

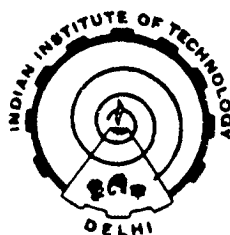
**DEVELOPMENT AND CHARACTERIZATION OF
BARIUM TITANATE: POLYVINYLIDENEFLUORIDE
COMPOSITES FOR PYROELECTRIC TRANSDUCERS**

By

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THESIS SUBMITTED
IN FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY



to

INDIAN INSTITUTE OF TECHNOLOGY, DELHI

NEW DELHI - 110016, INDIA

February, 1992

TO MY SON

SAURABH

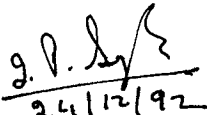
CERTIFICATE

We are satisfied that the thesis, entitled "DEVELOPMENT AND CHARACTERIZATION OF BARIUM TITANATE - POLYVINYLIDENE FLUORIDE COMPOSITES FOR PYROELECTRIC TRANSDUCERS", presented by RINA SHARMA, to the Indian Institute of Technology, Delhi, 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 our 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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ACKNOWLEDGEMENT

I express my deep sense of gratitude to Dr. I. P. Singh for his valuable and meticulous guidance and constant encouragement at every stage of this work. I am grateful to Dr. P. K. Sharma for his support and beneficial discussions throughout the course of this work.

I extend my sincere thanks to Prof. Arokiaswamy for his keen interest and valuable comments. I am thankful to the faculty of IDD centre for their encouragement and inspiration.

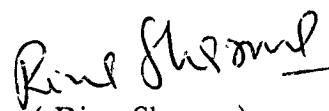
I am indebted to Prof. P. K. C. Pillai and the members of Electret group, specially Dr. A. K. Tripathi and Dr. Anita Tripathi for their kind help and useful technical discussions during the course of this work.

Thanks are due to all the members of IDDC workshop for their help in fabrication of sample cells. I wish to thank all the members of electronics group.

Thanks are due to Dr. Maiti for allowing to use the facilities for sample preparation. I acknowledge the help of Mr. D. C. Sharma, Mr. Kala, Mr. Tiwari and Mr. Durga Singh for their help in carrying out SEM, DSC, XRD and IR experiments.

It gives me pleasure to thank my colleagues Mr. H. L. Yadav and Ms. Seema Jain and Ms. Pramila for their cooperation and moral support. I am also thankful to Mr. Manoj Sharma, Mr. Prafulla, Mr. Rakesh, Mr. Baldev and Mr. Sunil Garg for their help during compilation of the thesis. Special thanks are due to Dr. V. T. Chitnis, Dr. Rashmi and Mr. A. K. Kanjilal, Mr. Ram Narain and all the members of length standards, NPL.

I cherish the support, encouragement and care shown by my husband throughout this work. In the end I love to thank my son, from whom I borrowed the time to complete this work.


(Rina Sharma)

ABSTRACT

The major aim of the investigations was to study the Barium Titanate-PVDF composite for pyroelectric transducer applications. Composite samples of varying compositions of Barium Titanate and PVDF were made, mainly, by the hot rolling technique. A few initial samples were also made by solvent casting, but they were found to show inferior pyroelectric properties. Samples containing 90% and 100% BaTiO₃ had to be made in the form of pellets by hot pressing and sintering, respectively, because of their brittleness.

Apart from pyroelectric studies, dielectric, charge field hysteresis, and DC conductivity studies were also carried out on these samples, to determine their pyroelectric figure of merit and other electrical characteristics. These investigations were carried out at temperatures ranging from ambient to about 160°C, using simple experimental techniques. The structure of the composites was studied by using various techniques such as DSC, SEM, IR spectroscopy and XRD, to observe the effect of interactions of the two phases on their structure. An attempt was made to correlate the results of the above studies. Finally a pyroelectric detector-amplifier was fabricated using the 80% Barium titanate composite and tested.

The pyroelectric coefficient, dielectric constant, DC conductivity and achieved polarization of the composites were observed to increase with temperature, as well as, an increase in BaTiO₃ content. The studies also indicated that the pyroelectric coefficient of composites is governed by PVDF at temperatures less than 50°C, whereas, at higher temperatures, BaTiO₃ also contributes to it. Furukawa's local field model was extended to predict the variation of pyroelectric coefficient of the composite with respect to composition.

Structural modifications of BaTiO₃ particles as well as PVDF matrix was observed through the DSC, SEM, IR and XRD studies. This indicates an interaction between the two phases of the composites. The upward shift of Curie transition and the appearance of a kink in DC conductivity behaviour can be explained on this basis.

The composites were compared for their figures of merit. It was found that for composites with a 70% barium titanate content and higher the figure of merit was comparable to that of pure barium titanate.

The experiments conducted on the fabricated detector clearly brought out the increase in pyroelectric coefficient with respect to temperature and thus supports the results of the direct tests as well as the results reported in literature.

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