



Effect of Mass on the Lyoluminescence of γ – Irradiated Potassium Halide Microcrystals

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ABSTRACT: When γ – irradiated microcrystals of potassium chloride, potassium bromide and Potassium iodide were dissolved in luminal solution, initially the lyoluminescence intensity increases linearly with time, attains an optimum value and then decreases and finally disappears. The LL intensity was detected by Photo Multiplier Tube whose output was connected to X-Y recorder. The LL intensity depends upon the mass of solute. The LL intensity initially increases with mass of the solute and then tends to attain a saturation value for higher mass of the solute added into the solvent. A plausible explanation for the experimental results is given.

Keywords: Lyoluminescence, luminol (3 amino-phthalahydrazide).

I. INTRODUCTION

Lyoluminescence is the process by the term applied to the emission of light while dissolving a irradiated solid into a liquid solvent. It was first reported by Wiedemann and Schmidt [1]. Who noted that light was emitted by materials that had been irradiated prior to dissolution where as these same materials did not emit light on dissolution if they had not been irradiated. After some year Ahnstrom and Ehrenstein [2] was reported subsequent research. Westermarck [3] described experiments in which not only organic but also inorganic phosphors were investigated for LL. Later on alternative mechanisms were proposed for the emission by Ahnstrom [4]. When alkali halides are irradiated with ionizing radiation, colour centres are formed in the materials. It is known that the coloration produced by electrolysis is very stable [5]. It has been shown that the coloration in microcrystalline powder obtained by crushing the electrolytic ally coloured single crystal is not stable [6-9]. Correlation between microhardness, dislocation mobility and the stability of coloration in microcrystal powder established by Deshmukh and his co-worker [6-9]. Recently a theoretical approach has been made to the stability of colour centres in microcrystal powder of alkali halides [10]. Mass of the LL phosphor dissolved in a particular volume of the solvent plays prominent role as the colour centre density available and solubility of the solid is then modified in the solution. Arnika [11] studied the variation in LL intensity with the amount of irradiated halides added to 50ml of distilled water. The observed

LL intensity tends to saturate at a given mass of the crystalline added. According to Arnika [11], it may depend upon the total number of colour centres produced and the solubility of each salt. Effect of LL decay in impurity doped KCl.

Microcrystalline powder in LL dosimetry of ionization radiation is reported by Sahu *et al.*, [12]. Chandok *et al* [13] studied effect of particle size on the LL of γ -irradiated alkali halide microcrystals. Nayer *et al.*, [14] studied the mass & temperature dependence of LL intensity of microcrystalline powder of KCl. Experimental and theoretical study of LL and ML was reported by Sahu *et al* [15]. In order to investigate effect of mass on the lyoluminescence we have chosen potassium halide microcrystals in the present paper.

II. MATERIALS AND METHOD

For the study of effect of mass on Lyoluminescence we use γ -irradiated pure KCl, KBr and KI microcrystal. The pure crystal of KCl, KBr, and KI were grown from their melt using slow cooling method. For the measurement of LL, the crystals were crushed into microcrystal having different grains sizes were separated by using sieves of particular dimensions. Then the microcrystals were coloured by exposing them to ^{60}Co source. To study the effect of mass of solute on the LL, 2ml luminol solution was injected with the help of a syringe into the sample taken in transparent glass tube placed close to the PMT in a LL cell. The intensity of LL produced was detected by RCA-931 PMT, whose output was connected to an X-Y recorder. The process was repeated for different mass of solute.

III. RESULTS

Fig. 1, 2 and 3 shows the time dependence of γ -irradiated microcrystal's of pure KCl. It is seen from figure that, when γ - irradiated microcrystal are dissolved in a fixed volume of luminol solution, then the LL intensity initially increases, attains a maximum value at a particular time later on it decreases and finally disappears.

Fig. 4 shows the variation in peak of LL intensity I_m with mass of KCl, KBr and KI. It is seen from the figure that the value of I_m initially increases with increasing mass of the sample, then tends to attain a maximum peak value for a particular mass of the solute

and then after the intensity of the light saturated with increase in the mass of the solute added to the solvent.

Fig. 5 shows the dependence of t_m on the quantity of solute dissolved in the solution for microcrystal of pure KCl, KBr and KI. It is seen from the figure. That the value of time t_m increase in the quantity of the solute dissolved into the solvent for KCl, KBr and KI.

Fig. 6, 7 and 8 shows that the plot of $\log I$ vs $(t-t_m)$ is a straight line with a negative slope for different amount of solute added to the solvent for potassium halides.

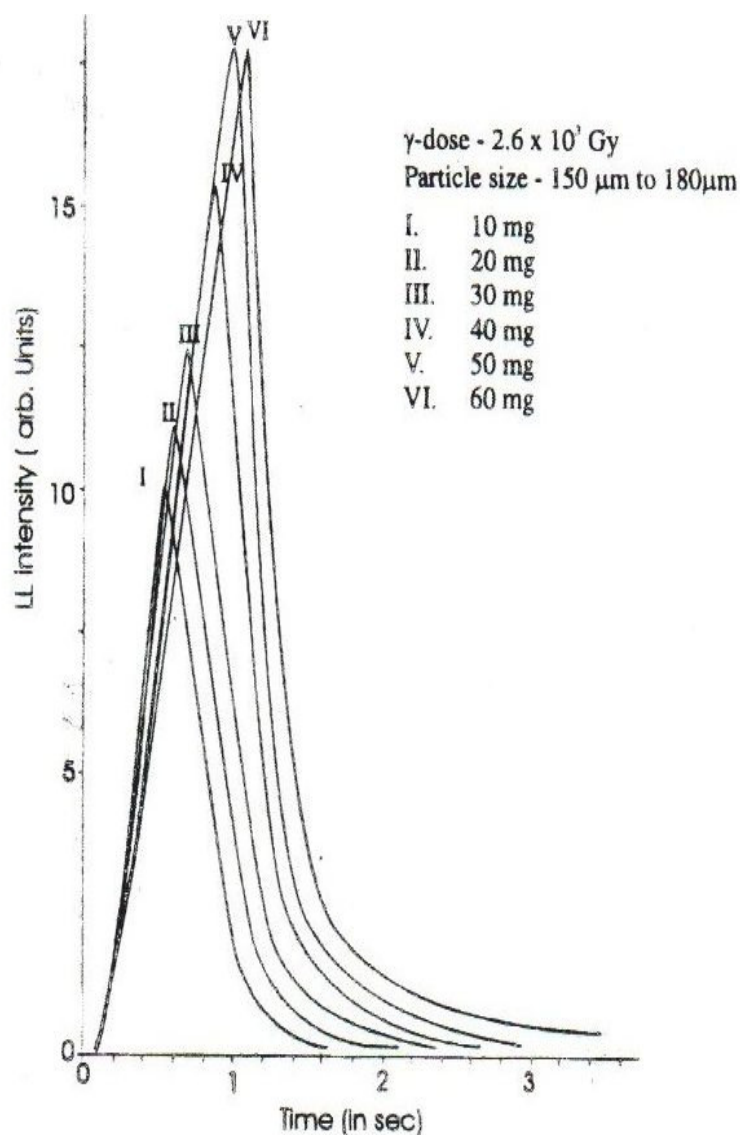


Fig. 1. Time dependence of LL intensity of γ -irradiated KCl sample for mass of solute.

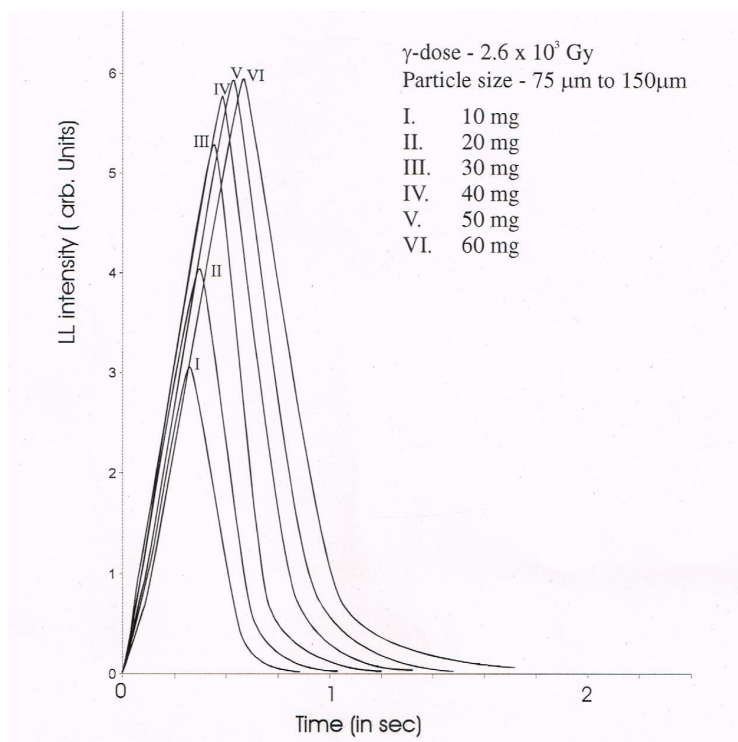


Fig. 2. Time dependence of LL intensity of γ -irradiated KBr sample for mass of solute.

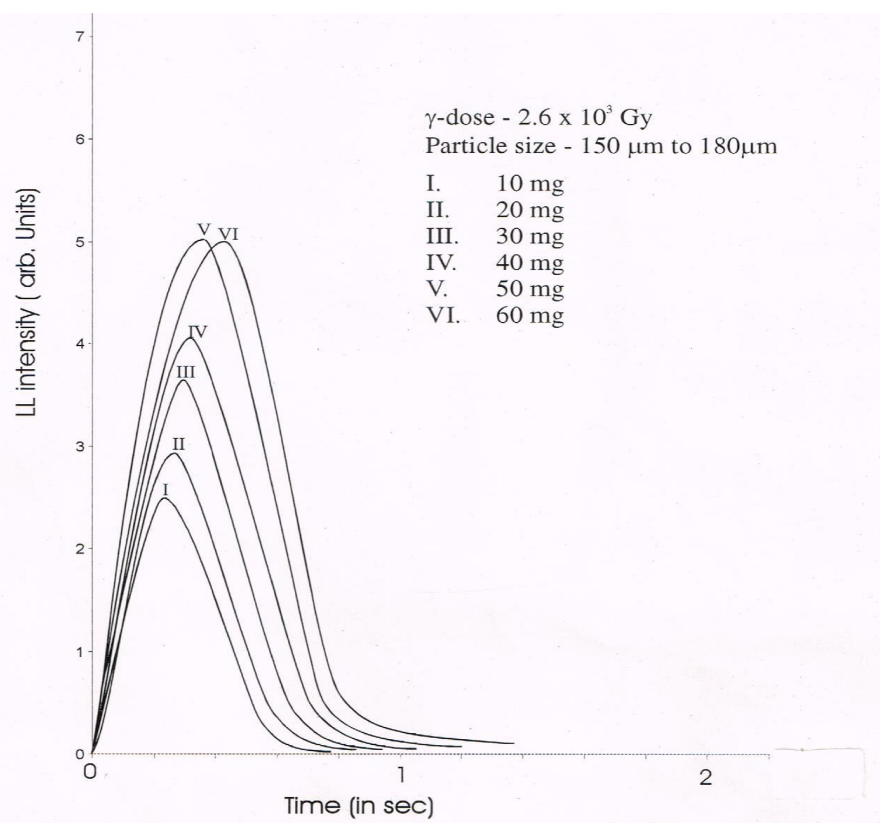


Fig. 3. Time dependence of LL intensity of γ -irradiated KI sample for mass of solute.

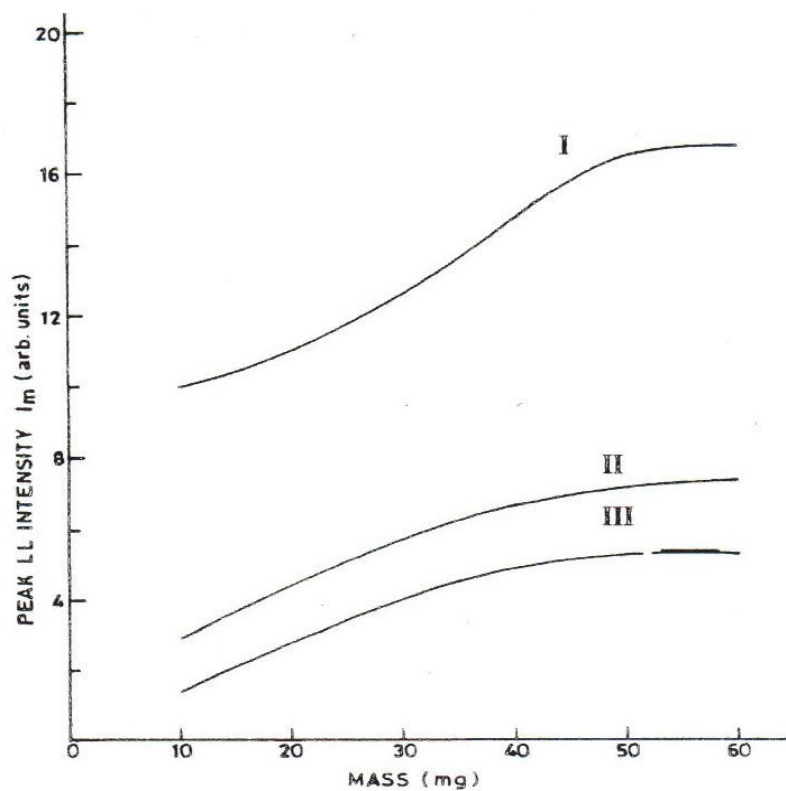


Fig. 4. Variation in peak LL intensity I_m with mass of (I) KCl, (II) KBr, (III) KI.

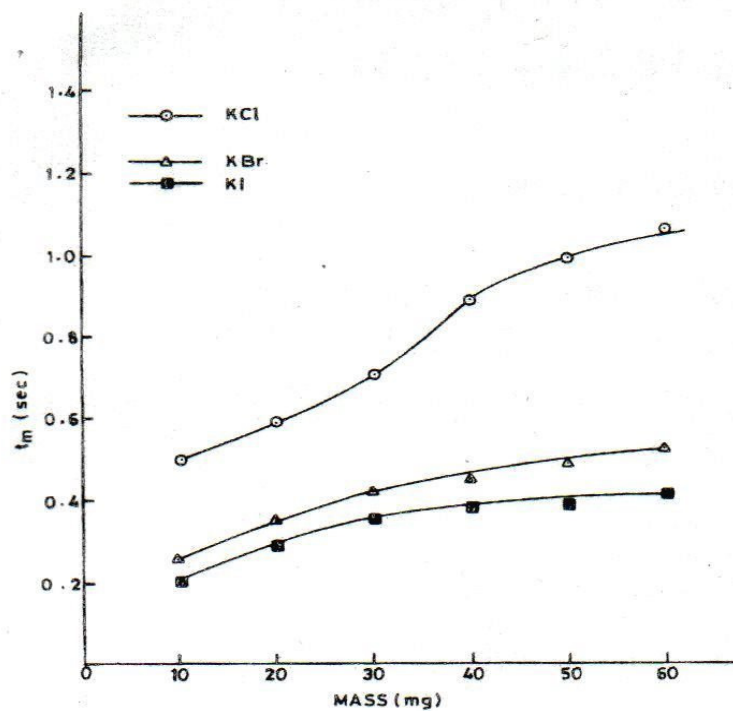


Fig. 5. Dependence of t_m pure potassium halides on the mass of solute.

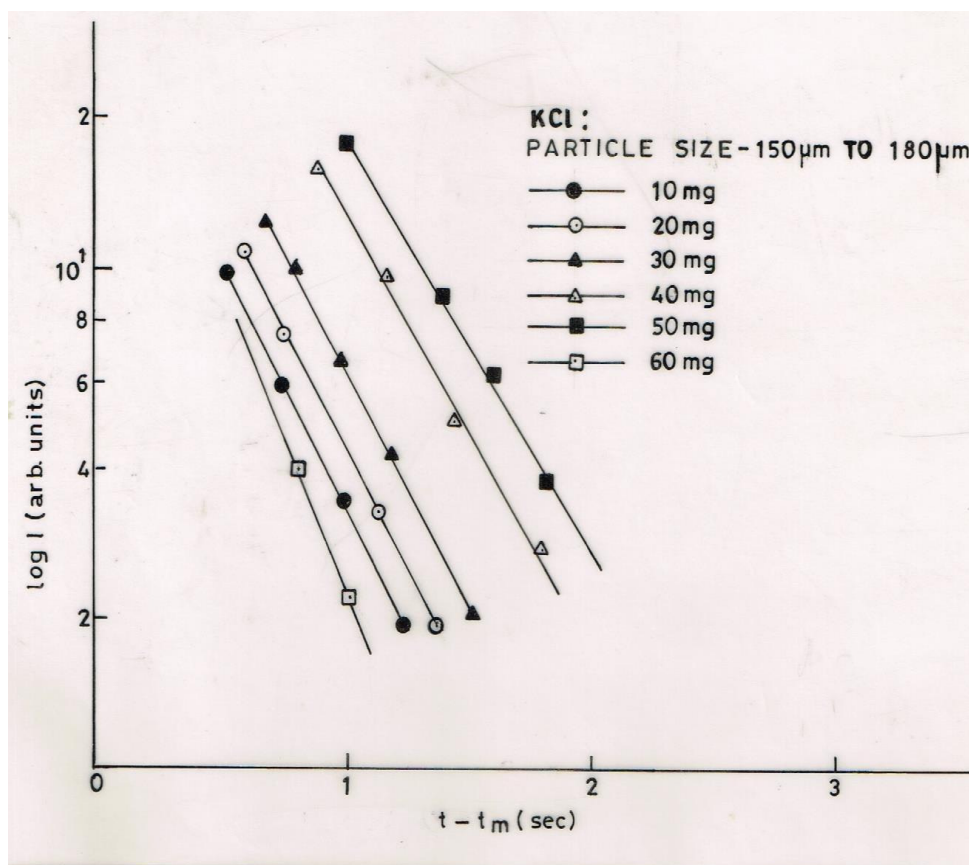


Fig. 6. Plot of $\log I$ versus $(t-t_m)$ of different mass of solute for KCl microcrystal.

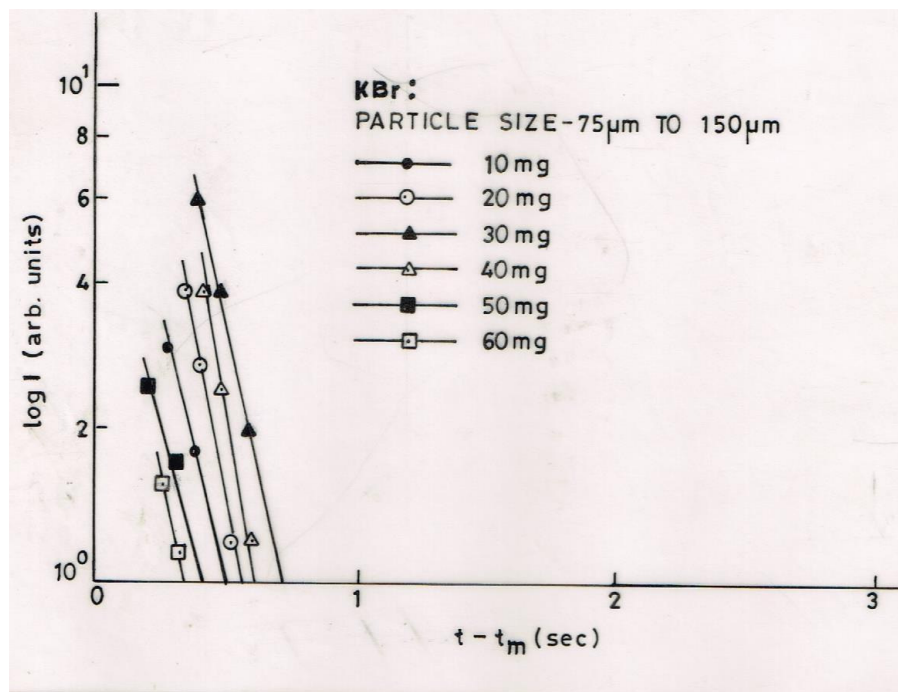


Fig. 7. Plot of $\log I$ versus $(t-t_m)$ of different mass of solute for KBr microcrystal.

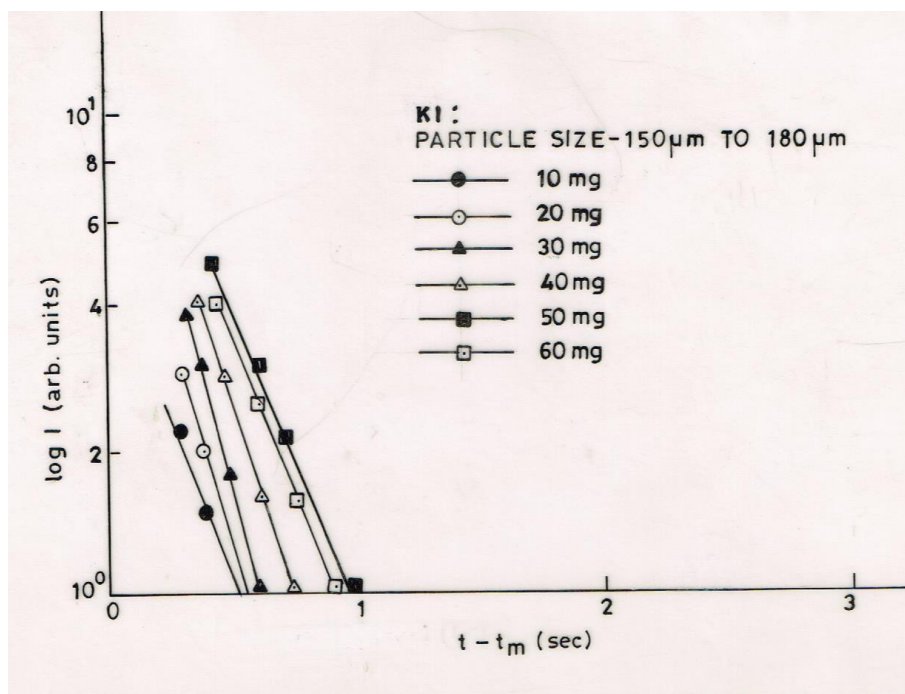


Fig. 8. Plot of log I versus (t-t_m) of different mass of solute for KI microcrystal.

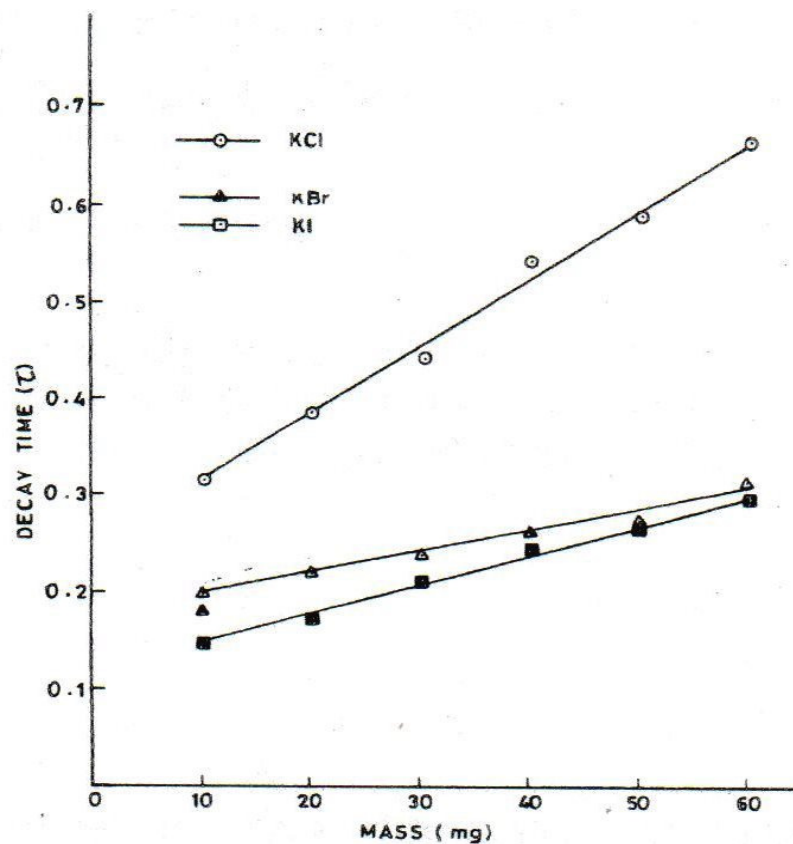
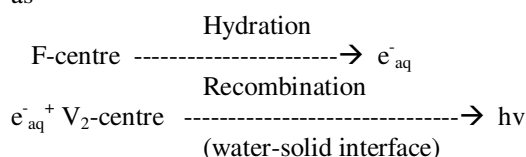


Fig. 9. Dependence of decay time of LL intensity on the different mass of solute of potassium halide microcrystals.

Fig. 9 shows the dependence of the decay time τ of LL intensity on the quantity of the solute dissolved into the solution. It is seen from figure that decay time increases with increasing quantity of the solute.

IV. DISCUSSION AND CONCLUSION

When γ – irradiated micrystals of KCl, KBr and KI were dissolved in luminal solution, the LL emission is found in which electrons are released from F-centres and the formation of hydrated electrons takes place. The hydrated electrons radiatively recombines with the holes on the surface of the crystallites and gives rise to LL emission. The mechanism of LL may be described as



The expression for I peak intensity of LL, I_m and t_m are as given below.

$$I = \eta\gamma\alpha_F N_0 \exp[-(t-t_m)/\tau] \quad \dots(1)$$

$$I_m = \eta\gamma\alpha_F N_0 \quad \dots(2)$$

$$t_m = \frac{1}{\beta - \alpha} \ln(\beta/\alpha) \quad \dots(3)$$

Where β is the rate constant for the recombination of hydrated electrons with holes, $\alpha=1/\tau$ is the rate of dissolution of solute in the solvent, η the probability of radiative recombination, γ is the factor correlating the number of hydrated electrons, n_F is the density of F-centers, and N_0 the initial number of the molecules of solute. Equation (1) shows that when luminol solution will be dropped into the solute then initially the intensity should increase linearly with time, attains a maximum value and then it should decrease exponentially with time such results are shown in figure 1, 2 and 3.

Fig. 2 shows that I_m increases with increasing quantity of the solute dropped into the solution. At a particular quantity of solute, it attains a saturation value with further increase in the quantity of solute dropped into the solution. This may be due to the formation of more hydrated electrons produced in a larger quantity of the solute dropped into the solution. Such result is predicted from equation (2) which shows N_0 is related to the quantity of the sample added to the solution. When higher quantity of crystallites are added to the

solution, a saturation will occur and only a fixed amount of the solute will be dissolved, hence the LL intensity will attain a saturation value at a particular quantity of the solute.

It is seen from Fig. 5 that time t_m increases with increasing quantity of the solute dropped into the solution. This may be due to longer time duration needed

for dissolving the sample of larger quantity of the solute. As the rate of dissolution of solute decreases with increasing quantity of solute dropped into the solution. Equation (3) show that the time t_m should increase with increasing quantity of the solute dropped into the solution.

Fig 9. Shows that the decay time of LL intensity increases with increasing quantity of the solute dissolved into the solution. This is in accordance with equation (1) which shows that the time τ should inversely depend on the rate constant α of the dissolution of solute into the solution.

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