CHAPTER - I

INTRODUCTION

In the present scientific world, people have realized the high application potential of ionizing radiations. Scientists, doctors, engineers, research workers and other professional workers have used different types of radiations namely alpha, beta, gamma, ultraviolet and X-radiations, in various scientific applications to serve modern society. In all these applications, the interaction of radiations with different materials, human body and other living life, detection of their presence and estimation of radiation doses are the main points to be investigated thoroughly.

The interaction of ionizing radiation produces electrons and holes in crystalline substances. Most of these electrons and holes recombine promptly resulting either in photon emission or lattice vibrations. The remaining electrons and holes are trapped at the defect sites which may be present in the host lattice instrinsically or due to some foreign impurities. On heating the irradiated crystals, electrons (or holes) are released from the traps and diffuse in the medium till they undergo recombination. A part of the recombination energy is emitted in form of light called thermoluminescence (TL) glow. The energy required to release the electrons (or holes) from the trap is called activation energy (E). Normally, a number of trapping sites exist having different activation energies. This results in the appearance of number of glow peaks, each glow peak representing one type of trap. The plot of light intensity versus temperature is called glow curve. The spectral quality of luminescence light output versus wave-length at any particular temperature is called the TL-emission spectrum. Both the TL glow curve and spectral emission curve may exhibit many peaks depending upon the nature of material.

Ionizing and non-ionizing radiations are extensively used in industries, research and medical fields. In medical field they are used for diagnosis and therapy. Sources of ionizing radiations are X-ray machines, accelerators and radionuclides. Exposure to any of these types of radiations is found to cause biological effects if excessive, these could be harmful. For a proper assessment of benefit versus risk in the use of these radiations, quantification of radiation exposure and radiation absorbed dose is highly essential. In view of this, the basic need of these professional workers, is, to estimate the absorbed radiation dose precisely for the better use and ascertaining requisite precautionary measures. Many methods have been suggested for the determination of radiation doses[1-3]. Before two decades, the film badge-spectroscopic method was considered to be most common in practice, inspite of being expensive and time consuming. Recently thermoluminescence (TL) technique has been developed, established and standardized as the cheapest and quickest method to estimate the doses of high energy ionizing radiations namely, alpha-, beta-, gamma- and X-irradiations[4-9]. Now-a-days, thermoluminescent dosimeters are widely used for dose estimation in medical fields and industries.

In principle, thermoluminescence is an attractively simple technique of dosimetry. The energy stored as trapped electrons, or holes in the phosphor, on irradiation is subsequently liberated by the application of heat and the thermoluminescent light emitted by the material is used as a measure of exposure or absorbed dose.

TL was known since long, but real interest in this phenomenon started with the realization of its usefulness in radiation dosimetry. The heart of TL radiation dosimetry is the TL material. Major phosphors studied from the point of view of radiation dosimetry are LiF (Mg, Ti), $Li_2B_4O_7$:Mn, CaF_2:Mn, CaF_2:Dy, CaF_2:Nat, $CaSO_4$:Dy and Mg_2SiO_4:Tb [4,5,8,10-13]. Besides this the phenomenon of TL is found related with colour centre studies[14], especially colouration due to irradiation. In this respect alkali halides other than LiF are also known but these phosphors did not find any space in radiation dosimetry due to their low sensitivity. Recently alkali halides other than LiF, namely, NaCl and KCl have been made sensitive and examined for their suitabilities in radiation dosimetry[15-22]. On the basis of their experimental results they recommended these phosphors as solid state dosimetric materials.

The performances of TL phosphors, namely, sodium and potassium chloride doped with monovalent and divalent impurities have been found to be excellent and satisfactory for the dosimetry of beta-, gamma-, UV- and X-radiations. In order to investigate the use of these materials for the estimation of doses of alpha radiation, the present work is undertaken. The research work of this thesis is mainly divided into following two parts :

(I) Basic studies on thermoluminescence properties of Ba- doped sodium and potassium chlorides.

(II) Application of TL of NaCl:Ba (T) and KCl:Ba (T) to alpha radiation dosimetry.

The part-I describes the TL characteristics of pure and Ba doped NaCl and KCl in different physical conditions after an exposure to alpha radiation (standard dose of 3800 rad).

The particular physical conditions of the materials in which NaCl:Ba and KCl:Ba display prominent well defined isolated glow peaks are selected for the examination of the dosimetric properties to find their utilities in alpha radiation dosimetry. The experimental data related to this are represented in the second part (Part - II) of this thesis.

The present experimental work clearly brings out the fact that 750°C air-quenched NaCl:Ba (10^{-2}m.f.) and KCl:Ba (10^{-2}m.f.) designated in this thesis as

NaCl:Ba (T) and KCl:Ba (T), respectively, exhibit dominant isolated glow peaks around 220 and 170°C. These glow peaks satisfy most of the basic requirements which should be fulfilled by the TL peak of an efficient dosimeter material. Therefore, it is concluded that these materials are of use in the estimation of alpha dose in radiation applications.