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Light Valve Array Utilizing Ferroelectric SBN Single Crystal

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An array of electrically addressed light valves is an important component of an optical memory, which referred to as a page composer or a pattern generator, and also expected for usual graphic display. Ferroelectrics and related materials, such as nematic liquid crystals, are attractive candidates for this application. Some ferroelectrics with useful electro-optic properties, such as ceramic lead zirconate titanate, single crystal bismuth titanate and gadolinium molibdate have been enthusiastically investigated.[1] The change in birefringence of these ferroelectrics is nonlinear to the applied field and has a memory action.

Smolensky et al. investigated dielectric and electro-optic properties of $Pb(Mg_{1/3}Nb_{2/3})O_3$ (PMN). They showed that this ferroelectrics has a diffuse phase transition and consists of microscopic regions (Känzig region), each of which has a slightly different Curie temperature. They also observed that dependence of the induced birefringence on the electric field strength in PMN crystal shows hysteresis characteristics in the transverse mode of operation in the temperature range from -48°C to -160°C.[3]

Glass reported that dielectric properties of $Sr_xBa_{1-x}Nb_2O_6$ (SBN/x) are similar to that of PMN.[2]

In our recent experiment, the change in birefringence of electro-optic crystal SBN/ 75 has been found to be nonlinear and to show hysteresis characteristics in the longitudinal mode of operation at room temperature. The purpose of this report is to discuss the possibilities of building the page composer out of ferroelectric SBN single crystal.

We have earlier demonstrated that the longitudinal mode of operation is possible for an oblique-cut plate of SBN crystal, which has a large angular aperture and can modulate white-light efficiently.[4] In stead of the poled crystal used in the previous experiment, the unpoled samples which were once heated about to 100°C and cooled without a bias field were measured. Just like hysteresis characteristics of the induced retardation by DC field as that observed in PMN were found as shown in Fig.1 . The quadratic dependence of the induced retardation in the low field region corresponds to the poling process of the sample. Common ferroelectric switching

operation, 180° domain switching, which reverses the internal polarization, leaves a uniaxial crystal optically unaltered. The cause of difference between the birefringence of the single domain state and that of the multi-domain state is not evident.

Fig.2 shows the polarization hysteresis (upper trace) and the light intensity through the sample between crossed polarizers vs. switching voltage hysteresis at 60 Hz and 100 V measured at the same time (lower trace). This hysteresis characteristics allows us to construct the array of coincidentally matrix addressed light valve out of the oblique-cut ferroelectric SBN single crystal. An example of the array is shown in Fig.3. The switching speed and the fatigue problem will be discussed.

1) Ferroelectrics, 1972 vol.3

2) A.M. Glass, J. Appl. Phys. 40, (1969) 4699

3) G. A. Smolensky, J. Phys. Soc. Japan 28 Suppl. (1970) 26

4) T. Yazaki , K.Kanatani and S. Sakamoto
Suppl. to Japan. J. Appl. Phys. 40 , (1970) 177-185

Fig.1

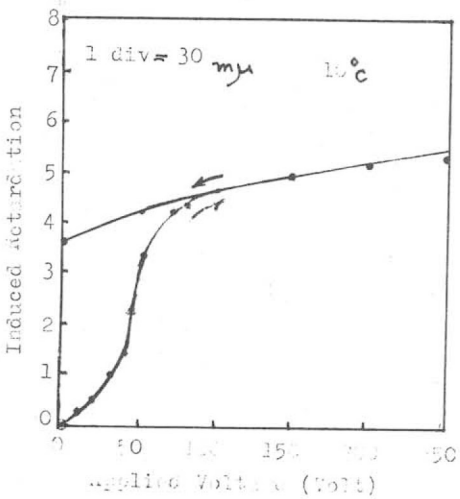

Fig.3

Array with transparent electrodes of width 150 μm on 300 μm centers

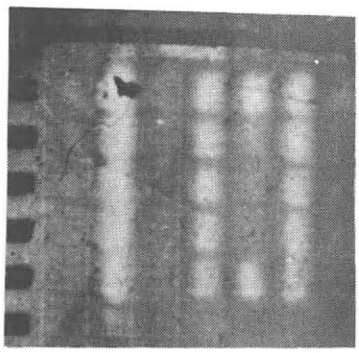

Fig.2