Development of the readout system for waveguide multi-layer optical card*

GU Min-fen[1,2], LIANG Zhong-cheng[1], WANG Ren-zhou[2], DONG Xiang-mei[3], ZHANG Pei-ming[3], and CHEN Jia-bi[3]**

1. *College of Mathematics & Physics, Nanjing University of Posts & Telecommunications, Nanjing 210003, China*
2. *Jiangsu Key Lab. of Optoelectronic Technology, Nanjing Normal University, Nanjing 210097, China*
3. *College of Optics and Electronics Information Engineering, Shanghai University for Science and Technology, Shanghai 200093, China*

(Received 14 August 2007)

Waveguide multilayer optical card (WMOC) is a novel storage device of three-dimensional optical information. An advanced readout system fitting for the WMOC is introduced in this paper. The hardware mainly consists of the light source for reading, WMOC, motorized stages addressing unit, microscope imaging unit, CCD detecting unit and PC controlling & processing unit. The movement of the precision motorized stage is controlled by the computer through Visual Basic (VB) language in software. A control panel is also designed to get the layer address and the page address through which the position of the motorized stages can be changed. The WMOC readout system is easy to manage and the readout result is directly displayed on computer monitor.

CLC numbers: TP333 **Document code:** A **Article ID:** 1673-1905(2008)02-0150-3
DOI 10.1007/s11801-008-7091-x

Compared with the magcard and the IC card, the optical card is a new information storage device. It has many advantages such as large capacity, long storage life, magnetic field interference impregnability, etc. Combining together with the principles of waveguide multilayer optical memory (WMOM) and the optical card storage technology, waveguide multilayer optical card (WMOC) is born as a novel storage device of three-dimensional optical information to increase the storage capacity effectively[1-4]. The basic principles of a WMOC include recording data in the form of waveguide defects, reading data by collecting the scattered light from the defects and suppressing the crosstalk between layers by taking the benefit of the waveguide structure. Some experimental results of WMOM are reported in correlative references[5-8]. It is very important to develop a WMOC driver for the application purpose. This paper introduces a WMOC readout system developed by our group recently.

The structure frame of WMOC readout system is shown in Fig.1. It mainly consists of the light source for reading, WMOC, motorized-stage addressing unit, microscope imaging unit, CCD detecting unit and PC controlling & processing unit.

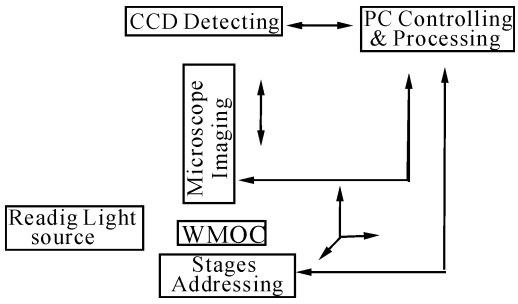

Fig.1 Frame of the readout system for WMOC.

In this system, we use a semiconductor laser (wavelength λ=650 nm, power P=10 mW) as the light source for reading. To save the interspaces, an adjustable reflector is put in front of the laser to change the light direction by 90° before the modified light is coupled into the WMOC. WMOC is fabricated with soft lithography method[9]. The process includes PC stamper making, information copying and multilayer bonding. A 10-layer WMOC sample is exhibited in Fig.2, which has a size of 25 mm×25 mm and 2.3 mm thickness and has an area density of 10×2 MB/cm^2.

Three-dimensional precision motorized stages (TSA30-C,Zolix) compose the stages for addressing unit. In order to carry out the layer addressing, reading light is immovable, and WMOC can be moved to choose the different layer in

* This work has been supported by National Natural Science Foundation of China (Grant No. 60377006) and the Optical Science and Technology Program of Science and Technology Committee of Shanghai (Grant No. 036105033).

** E-mail: zcliang@njupt.edu.cn

the vertical direction (*Z* way). In each layer, the data are read out with the parallel page readout method. This method is very helpful to improve the readout speed and the rate of signal to noise, which is different from that for the traditional readout system. To select the different pages and realize the page addressing, the numbers of row and column can be gotten through the control panel, and the location is changed by the movement of the motorized stages in the *X* way and the *Y* way from the page starting position.

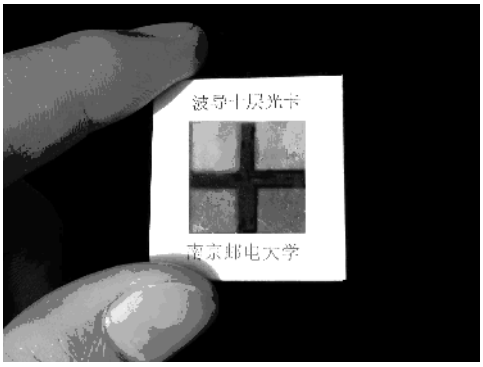

Fig.2 10-layer WMOC.

A refitted microscope is used as the imaging unit. It is fixed on the motorized stage and can be adjusted to focus better in the M direction. Because the parallel page readout method decreases the requirement of the detector response, CCD is very appropriate to reduce the difficulty and the costs. CCD (DH-HV2002UC-T,DAHENG IMAGE) is connected with the microscope imaging unit by a tailor-made port as the detecting unit. The collected information is sent to the computer. Computer is a hard-core in the system, which completes the tasks of the system controlling and information processing. The structure of the hardware is shown in Fig.3.

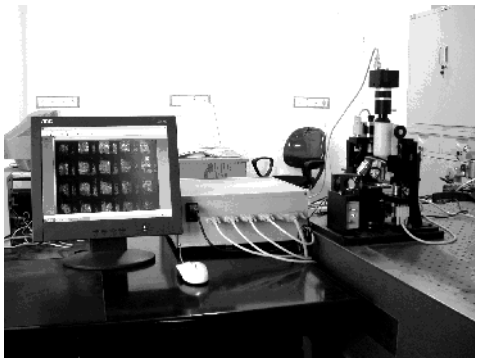

Fig.3 Hardware of the readout system.

Information is collected by CCD and is sent to a computer for display and process. In order to realize the layer addressing, the page addressing and the focusing adjustment, the movements of the motorized stages are controlled by the computer through Visual Basic (VB) language in software.

Fig.4 shows the flow chart of the control program and Fig.5 shows the simple control panel of the readout system for WMOC. Four option buttons named *X* way, *Y* way, *Z* way and *M* way are used in the panel. *X* way and *Y* way can decide the location of the page section start; *Z* way represents the layer number of the WMOC. *M* way is the movement direction of the microscope imaging unit. When we start the program, the PCI and the motorized stages are initialized at first. After the target address is put into the text frames, the command button whose caption is page collection can be pressed to move the motorized stage. According to the content shown in the computer monitor and its definition, the fine adjustment in the selected direction can be carried out by moving the horizontal scroll bar. When the continue collection button is pressed, the system will move from page to page according to the enacted rules in the software.

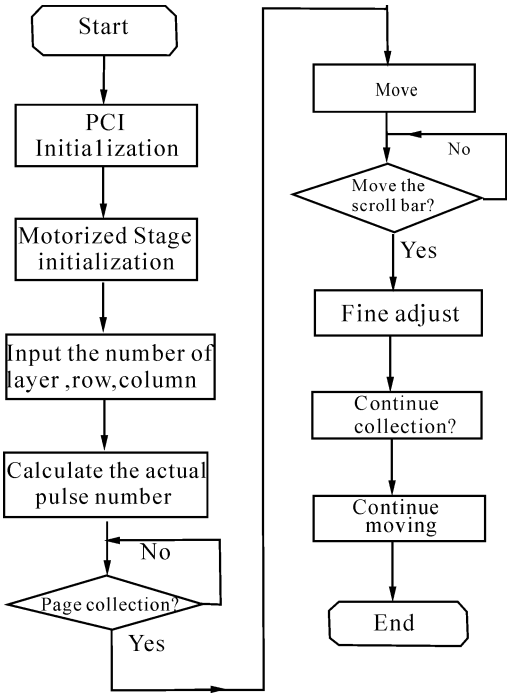

Fig.4 Flow chart of the control program.

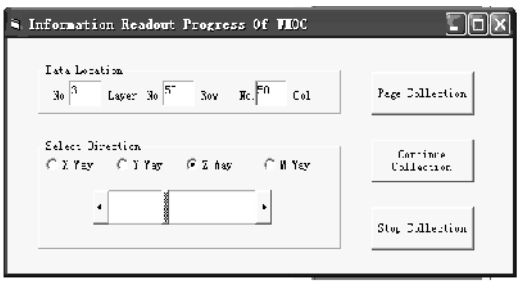

Fig.5 Control panel designed with VB.

In our research, we develop a readout system fit for the

WMOC. The hardware mainly consists of the light source for reading, WMOC, motorized-stage addressing unit, microscope imaging unit, CCD detecting unit and PC controlling & processing unit. The software includes the control panel and the program designed with VB. All the functions are debugged and accomplished. The system control precision is about 0.2 μm and the maximal moving speed of motorized stage is 10 mm/sec. The system can satisfy the basic requirement of the information readout for WMOC.

References

[1] Liang Zhongcheng,Yang Tao, and Ming Hai, Proc. SPIE, **4930** (2002), 134.

[2] Liang Zhongcheng, Tan Xilin, Yang Tao, Chin. Patent 02138418.5, Nanjing Normal University, 2002.

[3] Liang Zhongcheng, Xie Yong, "Optical waveguide multilayer data memory and double-beam recording, reading methods." Chin. Patent 02138417.7, Nanjing Normal University, 2002.

[4] Liang Zhongcheng, Chen Jiasheng, Yang Tao, Xie Yong, Chen Jiabi, and Zhuang Songlin, Jouranal of Optoelectronics.laser, **15** (2004), 315.(in Chinese).

[5] Yang Tao, Liang Zhongcheng, and Cai XiangBao, Chinese Journal of Lasers: **33** (2006), 1168.(in Chinese).

[6] Yang Tao, Liang Zhongcheng, and Qin Weiping, Optical Engineering, **45** (2006), 095201.

[7] Liang Zhongcheng, Ding Dongyan, and Xie Haiyan, Proc. SPIE, **6028** (2005), 60281N .

[8] Xie Haiyan, Liang Zhong-cheng, and Chen Jiabi, Proc. SPIE, **6027** (2006), 60274R.

[9] Gu Minfen, Liang Zhongcheng, and Ding Dongyan, et al., Jouranal of Optoelectronics.laser, **18**（2007）,164.(in Chinese)