CHAPTER I - INTRODUCTION

1. Solid State Physics, Electronic structure of solids and Luminescence. 1

2. The Concept of Luminescence. 3
   (a) Definition.
   (b) Phosphor.
   (c) Classification of Luminescence.
   (d) Fluorescence and Phosphorescence.

3. Localized energy levels in the forbidden energy gap. 7
   (a) Luminescence centers.
   (b) Killer centers.
   (c) Traps and Trapping states.

4. Basic Ingredients of a phosphor. 9
   (a) Host lattice.
   (b) Activator.
   (c) Flux.

5. Classification of phosphor types. 12


7. Theories of Luminescence. 15
   (a) Absorption and Excitation.
   (b) Transfer of excitation energy.
      (a) Energy transfer without movement of charge carriers.
(i) Cascade mechanism.
(ii) Transfer of energy by nonradiative process.
(iii) Exciton migration.

(b) Energy transfer with movement of charge carriers.
(c) Explanation of concentration quenching.

(c) The storage and release of excitation energy.
(a) Phosphorescence decay.
(b) Thermoluminescence.

(D) Emission.

(a) Configurational coordinate model.
(b) Continuous dielectric model.
(c) Energy band models for photoconducting phosphor.

(i) The classical Röhl-Schon-Klasens model.
(ii) Lambe and Klick model.
(iii) Prener and William associated donor-acceptor model.

6. Allied properties and Related topics.

(a) Photoconductivity.
(b) Photodielectric effect.
(c) Photoelectroluminescence.
(d) Infrared stimulation and quenching.
(e) Electron emission from phosphores.
(f) Paramagnetic resonance.

10. References.

CHAPTER II - PREPARATION OF PHOSPHORS.

1. Introduction.

2. Preparative parameters of a phosphor.

   (a) Lattice structure of the host material.
   (b) Nature of the activator and its concentration.
   (c) The nature and quantity of flux.
   (d) Purity of ingredients and of reaction vessels.
   (e) Grain size of ingredients.
   (f) Method of mixing the ingredients.
   (g) Size of the batch (charge).
   (h) Reaction vessels for firing.
   (i) Furnace.
   (j) Temperature and time of firing.
   (k) Choice of ambient atmosphere during firing.
   (l) Cooling of the phosphor.
   (m) Grinding and grain size of the phosphor.
   (n) Mechanical handling of the phosphor.

3. Preparation of Alkaline earth sulphide phosphors.
4. Present method.
   
   (a) Purification of raw materials and other intermediates.
      
      (i) Purification of calcium sulphate.
      
      (ii) Purification of the reducing agent carbon.
      
      (iii) Preparation of activators.
      
      (iv) Flux.
      
   (b) Preparation of charge.
      
      (i) Selection of typical formula.
      
      (ii) Mixing of ingredients.
      
   (c) Firing process.
      
   (d) Grinding and mechanical handling.

5. References.

CHAPTER III - DECAY.

1. Introduction.

2. Kinetics of Luminescence.

   (A) Fluorescence decay.
      
      (a) First order kinetics of fluorescence.
      
      (b) Second order kinetics of fluorescence.
      
   (B) Kinetics of phosphorescence.
      
      (a) First order kinetics of phosphorescence.
(b) Effect of retrapping.

(c) Second order kinetics of phosphorescence.


(A) Bimolecular superposition theory.

(B) Monomolecular superposition theory.

4. Methods of decay measurement.

(A) Fast decay.

(a) Oscilloscope method.

(b) Phase shift methods.

(B) Slow decay.

(a) Becquerel’s phosphoroscope.

(b) Rotating disc phosphoroscope.

(c) Oscilloscope methods.

(d) Other methods.

5. Present method.

(A) Decay apparatus.

(B) Source of excitation.

(C) Electron multiplier photometer.

(a) Detector unit.

(b) Power supply control.

(c) Galvanometer.

(D) Setting up of the photomultiplier.

(E) Experimental procedure.
6. Results.

(A) Decay curves.
(B) Correlation coefficient.
(C) Decay constant.
(D) Variation of decay constant with zirconium.
(E) Variation of decay constant as a function of time.
(F) "Pealing off" of the decay curves.
(G) The variation of intensity with zirconium.

7. References.

CHAPTER IV - THERMOLUMINESCENCE.

1. Introduction.
2. Theories of thermoluminescence.
3. Evaluation of 'S'.
4. Evaluation of trap depth.
   (a) Method of Randall and Wilkins.
   (b) Method given by Urbach.
   (c) Method proposed by Garlick and Gibson.
   (d) Method proposed by Curie.
   (e) Method proposed by Grossweiner.
(f) Method proposed by Halperin and Braner.

5. Experimental methods. 116

6. Present method. 117
   (a) Description of the apparatus.
   (b) Experimental procedure.

7. Results. 119
   (a) Glow curves.
   (b) Attempt-to-escape frequency \( S \).
   (c) Trap depth \( E \).

8. References. 126

CHAPTER V — DISCUSSION AND CONCLUSIONS.

1. Problem. 123

2. Discussion. 128
   (a) Validity of equation \( p = \frac{E}{kT} \).
   (b) Magnitude of \( S \).
   (c) Order of kinetics involved in decay.
   (d) Nature of the present decay curves.
   (e) Effect of zirconium on the distribution of trapping states.
      (i) Variation of decay constant \( b \) as a function of zirconium concentration.
(ii) Variation of decay constant during decay time.

(iii) Distribution of traps.

(iv) Glow curves.

(v) Trap depth from glow curves.

(f) Identity and physical nature of traps.

(i) Traps associated with specific impurities.

(ii) Traps associated with lattice defects and other perturbations.

(g) Sites occupied by activators.

3. Conclusions. 148

4. References. 150

***************