



STUDIES IN THE
LUMINESCENCE OF ORGANIC MOLECULAR CRYSTALS

by

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A thesis

submitted for the degree of

Master of Science

in the

Department of Physics

University of Adelaide

March, 1970.

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SUMMARY

The first chapter of the thesis states the aims of the project, and gives a brief survey of the types of luminescence processes which have been observed in organic solids by other workers. It is pointed out that the luminescence studies in this thesis provide a method of detection of the energy which is stored in the specimen after ultraviolet irradiation.

The second chapter presents details of the apparatus which was designed by the author, and gives a brief resume of the remaining associated equipment. Basically, the apparatus consists of an automatically operated light switch, with the specimen held centrally on a finger whose temperature can be controlled over a wide range. The apparatus was used to measure certain characteristics of the ultraviolet induced long-lived luminescence decays, thermoluminescence, and infrared stimulated luminescence of three organic solids.

Chapter 3 describes these characteristics in urea, a sample which was found to be quite luminously efficient. Results show that the after-glow is composed of several segments, each of which is the result of a monomolecular recombination process which exhibits an activation energy in the approximate range 0.01 to 0.04 eV. A model is proposed in which it is postulated that each segment is the result of the release of charges from a shallow trapping level. Emission spectra indicate that the traps have different energy separations from the ground state,

a result which is confirmed by the action spectrum for the production of the decay. The action spectrum also implies that charges are excited directly into the trapping levels, inferring that the recombination of a charge trapped at one site and the resulting vacancy at another constitutes a unique entity in itself which may be, in fact, an electron-hole pair. The numerical energy values obtained from the action and emission spectra are reconciled semi-quantitatively by a consideration of the Franck-Condon Principle. The technique of decay measurements supplies a method for the detection of shallow traps which have hitherto been unobservable by thermoluminescence.

A serious difficulty was presented when the chamber became contaminated, and this is discussed in Chapter 4.

Experiments similar to those carried out on urea and repeated on p-dichlorobenzene and p-dibromobenzene are outlined in Chapter 5, and models comparable to that postulated for urea are formulated for both. The dependence of the thermoluminescence glow peak intensities of p-dibromobenzene on the ultraviolet irradiation time is described in some detail, and possible interpretations of the results are discussed. The action spectra of the first two glow peaks were found to be essentially the same, in contrast to the different excitation energies which it was found were required to populate the various trapping levels responsible for the decay. The implication is that an electron-hole pair model may not be valid for the deep traps, a result confirmed by earlier workers quoted in the text. A very long-lived luminescence decay and

an infrared stimulated decay from ultraviolet irradiated p-dibromobenzene are reported.

The thesis concludes in Chapter 6 with an outline of possible future work which may confirm and extend the results already obtained.

PREFACE

The work described in this thesis was carried out in the Department of Physics between August 1967 and January 1970.

To the best of the author's knowledge and belief, this thesis contains no material which has been accepted for the award of any other degree or diploma in any University, and contains no material previously published or written by another person, except when due reference is made in the text.

W. D. RICEZIAN

ACKNOWLEDGEMENTS

I am grateful for the guidance and encouragement offered to me by my supervisor, Dr. L. G. Ericson, and for the valuable advice given by Dr. R. Lawrence during the latter part of the project. I am also indebted to Dr. A. W. Butterfield for many helpful discussions and for reading the manuscript, and to Mr. D. W. Field and Miss Mary Riceman for reading the typescript.

The facilities of the Department of Physics were generously provided by Professor J. H. Carver.

I would like to thank Mr. W. Jamieson of the Department Workshop for skilfully constructing much of the apparatus. His expert advice on many aspects of the design was greatly appreciated. I am also grateful to Mr. A. Swart for his help with many technical problems.

This work was made possible by the tenure of a University Research Grant (August - December, 1967) and a Commonwealth Postgraduate Award (1968-69).