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PHOTO-INDUCED CHANGE OF TRANSPARENCY IN PLZT CERAMICS

Wataru Endo, Junji Inui and Kentaro Hirata
Fujitsu Laboratories, Ltd.
1015 Kamikodanaka, Nakahara, Kawasaki

Introduction: The electrically controlled light scattering in Lead-Lanthanum-Zirconate-Titanate (PLZT) ceramics, which is applicable to image storage and display devices, optical shutter arrays, etc., was reported by C.E. Land et. al.(1) Recently, F. Micheron reported the photoferroelectric memory effect and its application to the optical information processing.(2) This paper presents a new phenomenon observed when light was irradiated to the ferroelectric PLZT ceramics during the electric poling. This phenomenon has a capability of improving the optical efficiency as well as the contrast of image storage and display devices or the optical shutter arrays.

Experiment and Result: The samples investigated were 0.3mm thick plates of 7/65/35 (La/Zr/Ti) PLZT ceramics with the transparent electrodes on the major surfaces. The ceramics were irradiated using Ar laser (λ =4880Å, 0.1W/mm^2) with the electric field for poling. Then the transmittance was measured as a function of the applied field using He-Ne laser. The aperture angle of detector was approximately 1°. The resultant transparency was increased by the irradiation as shown in fig.-1. The electric field and temperature dependences of the dielectric constant (ε) were investigated to explain this phenomenon connecting to the domain rotation. Fig.-2 and fig.-3 show that the light irradiation caused the change in the dielectric constant. This light irradiation effect could be preserved at the room temperature for long time after the light irradiation, and then was found to be erased by heating at 200°C for 30 minutes.

Discussion: The light scattering effect is distinctly observed in the coarse grained PLZT ceramics. In the plate of ferroelectric PLZT ceramics poled normal to the major surfaces, an incident light is multiply scattered as it is transmitted, and the intensity of scattered light depends on the ferroelectric polarization state. This effect has been explained as a result of the multiple-reflection and refraction caused by the discontinuity of the refractive index in the 90° (71° or 109° in rhombohedral phase) domain boundary.(3) The change in dielectric constant with the electric field has been explained as related to 180°-reversal and 90°-rotation of the domain.(4)

The local field is generated within PLZT ceramics due to the photo-electrons which are excited by light irradiation, which resulting in the increase and the decrease of the 90°-rotation causes the difference of ε in plus and minus electric fields as shown in fig.-2. The peak of ε at about 100°C was shown in fig.-3, which corresponds to the disapperance of domains. It is noticed that the peak value of ε in the irradiated specimen was higher than that of specimen with no irradiation, on the other hand applying the electric field of the opposite direction after the light irradiation the peak value became small. This fact means that the rotating-back of 90° domain is much in the irradiated specimen and less in the non-irradiated specimen.

From these results, it seems that the 90°-rotation is prompted and the number of domain boundaries are decreased while plus directional electric field is applied. Therefore the light scattering is reduced and the transparency is consequently improved as shown in fig.-1.

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2) F. Micheron; Proc. 5th conf. Solid State Devices, 146 (1973)

3) A.L. Dalisa and R.J. Seymour; Proc. IEEE, 61, 981 (1973)

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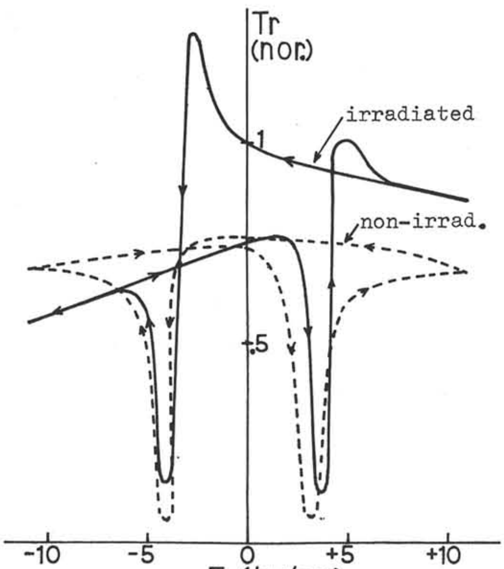

Fig-1 Normalized transmittance vs. electric field.

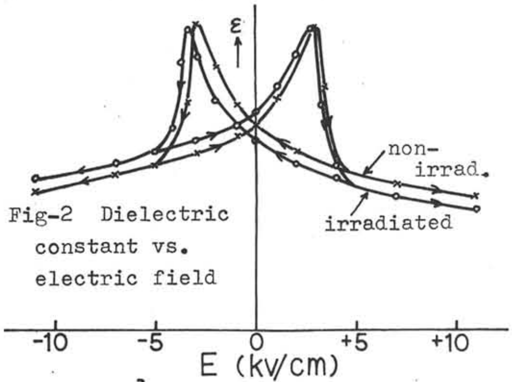

Fig-2 Dielectric constant vs. electric field

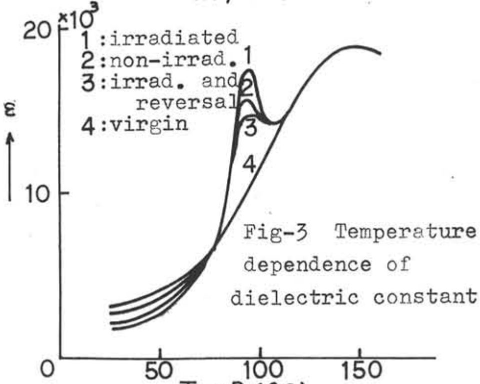

Fig-3 Temperature dependence of dielectric constant