ABSTRACT OF THE THESIS

CHAPTER I

Chapter I deals in brief with the concept, associated definitions, theories and mechanisms of luminescence. The phenomenon of triboluminescence has been described with regard to its various aspects and thereby the works done up to date on triboluminescence have been reviewed. Then the problem undertaken in the present investigation has been stated. It has been mentioned that the chief interest of the study is to investigate the dependence of triboluminescence intensity in tartaric acid, rochelle salt, sodium tartrate, dipotassium tartrate and ammonium tartrate crystals, on the mode of mechanical crushing and to verify the results so obtained with the help of other experiments on the triboluminescence.

CHAPTER II

In this chapter the study on the dependence of triboluminescence intensity of the tartrate crystals on the mode of mechanical crushing has been described. It has been shown that in statical crushing, the triboluminescence intensity increases with crushing mass and follows the relation

\[ I = I_0 M \exp \left( - \frac{b}{M} \right). \]

In impulsive crushing, the triboluminescence intensity increases with crushing mass and height through which weight is dropped on the crystal. The variation of triboluminescence intensity in impulsive crushing with crushing mass and crushing height can be expressed by the relation
\[ I = I_0 \sqrt{\frac{M}{h}} \exp \left( -\frac{b}{\sqrt{Mh}} \right). \]

The value of Young's modulus of elasticity of the tartrate crystals calculated with the help of triboluminescence measurement using the above relations, is found to be nearly the same as obtained by other methods.

The triboluminescence intensity of a given mass of the tartrate crystal attains a saturation value after a particular value of crushing mass for a given crushing height. The saturation value of triboluminescence intensity is much higher in impulsive crushing than statical one. The variation of saturation value of triboluminescence intensity with crushing height follows the relation

\[ I_{h_2} - I_{h_1} = I_{00} \left( \sqrt{h_2} - \sqrt{h_1} \right) \exp \left[ C \left( \sqrt{h_2} - \sqrt{h_1} \right) \right]. \]

The triboluminescence intensity of the tartrate crystals diminishes considerably when they are crushed inside the liquid anhydrous diethylether, but it does not cease. The triboluminescence intensity of the tartrate crystals obtained by crushing them inside the liquid depends on the mode of mechanical crushing in a similar manner as the triboluminescence intensity obtained by crushing the crystal in air depends.

It has been discussed that the increase of triboluminescence intensity with applied stress is due to the increase of the area of the new surface created by fracture of the crystal. The triboluminescence intensity attains a saturation value at much higher value of crushing mass, because the creation of new surfaces by fracture of the crystal gets
saturated due to work-hardening. However, the increase of saturation value of triboluminescence intensity with crushing height has been discussed in Chapter VI, with the help of configuration co-ordinate curve model.

CHAPTER III

In this chapter, the study on the effect of temperature on the triboluminescence of the tartrate crystals has been described. It has been shown that the triboluminescence intensity of the tartrate crystals decreases with rise of their temperature. The triboluminescence intensity at a fixed temperature of the crystal is higher when the temperature is attained by heating the crystal than by cooling them from a higher temperature. The variation of the saturation value of triboluminescence intensity in the tartrate crystals with temperature follows the relation

\[ I_{S_{T_1}} - I_{S_{T_2}} = I_{0} \left( T_{2} - T_{1} \right) \exp \left[ \frac{E_{a}}{K} \left( \frac{1}{T_{1}} - \frac{1}{T_{2}} \right) \right]. \]

The activation energy for thermal radiation has been determined with help of the above relation and found to be 0.05 ev, 0.04 ev, 0.045 ev, and 0.037 ev for tartaric acid, sodium tartrate, dipotassium tartrate and ammonium tartrate crystals respectively. The triboluminescence intensity in rochelle salt crystals varies in a irregular manner with rise of their temperature.

It has been discussed that the decrease in the saturation value of triboluminescence intensity of the tartrate crystals with temperature is: (1) due to decrease of Young's
modulus of elasticity of the crystals and (2) due to decrease in activation energy for thermal radiation which increases the probability of diffusion of excited triboluminescent centres.

CHAPTER IV

In this chapter, the study on the effect of ultraviolet, X-rays and radio-active irradiations on the triboluminescence intensity of the tartrate crystals has been described. It has been shown that the triboluminescence intensity of the tartrate crystals does not get affected with ultraviolet irradiations, however it decreases with X-rays and radio-active irradiations. The triboluminescence intensity of rochelle salt, sodium tartrate and dipotassium tartrate crystals decreases exponentially with the irradiation time and the decrease attains nearly a saturation value after two hours. The decrease is higher in those tartrate crystals which have higher triboluminescence intensity before the irradiation. But, the percentage of decrease in triboluminescence intensity is nearly the same as 5% for rochelle salt, sodium tartrate and dipotassium tartrate crystals. These crystals get coloured with X-ray irradiation. However, no change in triboluminescence intensity of tartaric acid and ammonium tartrate crystals has been observed, neither these crystals get coloured with X-ray irradiations.

The triboluminescence intensity of tartaric acid, rochelle salt, sodium tartrate and dipotassium tartrate crystals decreases exponentially with the time of exposure to radio-active rays and the decrease attains nearly a saturation value
after 48 hours. The decrease is higher in those tartrate crystals which has higher triboluminescence intensity before the irradiation. But, the percentage of decrease in triboluminescence intensity is nearly the same as 8% for tartaric acid, rochelle salt, sodium tartrate and dipotassium tartrate crystals. These crystals also get coloured with the radioactive irradiations. However, no change in triboluminescence intensity of ammonium tartrate crystals has been observed, neither they get coloured.

It has been discussed that the displacement of electrons occurs from triboluminescent centres, which get subsequently trapped to negative ion vacancies in the crystal. Thus the triboluminescence intensity decreases with the appearance of stable colour centres in the crystals.

CHAPTER V

In this chapter the variation of triboluminescence intensity in tartaric acid, rochelle salt, sodium tartrate, dipotassium tartrate and ammonium tartrate crystals with the simultaneous piezo-induced charge produced at fracture has been described. It has been shown that for the crystals of a given mass, the triboluminescence intensity and the simultaneous charge produced at fracture increases with crushing mass and both of them attain saturation values after particular values of crushing mass, for a given crushing height. The saturation value of triboluminescence intensity increases, but the corresponding charge produced at fracture decreases due to increase of crushing height. The tribolu-
minescence is higher in those tartrate crystals which develop less piezo-induced charge at fracture. It has been discussed that in impulsive crushing, mechanical stress in crystal increases due to the reduction of piezo-electric stress. Hence at higher value of mechanical stress, moving dislocations are able to interact with more luminescent centres, due to which the triboluminescence intensity increases.

CHAPTER VI

In this chapter, a brief description of some of the facts intimately related with the phenomenon of triboluminescence, has been made. The increase of saturation value of triboluminescence intensity in impulsive crushing has been discussed. It has been shown that the shock-wave distorts the configuration co-ordinate curve of triboluminescent centres, thereby increasing the activation energy for thermal radiation and the Young's modulus of elasticity of the crystal, due to which the triboluminescence intensity increases in impulsive crushing.

The triboluminescence intensity in the tartrate crystals is composed of two parts: (1) triboluminescence due to the luminescence property of the crystal and (2) triboluminescence due to the discharge of gases between the fractured surfaces of the crystal. It has been discussed that the discharge part of triboluminescence is due to the exo-emission of ionized electrons from triboluminescent centres.

A discussion of the mechanism of triboluminescence has been made on the background of the results (1) that the
increase of triboluminescence intensity in impulsive crushing is due to the increase of Young's modulus of elasticity of the crystal, (2) that the decrease of triboluminescence with temperature is also due to the decrease of Young's modulus of elasticity of the crystal and (3) the triboluminescence is higher when the simultaneous piezo-induced charge produced at fracture is less also illustrates that the increase of triboluminescence intensity is due to the increase of Young's modulus of elasticity of the crystals. These results illustrated that the passage of elastic wave in crystal is responsible for the excitation of triboluminescence centres in the tartrate crystals. With a further discussion it has been concluded that at fracture of the crystals, large number of dislocations are created which interact with luminescent centres, thereby changing the electric field in the vicinity of the latter. This change of electric field produces the following four process in the crystal: (1) luminescence in the crystal (2) thermal radiation in the crystal (3) diffusion of triboluminescence centres and (4) the ionization of triboluminescence centres, which is responsible for the discharge of gases between the fractured surfaces of the crystal.

At the end of this chapter, the different conclusions drawn from the "studies on triboluminescence in tartrate crystals" has been summarized and some problems for the further research on triboluminescence has been suggested.