



Lyoluminescence characteristics in Gamma irradiated Maltose

R.S. Gupta¹, S.K. Sharma²

^{1,2}Department of Physics

Govt. P.G. College, Satna (M.P.) 485001, INDIA

Abstract: Lyoluminescence (LL) characteristics of gamma irradiated Maltose (Saccharides) have been investigated using LL reader. The CO-60 is used for irradiating the powdered Maltose at a fixed irradiation dose ($\sim 10^3$ Gy). And distilled water is used as a suitable solvent. It is found that LL intensity is more for Maltose at 1.0 mg mass and for 1.0 ml solvent. It is also found that LL intensity does not change appreciably with pH of the solvent in the range 4 to 9. And the LL intensity is more at pH $\sim$ 12 and there exist a significant spectral shift with increase in pH of solvent. The decay time of Maltose decreases with increasing solvent's temperature.

Keywords: Lyoluminescence (LL), gamma irradiation, Saccharides, pH.

I. Introduction

The phenomenon of lyoluminescence involves the light emission, when materials after being irradiated with ionizing radiation is dissolved in suitable solvent (Wideman and Schmidt 1895, Ahnstrom. and Ehrenstein 1959). A large number of organic and inorganic materials exhibit the phenomenon of lyoluminescence when they are irradiated with ^{60}Co and dissolved in a suitable solvent, e.g. distilled water. The LL has been observed in a large family of mono and oligosaccharides and commercially available sugar and in all water soluble amino acids, proteins, glycoproteins, enzymes. RNA, DNA, some alcohol and salts of organic acid (Reynold, 1992, K.V. Ettinger and K.J. Puite 1982). The solvents have included pure water, aqueous solutions, glacial acetic acid, acetone, methanol and ethanol. The phenomenon of LL is very important from theoretical and application point of view because it is directly related with human food and health mainly concerned with radiation dosimetry (Ettinger 1989, Puite and Ettinger 1989). The other applications of LL are diagnosis dermatology dentistry, radiography, clinical dosimetry, radiotherapy, radiology, neutron therapy, genetic study, public health and tissue equivalents dosimetry for different types of ionizing radiations like gamma-rays, x-rays and other charged particles (Reynold, 1992, Chandra et al 2003, R.S.Gupta et al 2007). The present paper reports the Lyoluminescence characterization of Maltose.

II. Materials and Methods

In this investigation Maltose (212 μm grain size) is taken and the irradiation was carried out using ^{60}Co Gamma rays (γ) facility with exposure rate 1×10^3 Gy/hr. The LL reader is shown in figure (1) in which the Lyoluminescence cell and the PMT are kept in light tight box. The glass tube is used as the dissolution vessel which rest just in front of the window of PMT. The solvent is injected by a conventional hypodermic syringe on the solute taken. The emitted light during the dissolution was detected by RCA-931 PMT whose output is amplified by a D.C. amplifier which was fed to an X-Y recorder. Experiments have been conducted in a darkroom at room temperature. And the solute is kept nearly the same [~ 1 mg] in each case while doubly filtered distilled water [pH $\sim$ 2 to 14] is used as a solvent. The solvent volume was 1.0 ml in each measurement.

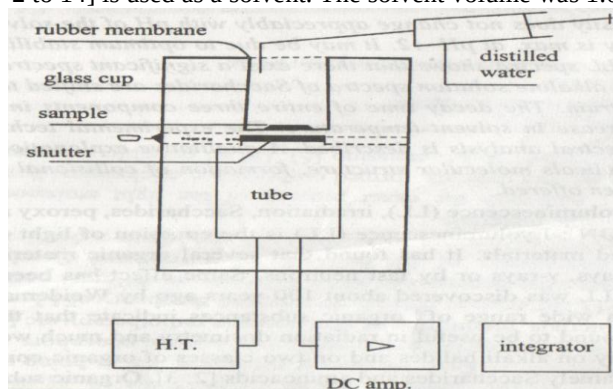


Fig.1. Schematic Diagram of the LL Experimental Set-up.

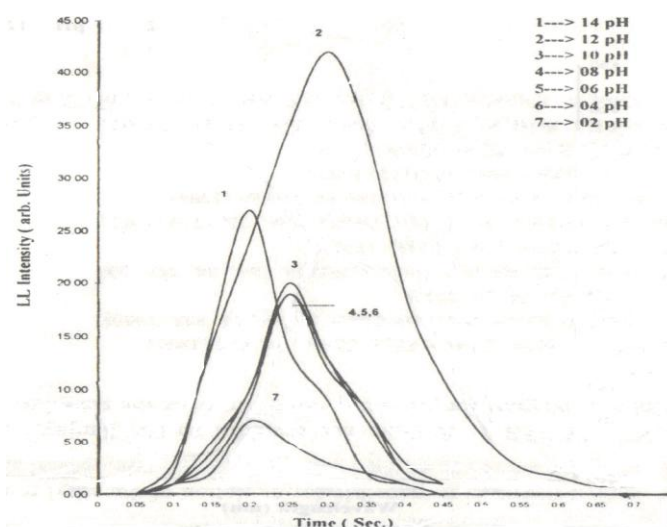


Fig.2. LL Glow curve of Maltose exposed to gamma dose 1.4×10^3 Gy for different pH of the solvent.

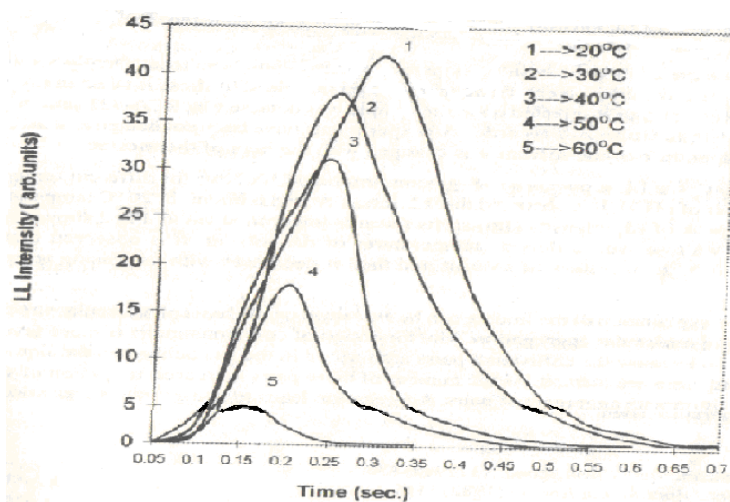


Fig.3. LL Glow curve of Maltose expose to gamma dose 7.3×10^3 Gy for different temperatures of solvent

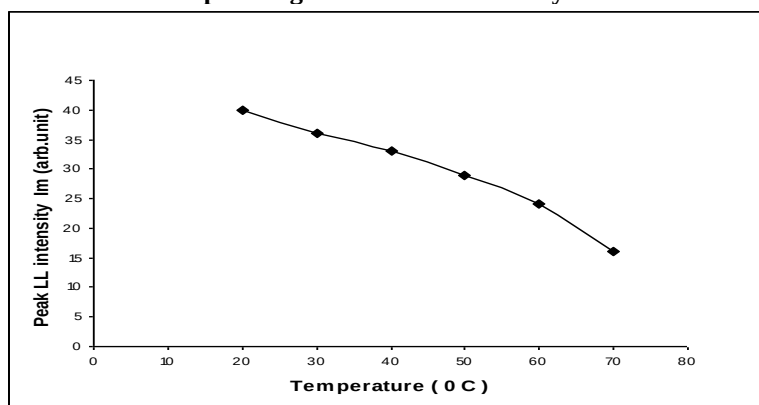


Fig.4 Variation of peak LL intensity I_m of Maltose with different temperatures of solvent exposed to Gamma dose 7.3×10^3 Gy.

III. Results and Discussion

Fig.2 shows the LL glow curve for different pH at room temperature. It is observed that initially the LL intensity increases with time, attain a maximum value at pH ~ 12 then it decreases exponentially. It is found that the total LL yield does not change appreciably with pH of the solvent in the range 4 to 9 and it is maximum at pH ~ 12 . It

is also found that there is significant spectral shift with increase in pH value. Fig. 3 shows the LL glow curve of gamma irradiated Maltose for different temperatures of the solvent at pH~7. It is observed that LL intensity is maximum for 20⁰C temperature of solvent. It was also seen that peak of LL intensity (Im) shifts towards lower time value. Fig. 4 shows the LL intensity (Im) of the peak of Maltose with different temperatures of the solvent. It is observed that Im is maximum at 20⁰C temperature of solvent and then it decreases with increasing temperature of the solvent. It is due to open chain structure and acidic character of Saccharides, as postulated by Ettinger and Puite 1989, the oxygen present in the Sample is responsible for oxidation of the alkyl radicals. Thus it can be said that the LL emission comes from the radiation induced free radical reactions.

References

1. Wideman, E. and G.C. Schmidt (1895) Ueber luminescence, Ann. Phys. Chem., **54**, 604.
2. Ahnstrom, G. and G.V., Ehrenstein (1959) Luminescence of aqueous solutions of substances irradiated with ionizing radiation in the solid state, Acta Chem. Scand., **13**, 855.
3. G.T. Reynold, (1992) Lyoluminescence, J. Lumin., **54**, 43.
4. K.V. Ettinger and K.J. Puite (1982), Lyoluminescence Dosimetry part I principle, Int. J. Appl. Radiat. Isot., **33**, 1115-1138.
5. K.V. Ettinger, (1993), Lyoluminescence readers for free radical dosimetry, Appl. Radiat. Isot., **44**, 337.
6. K.J. Puite, and K.V. Ettinger (1989) Lyoluminescence Dosimetry part II, Int. J. Appl. Radiat. Isot., **33**, 1139-1155.
7. B.P. Chandra, S., Gour, V.K., Chandra, D.S. Baghel, and P.K. Khare (2003), Theoretical approach to Lyoluminescence of organic materials, Ind. J. of Pure and Appl. Phys., **41**, 884.
8. R.S.Gupta, S.K.Sharma, R.S.Kher and S.K.Gupta (2007), Lyoluminescence characteristics in Gamma irradiated Saccharides suited to radiation dosimetry" Acta Ciencia Indica, Vol XXXIII, P.No.3, 403.

Acknowledgements

Authors are thankful to Dr. S.J.Dhoble, Associate Prof. RT M University, Nagpur, India and Dr.R.S.Kher, Prof. Model Science college Bilaspur (C.G.), India, for providing experimental facilities.