An optical micro-magnetic device: magnetic-spatial light modulator

Mitsuteru INOUE[1,2&3], J. K. Cho[4], J. H. Park[1], H. Uchida[1] and K. Nishimura[1]
[1]Department of Electrical & Electronic Eng., Toyohashi University of Technology, Japan.
[2]Department of Electrical Eng., Stanford University, USA.
[3]CREST, Japan Science & Technology Corporation, Kawasaki, Japan.
[4]Department of Electronics Materials Eng., Gyeongsang National University, Korea.

A Spatial light modulator (SLM) is a real-time programmable device having the modulation function of the amplitude, phase or polarization of an optical wavefront as a function of position via electrical or optical control signals. Various types of reusable SLMs with two-dimensional pixel arrays are centrally important devices in volumetric recording, data processing, pattern recognition, optical computer and other optical systems. The magnetooptic spatial light modulators (MOSLMs) have the advantages of high switching speed, robustness, nonvolatility, and radioactive resistance. The high switching speed in MOSLMs results from the fact that the pixel switching of magnetization direction, up or down, can be performed within the order of 1 ns. The MOSLM, which is a robust solid state device, is also nonvolatility because the pixels are not spontaneously demagnetized even after shutting off the electric power.

The first commercialized MOSLM was the Litton iron garnet H (magnetically) triggered magnetooptical device (LIGHT-MOD) developed by Ross et al. at Litton Co. two decades ago. The advanced version of the LIGHT-MOD, that is, the reflected mode MOSLM (R-MOSLM), was developed by Cho et al. a decade ago. The R-MOSLM took advantage of the nonreciprocity of the Faraday effect, used a thinner garnet film, and had a high resolution with narrower pixel gaps. However, they are no longer commercially available due to the thermal problem generated by driving current.

In this report, we show several actual methods to materialize the MOSLM in practical applications including new type drive line for low driving current, patterned assist permalloy film and application of magnetophotinic crystal. In particular, we mainly demonstrate new novel methods described as followed. One is a novel MOSLM driven by an electric field. The novel field-driven MOSLM can overcome the thermal problem of the conductor lines due to the voltage-addressed method by using the electrostrictive effect of PZT thin film, and provide high frame rate due to high speed of PZT thin film and high resolution due to simple conductor line structure. One is a flat-surface MOSLM without the physically isolated pixels and external bias coil. Flat-surface pixels on the novel MOSLM were produced by the combinatory use of the infrared local annealing effect and the stress. The pixel of the MOSLM was switched by over ten times smaller driving current than that of the conventional MOSLM. The novel MOSLM can provide higher resolution, simpler fabrication process, more compact systems and lower driving current than those of the conventional MOSLM. It is also possible to make the application for micro-displays like FLC-SLM and DMD.