9-2 Digital Spatial Modulator Made of Gadolinium Molybdate Crystal

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An optical spatial modulator capable of composing 2-dimensional binary codes by electronic signals is expected for the high speed data composer in optical memory systems and for the matrix shutter device of information retrieval or identification systems.

This paper introduces a new model of the digital spatial modulator made of a ferroelectric and ferroelastic crystal of gadolinium molybdate ($Gd_2(MoO_4)_3$). The crystal offers the following merits in production of the digital spatial modulator.

1) The domain switching voltage can be controlled to have a clear threshold by an external process of the crystal plate.
2) The direction of the polarization of the switching region of the crystal plate can have bistable states.
3) The birefringence switching for the light waves follows the domain switching.
4) Such optical properties as transparency and homogeneity are perfect.
5) The service life is almost eternal.

An example of the grown crystal of $Gd_2(MoO_4)_3$ is shown in Fig. 1 and the important properties are listed in Table 1.

The principle of the construction of a model of the digital spatial modulator is shown schematically in Fig. 2. A crystal plate of the thickness of the half-wave plate is supplied by slicing the grown crystal perpendicularly to the c-axes. After the careful polishing the plate is processed to have a matrix of independent single domain cells. There is an insulating layer between the front surfaces of the nearest switching regions. This layer acts not only as an electrostatic insulator between the electrodes but also as a rigid surface that produces the stable multi-domain structure capable of separating the nearest domain cells. The

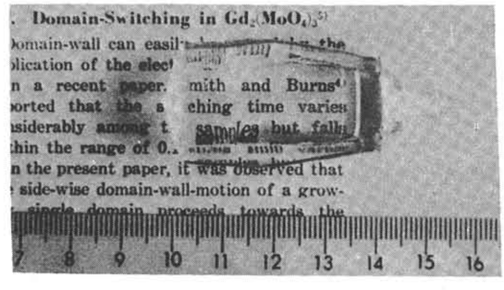

Fig. 1 A Grown Crystal of $Gd_2(moO_4)_3$

Table 1. Properties of $Gd_2(MoO_4)_3$

*Species	42mFmm2
*Curie Temperature	159 ℃
*Refractive Index	$n_a \doteqdot n_b = 1.843$ $n_c = 1.896$ $n_b - n_a = 4 \times 10^{-4}$
*Spontaneous Polarization	$P_s = 0.185 \mu C/cm^2$
*Spontaneous Strain	$X_s = 1.5 \times 10^{-3}$
*Threshold Field for Domain Motion	$E_c = 300 V/cm$

boundary domain-wall between the switching region and the multi-domain region acts as a starter for the domain switching. The threshold voltage of the domain switching can be obtained as the potential barrier for the side-wise motion of the domain-wall under the insulating layer. When the threshold voltages of the ensemble of the cells are controlled between the selecting voltage and the half-selecting voltage, it is possible to drive the switching regions as the light valve array by the matrix driven electronic signals. A fabricated model of the digital spatial modulator of 8 x 8 (=64) bits is shown in Fig. 3 and the typical switching characteristics of the cells are shown in Fig. 4.

As an example of the application, it is tried to make holographic memories by using the model of the digital spatial modulator with a double exposure holographic technology. The reconstructed information from the holographic memories are shown in Fig. 5.

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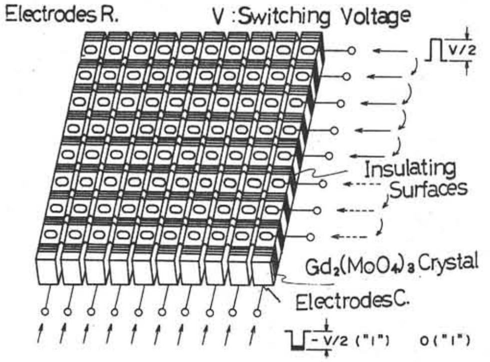

Fig. 2 Construction of Digital Spatial Modulator

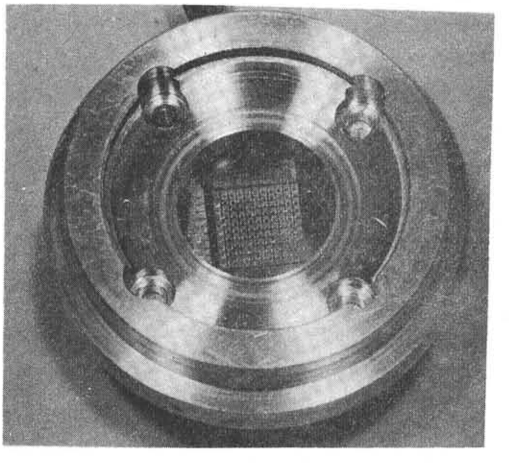

Fig. 3 A Cultivated Model of D.S.M.

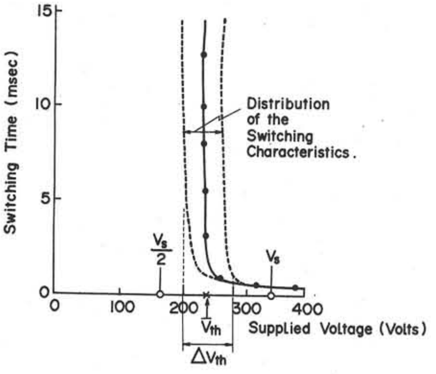

Fig. 4 Typical Switching Characteristics

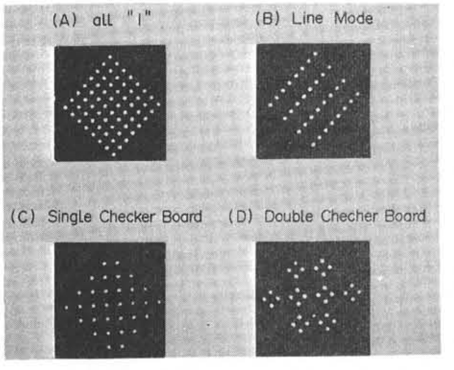

Fig. 5 Reconstructed Images from Holograms