10 individual read –out values from the mean for those samples [9].

To find out the CV% of solution salt sample under study, the same sample after being were exposed to a dose of 20 kGy 10 times and then their absorbance read after radiation. The overall variation coefficient electrical conductivity and optical absorbance was calculated to be 1.7 %, 2.3 % respectively.

CONCLUSION

The use of table sugar detector for gamma dosimetry is cheap and electrical conductivity, absorbance analysis is very simple. The result obtained show that the electrical conductivity increases linearly with the dose absorbed and that the solution containing 20% w/w of sugar is the most radiation sensitive. Also, from the optical absorbance studies, it is confirmed that table sugar is a good material for high dosimeter application .the absorbance at 470 nm is liner up to radiation dose of 160 kGy. The different dose rate at high and low dose very small.

REFERENCES

[1] F.H. Attix , Inroduction to radiological physics and radiation dosimetry .Wiley –VCH.
[2] Saad, A.F.,Atwa,S.T.,Yokota, R., Fujii, M. *Radiation Mesurements* 40 (**2005**) 780-780 .
[3] Sinha, D., Sahoo, K.L., Sinha, U.B.,Swu,T.,Chemseddine,A.,Fink,D., *Radiation Effects and Defects in Solids*. 159 (**2004**) 587-595 .
[4] Horton,N.J., Hand book of radiation therapy physics.(**1987**) perntice Hall ,New York
[5] Nakajima,T., *Appl, Radiat, Isot.* 46 (**1995**) 819-825.
[6] Nickel, Th., Pitt, E., Scharmann, A., *Radiat. Prot. Dosim.* 35 (**1991**)173-177.
[7] Heide, L., Bogl, W., *Radiat. Prot. Dosim.* 19 (**1987**) 35-41.

[8] Cameron, J.R, Suntharalingan. N., Kenney. G., Thermoluminescent Dosimetry University of Wisconsin press **1968**.
[9] ISO/TC85/Sc2/WG7 **1980**; Personal and Environmental TL Dosimetry , Sixth Draft.