INVESTIGATIONS OF THE OPTOELECTRONIC PROPERTIES OF SOME PHOTOSENSITIVE SYSTEMS WITH SPECIAL REFERENCE TO THEIR USE IN SOLID STATE IMAGE INTENSIFIERS

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TO DARAIUS

CERTIFICATE

I am satisfied that the thesis entitled 'Investigations of the Optoelectronic Properties of some Photosensitive Systems with Special Reference to their use in Solid State Image Intensifiers', submitted by Niloufer Shroff is worthy of consideration for the award of the degree of DOCTOR OF PHILOSOPHY and is a record of the original bonafide research work carried out by her under my guidance and supervision and that the results contained in it have not been submitted in part or full to any other University or Institute for award of any degree/diploma.

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PREFACE

Whereas in the field of electronics, solid state components have virtually replaced the vacuum tube type devices, in the field of imaging vacuum type systems are still being used for TV picture tubes, TV cameras as well as Image Intensifiers. Solid state C.C.D. (charge coupled devices) are now beginning to give some competition to the vacuum tube type camera tubes. In the case of Image Intensifiers however, the solid state image intensifiers (SSII) have achieved only very limited success so far.

The fundamental elements of the SSII are a photoconducting layer and an electroluminescent layer. These are generally II-VI compounds used in layer form. The present thesis reports the studies on photo effects such as photoconductivity, photodielectric effect, electrophotographic effect and electroluminescence, on II-VI systems with special reference to their possible application in solid state image intensifiers. The characteristics obtained with SSII panels fabricated using some of the layers are also reported.

The work is presented in eight chapters. In the first chapter a survey of the various types of SSII and their properties and applications is given. The available literature on this subject has been reviewed and an introduction to the various photo effects, important from the point of view of SSII work is also given. The objective of the present work is outlined at the end of the chapter.

The second chapter gives the details of the materials studied, as well as, the methods of sample and electrode preparation. The measurement techniques employed, as well as the design and fabrication of the various samples and experimental procedure are discussed therein.

The photoconductivity studies on the CdSSe(Cu) in binder layer form and sintered layer form,are discussed in detail in Chapter III. The details about the trap distribution in the two forms,obtained on the basis of these studies are also given in this chapter. The variation of the photo and dark conductivity with field, temperature, light intensity, time and wavelength of illumination is studied. The important differences obtained between the two types of CdSSe(Cu) layers are discussed.

In the fourth chapter the photo effects observed in the binder CdSSe(Cu) layers and sintered CdSSe(Cu) layers under application of an a.c. field are studied and explained on the basis of the space charge hypothesis and polarisation of traps. The correlation between the a.c. and d.c. effects is shown. A critical analysis of the two types of layers from the SSII application point of view is also given.

The fifth chapter describes the effect of corona sensitization of CdSSe(Cu) binder layers, CdSSe(Cu):HgS layers, MK/polymer double layer systems and pure MK sprayed layers made using different curing conditions. Electrophotographic characteristics i.e. charge acceptance, photo decay and dark decay have been studied in all these systems. Corona modification of conductivity (necessary for using the system in field effect storage type intensifiers) has been studied in some of these systems.

The variation of electroluminescent output with field and frequency has been studied in Chapter VI for ZnS(Cu) using various ratios of ZnS(Cu): Cynoethyl cellulose binder. Various other binders such as PS,ABS,PVB and PF were also tested for use with ZnS(Cu). The choice of the electroluminescent layers for use in SSII along with different photoconductive layers is explained.

The seventh chapter gives the study carried out on five different SSII panels fabricated using the layers studied in the earlier chapters. Characteristics obtained are correlated with the properties of the individual layers described earlier.

In the last chapter (eight) a summary of the results and conclusions of the different studies is given.

The above mentioned studies have resulted in the following research publications:

1. A study of the photoconducting properties of CdSSe(Cu) with a view to its use in solid state image intensifiers. J. Phys. D: Appl. Phys., 16(1983), 393.

2. Photo and dark conductivity studies of CdSSe(Cu) sintered layers - Physical ReviewB. Accepted for publication.

3. Electrophotographic characteristics of CdSSe(Cu) in polystyrene binder layers. Journal of Material Science Letters. 2(1983)17.

4. Electrophotographic properties of Michlers Ketone/ Polymer double layer systems. Surface Technology. 25(1985) 159.

5. Photoelectric properties of Michler Ketone - Effects of curing. Journal of Electrostatics. In Press.

6. Some studies on a sandwich type solid state image intensifer. Bull. of Electrochem. 1(2)(1985)173.

7. Modification of the photo and dark conductivity of CdSSe(Cu) binder layers by corona charging. Conference record of the Industrial Applications Society, IEEE-IAS-1983, (Mexico City, Mexico, 3-7 Oct. 1983), p.1199.

8. Instrument for electro-optical measurements of photoconductors. Proc. Nat. Conf. on Instr. April 1983, CSIO, Chandigarh, India, p. 278.

9. Solid state image intensifiers - A Review.
Proc. Nat. Conf. on Instr., April 1983, CSIO, Chandigarh, India, p.285.

10. Studies on solid state image intensifier using CdSSe(Cu): Polystyrene and ZnS(Cu): Phenol formaldehyde binder layers.
Presented at Symposium on Optics, NPL, New Delhi, India, Feb. 1985.

11. Investigations of the photo and dark a.c. impedance in CdSSe(Cu) sintered layers. Communicated.

12. Photodielectric effect in CdSSe(Cu):ABS binder layers.
Communicated.

13. Solid state image intensifiers and their applications.
Communicated.

14. Some studies on solid state image intensifier systems.
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