7-2 A New Voltage-Tunable Light Deflector by Use of Off-Axis Acoustic Domain in CdS Crystals

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Introduction For possible use of hologram memories and so on, need for acousto-optic light deflector is increasing. Especially, an electrically controllable deflector having a large deflection angle is required. To realize such a deflector, a high power and frequency tunable oscillator, and a high efficiency ultrasonic transducer at high frequencies are necessary. Moreover, in order to control the deflection angle, acoustic frequency and the beam incident angle must be controlled at the same time. This has been accomplished by the phased array method[1). This method, however, needs many transducers and structures become much complicated. We have studied the CdS-acoustic domain which consists of high power and high frequency acoustic waves, and found that, in the case of C//E[2)], the off-axis angle of the domain and the frequency of maximum intensity changes at the same time with the applied electric field. Using these phenomena, we propose a voltage-tunable pulse light deflector having a very simple structure, and present preliminary experimental results.

Principle of the Deflector When an electric field is applied parallel to the C-axis of a CdS single crystal, off-axis acoustoelectric domain is generated[2)]. When the observation point is fixed, as shown in Fig.1, the frequency f observed by the usual Brillouin scattering method decreases with the increase of applied electric field. This is consistent with the well-known frequency down conversion[3)] along the domain propagation. As well-known, the incident angle θ_i which satisfies the Bragg's condition[4)] should be changed according to the change of the acoustic frequency, that is, according to the change of applied electric field as shown in Fig.2. On the other hand, the off-axis angle θ of acoustic domain increases with the increase of the electric field (Fig.2). Figure 2 shows that θ and θ_i are in good agreement. This agreement enables us to make a novel voltage-tunable acoustooptic light deflector. The Bragg's condition is satisfied even if the applied electric field is changed, as schematically shown in Fig.3. It means that

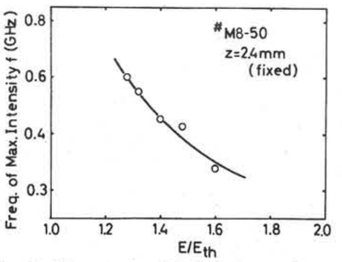

Fig.1 Electric field dependence of the frequency of maximum intensity in the acoustic domain.

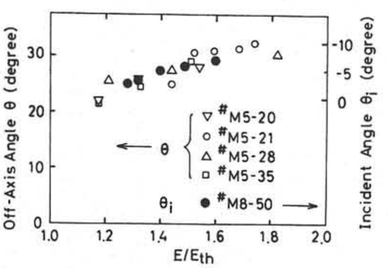

Fig.2 Electric field dependence of θ and θ_i which satisfies the Bragg's condition for f in Fig.1.

without any change of the incident beam position z and without any change of the beam incident angle Θ_i to the sample, the deflection angle Θ_s changes with the applied electric field.

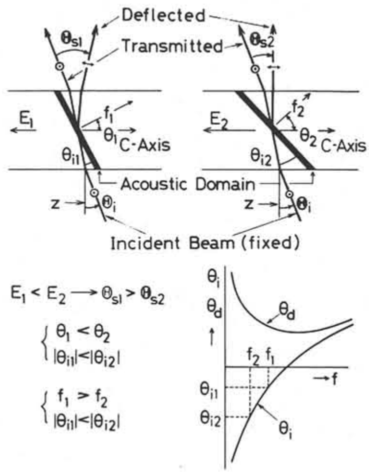

Fig.3 Schematic presentation of the voltage-tunable acousto-optic light deflector.

Experimental method Experiments were performed by applying electric field parallel to the C-axis of a crystal with 9.7Ω·cm resistivity. Sample dimension is 3×2×0.5mm^3. Electrodes of samples were made so as to let the shape-controlled domain[5] propagate. Samples were put near the center of a cylindrical glycerine bath to avoid the expected total reflection. Samples in the glycerine showed little change in the current oscillation waveform. A He-Ne laser (λ=6328Å) was used as a light source. The beam was fixed to the sample throughout the experiments.

Experimental Results Figure 4 shows an example of the electric field dependence of deflection pattern. The pattern changes markedly with the applied electric field. The deflection angle Θ_s of maximum intensity changes with the electric field from 5.5° (E/E_{th}=1.19) to 3.75°(E/E_{th}=1.44). This tendency agrees with the expected tendency in Fig.3. The deflected intensity is about 10^{-3}– 10^{-2} times the incident intensity. When the beam position is shifted toward the cathode, a larger deflection angle will be obtained. The spread of the deflection pattern is due to the spreads of the propagation direction and frequency of phonons in the domain. To get a most sharp deflection pattern, it is necessary to generate a single frequency domain by, for example, frequency locking.

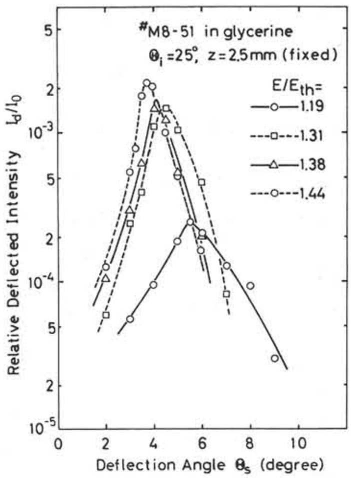

Fig.4 Electric field dependence of the deflection pattern.

Conclusion A voltage-tunable acoustooptic light deflector having a very simple structure was proposed and succeeded experimentally.

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