

**INVESTIGATIONS OF THE PHOTOELECTRET AND  
ELECTROPHOTOGRAPHIC CHARACTERISTICS OF  
Hg I<sub>2</sub>: CdS BINDER LAYERS**

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## PREFACE

The formation of electret state in a dielectric is a process in which a state of persistent electric polarization is set up and then destroyed fairly slowly with time. The study of electrets has enjoyed widening interest among the scientific community because of the realization of many practical applications possible with the different types of electrets, viz. thermoelectrets, photoelectrets, magneto-electrets, radioelectrets etc. The photoelectret state formation in high resistivity photoconductors, first identified by Nadhzakov in 1937, has evoked particular attention in this respect.

The photoelectret state in a material is the consequence of trapping of photogenerated carriers in certain deep traps during photoconduction. The lifetime of the 'quasi permanent polarization' is primarily governed by the depth and nature of the trapping levels involved. Thus an analysis of the decay characteristics of the photoelectrets can give valuable information about the trapping levels in a photoconductor. Also, since the rate of decay of the trapped carriers in dark and in the presence of light could differ considerably, it is possible to obtain a charge pattern on the photoconductor. In addition to the basic scientific information that the

photoelectret state studies could give about a photoconductor, it is also possible to use this information in the development of P.I.P. electrophotographic technique in practice.

While the studies on single crystals provide fundamental insight into the basic processes involved, it is the thin films or binder layers which give sufficient promise for the commercial applications. Binder layers have many advantages over the thin film or single crystal when it comes to the large area (as required in electrophotography), mechanical strength and economy of production. The use of binder layers in Xerography was pioneered by workers at Battelle Memorial Institute. Extensive work has been done on binder layers of selenium, zinc oxide, lead oxide, mercuric sulphide, zinc cadmium sulphide and cadmium sulphide. Mixed systems can be prepared either from powders or solid solutions of the two or more compounds, as in the case of zinc cadmium sulphide system or by mixing of two compounds in the binder. In general, it may be said that binder layers allow an extra degree of freedom in tailoring the properties of materials to a particular application, and the challenge is to achieve the ultimate performance inherent in the material itself.

This thesis is concerned with the persistent polarization and electrophotographic characteristics of binder layers consisting of extremely fine particles of photoconductive

powders of  $\text{HgI}_2$  and  $\text{CdS}$  bound together in an insulating matrix. The thesis is divided into seven chapters. The introductory chapter gives a brief historical review and present state of the subject. A section is also devoted on the basic theory of the formation and depolarization of photoelectrets.

In the second chapter, the measurement techniques and the method of preparation of the samples are outlined. The specifications of the materials and instruments used in the experiments are also given in this chapter.

The third chapter deals with the extensive investigations carried out on the photoconductivity of the binder layers. These include the dependence of the response time, photocurrent, dark current and  $I_{\text{photo}}/I_{\text{dark}}$  on the voltage, intensity of illumination and temperature. The effect of the percentage composition of  $\text{HgI}_2$  and  $\text{CdS}$  in the binder layers and the percentage and nature of the binder material on the above parameters is also discussed.

Studies on the photodielectric effect of the layers are given in Chapter IV. These studies were made to see the extent of trapping present in the photoconducting layers which is important for a clear understanding of the photoelectret state formation. The dependence of the photodielectric effect on the frequency, intensity of illumination, temperature

and their correlation to the results obtained from photoconductivity and photoelectret studies is found to give much valuable information.

Chapter V deals with the photoelectret state formation in the binder layers. Results on the dependence of photoelectret charge on the time of polarization, polarizing voltage, intensity of illumination and temperature are presented in this chapter. These studies are of immediate relevance to the electrophotographic applications. A section on photoelectret properties of the organic photoconducting polymer-poly N-vinyl carbazole is also included to compare the performance of different electrophotographic materials.

In Chapter VI, the possible use of the binder layers in electrophotographic techniques is discussed. An analysis of the decay and growth of photoconductivity, photoelectret charge and corona-sprayed surface charge and their relevance to electrophotography is also given.

Chapter VII gives the summary and salient conclusions of the whole work.

The work presented in this thesis has also led to the following research papers:

1. Photopolarization Characteristics of Mercuric Iodide Binder Layers, J. Appl. Phys., Vol. 45, No. 3, March 1974.
2. Photopolarization and Depolarization Characteristics of Poly N Vinyl Carbazole, J. Polymer Sci., Polymer Physics Edition, Vol. 12, 2465-2472, December 1974.
3. Investigation of Photoelectret Effect in  $\text{HgI}_2:\text{CdS}$  Mixed System, Photogr. Sci. & Eng., Vol. 18, No. 15, 544-48, Oct. 1974.
4. Investigation of the Photoelectret and Photodielectric Effect in  $\text{HgI}_2:\text{CdS}$  System, presented at the 146th Meeting of The Electrochemical Society held at New York, Oct. 14, 1974.
5. Photoconductivity of  $\text{HgI}_2:\text{CdS}$  Mixed System-I (communicated).
6. Photoconductivity of  $\text{HgI}_2:\text{CdS}$  Mixed System-II(communicated).
7. Dielectric Behaviour of  $\text{HgI}_2:\text{CdS}$  Mixed System-I (communicated).
8. Dielectric Behaviour of  $\text{HgI}_2:\text{CdS}$  Mixed System-II(communicated).
9. Photoelectret State Studies in  $\text{HgI}_2:\text{CdS}$  Mixed System - Effect of Binders (communicated).
10. Thermophotoelectret Effect in  $\text{HgI}_2:\text{CdS}$  Mixed System (communicated).
11. The Photoelectret State Studies in Poly N Vinyl Carbazole and its Charge Transfer Complex with Trinitrofluorenone (communicated).
12. Electrophotographic Characteristics of the  $\text{HgI}_2:\text{CdS}$  Binder Layers (communicated).

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