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STUDIES OF PYROELECTRICITY IN THIN SAMPLES OF FERROELECTRIC MAT--ETC(U)
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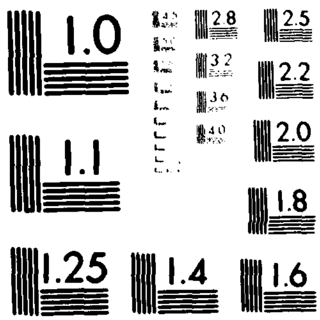

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TITLE

STUDIES OF PYROELECTRICITY IN THIN SAMPLES OF FERROELECTRIC MATERIALS FOR IMPROVED HIGH SPEED INFRARED DETECTORS.

FINAL REPORT.

AUTHORS

M. BASS AND M. SIMHONY

DATE

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The view, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

19. KEY WORDS PLZT pyroelectric infrared detectors for high-power pulses; subnanosecond pulse detectors. Incubation time of piezoelectric oscillations in pyroelectric detectors. Space-charge injection component of poling currents in thin PLZT samples. Measurement of pyroelectric coefficient under poling.

20. ABSTRACT Pyroelectric (PE) detectors made of 10 and 25 μm thick samples of PLZT 8/65/35 respond well to megawatt, 50 nsec CO_2 laser pulses. Superimposed piezoelectric oscillations have an incubation time, during which they do not disturb the PE response. Edge-electroded detectors showed an RC time of 60 picosecond. Poling currents in the samples appear to have components due to space-charge injection and to polaron formation and motion. A method was developed to separate the PE component of the poling current and to measure the PE coefficient under the poling voltage.

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A. Statement of Problem Studied

The problem studied was pyroelectricity in thin samples of ferroelectric materials. Most of our work was done on 10 μm and 25 μm thick samples of the ceramic PLZT 8/65/35. We studied the poling currents in the samples, their dependence on the poling voltage and the temperature treatment. We analyzed the pyroelectric responses of the samples to short (50 nsec) megawatt CO_2 laser pulses and the accompanying piezoelectric oscillations. We have also started to work on a better sample geometry for the detection of sub-one hundred psec laser pulses.

B. Summary of the Most Important Results

1.) We have proven the applicability of the PLZT 8/65/35 ceramic for the detection of infrared laser pulses. Thin samples of PLZT are easier to prepare than those of $LiTaO_3$ or SBN and they withstand powerful laser pulses (2 MW/cm^2) with less damage.[1] PLZT detectors with edge electrodes respond well to the sub-one hundred psec pulses of the Los Alamos CO_2 laser. They showed a 60 psec characteristic RC time and a 1-3 volt/MW responsivity. These preliminary results can be improved by increasing the absorbtivity of the detectors and improving the poling procedures.

2.) We have shown that the piezoelectric oscillations which are usually superimposed on the pyroelectric (PE) voltage response to radiation signals have an incubation time, i.e., they start after the beginning of the PE response.[2] During the incubation time (40-60 nsec in our samples) the PE response is not disturbed.

Thus, PE detectors for short laser pulses can be designed with minimum piezoelectric interference.[2,4]

3.) We have developed a method of measuring the PE coefficient under the poling voltage in the presence of non-pyroelectric currents, by applying short pulses of heating or cooling.[6] The method can be important for monitoring the stage of poling in the production of pyroelectric detectors.

4.) We have found that the poling currents in PLZT samples[1] are partially caused by injection of free charge, and are space-charge limited.[6,7] We have also considered the contribution to the poling currents of polaron formation and motion.[7]

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C. LIST OF PARTICIPATING SCIENTIFIC PERSONNEL

1. Dr. Michael Bass, Principal Investigator, 1977-1980.
2. Dr. Menahem Simhony, Senior Investigator, 1977-1980.
3. Dr. E.W. Van Stryland, Measurements with Mode-Locked TEA CO_2 Laser, May-August 1978.
4. Dr. E.M. Tenescu, Measurement of Poling Currents, Feb. 1978-Jan. 1979.
5. Benjamin Levy, Blackbody Responsivity Measurements in PLZT Samples After Using Different Poling Procedures, April-September 1978/ (Part of M.Sc. thesis work in Applied Physics; degree granted by the Hebrew University, Jerusalem).

D. LIST OF PUBLICATIONS

Submitted and Published Under this ARO Project

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2. Piezoelectric Oscillations in PLZT Pyroelectric Detectors in Response to Short CO_2 Laser Pulses, M. Simhony, and M. Bass, Appl. Phys. Letters 34 (1979) 426-427.
3. Peculiarities in the Electrical Conductivity and Pyroelectric Behavior of Thin Samples of PLZT 8/65/35, M. Simhony, E.M. Tenescu and M. Bass, Ferroelectrics 28 (1980) 391.
4. Delayed onset of piezoelectric oscillations in PLZT Pyroelectric Detectors, M. Simhony, Ferroelectrics 28 (1980) 373-376.
5. Measurement of the Pyroelectric Coefficient and Permittivity on Rhododendron and Encephalartos Leaves and on the Insect Periplaneta Americana, M. Simhony and H. Athenstaedt, Biophys. J. 29 (1980) 331-338.
6. Measurement of the Pyroelectric Coefficient from Poling Currents in Thin PLZT Samples Under Possible Injection of Free Charge, M. Simhony, Ferroelectrics __ (1980).
7. Measurement of Electric Charge, Current and Pyroelectric Coefficient in Thin PLZT Samples under Poling, M. Simhony, submitted to Ferroelectrics.