This article was downloaded by: [University of California, San Diego]
On: 20 August 2012, At: 22:02
Publisher: Taylor & Francis
Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK

Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gmcl19

New Modification of Goggles with Spatial Modulation of Blinding Objects

M. G. Tomilin [a], A. P. Onokhov [a] & N. T. Firsov [a]

[a] S. I. Vavilov State Optical Institute, St. Petersburg, Russia

Version of record first published: 04 Oct 2006

To cite this article: M. G. Tomilin, A. P. Onokhov & N. T. Firsov (1997): New Modification of Goggles with Spatial Modulation of Blinding Objects, Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals, 301:1, 255-259

To link to this article: http://dx.doi.org/10.1080/10587259708041775

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: http://www.tandfonline.com/page/terms-and-conditions

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae, and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand, or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

Mol. Cryst. Liq. Cryst., 1997, Vol. 301, pp. 255–259
Reprints available directly from the publisher
Photocopying permitted by license only

© 1997 OPA (Overseas Publishers Association)
Amsterdam B.V. Published in The Netherlands
under license by Gordon and Breach Science Publishers
Printed in India

NEW MODIFICATION OF GOGGLES WITH SPATIAL MODULATION OF BLINDING OBJECTS

M.G.TOMILIN, A.P.ONOKHOV, N.T.FIRSOV
S.I.Vavilov State Optical Institute, St.Petersburg, Russia

Abstract A new modification of precision safety goggles with improved parameters, compact optical scheme and lower cost, based on a single LC optically-addressed spatial light modulator and the field of their applications are discussed.

Downloaded by [University of California, San Diego] at 22:02 20 August 2012

INTRODUCTION

For many types of observational optical instruments (telescopes, binoculars, sighting devices etc.) and recording systems (tele- ,photo- ,cine- and videocameras), the protection of observer's eyes or photodetectors from blinding sources or high-intensity radiation is still an important problem. Particularly vital is the protection from sudden high-intensity radiation pulses which can lead to irreversible consequences. In human practice these problems arise in the process of welding, driving, handling the air-crafts and space-crafts or preventing the observer's eyes from laser radiation.

Initially different static radiation attenuators were used as elements of the safety goggles. The color or neutral and polarizing filters attenuated the brightness of an observed image over the entire field of view, whether the blinding objects were presented or not. At a low illumination level those filters may impair the contrast transfer and comfort of observation.

The dynamic attenuators that superseded the static ones, are activated from a threshold device adjusted to a certain illumination level. The photochrome glasses, optical ferroelectric ceramics or liquid crystal (LC) thin films are commonly used in dynamic modulators. The application of these materials causes certain problems since the photochrome glasses show low response and the ferroelectric ceramics require high-voltage power supply. As a result the LC devices performing modulation over the entire

field of view with a relatively fast response and low-voltage power supply became the main trend in development of dynamic attenuators. Such attanuators, based commonly on twist-effect in nematic, were used in several modifications of helmet goggles for welding, such as Hurnell Speedglasses, Optrell solarmatic glasses, Tesla modulator etc. All the above attenuators perform modulation over the entire field of view, where as in many cases the necessity arises to attenuate only the radiation from blinding objects, however retaining the possibility of observing other objects. To this effect the safety goggles with local modulation of blinding objects were developed in S.I.Vavilov State Optical Institute for the first time.

BASIC OPTICAL SYSTEM WITH LOCAL LIGHT MODULATION

The design principle of optical system with local light modulation is based on the use of optically addressed spatial light modulator (SLM), placed in the intermediate image plane and operating in the transmission or reflection modes [1-3]. The SLMs based on photoconductor-LC structure are distinguished by the small size, ease of manufacture and high sensitivity [4].

The basic optical system with local light modulation is binocular telescopic with $1^{\times}$ magnification direct image system consisting of objective lens 1, pentaprism 2, collective lens 3, SLM 4, rectangular prism 5 and eyepiece 6 (Figure 1). SLM 4 is essentially a sandwich-like structure comprising of the ZnSe layer adjacent to the LC layer deposited on the glass plate, which operates in the transmission mode. Therefore, the photoconductor based on polycrystalline or monocrystalline ZnSe, having the maximum transmission in the visible range is used. The SLM employs the twist-effect in the modulation medium of the nematic LC-1282, developed at the Research Institute of Optical Intermediates and Dyes. The 5mm thick LC layer was oriented by means of oblique deposition of CeO_2. The SLM is placed in the focal plane of objective lens, whereby the observed object's image is projected on it. When the voltage is applied to the electrodes in the absence of the optical signal, the voltage drop occurs basically across the photoconductor and the LC molecules retain the initial state of orientation. Under the illumination of the photoconductor, with the voltage applied to the electrodes, the voltage

Downloaded by [University of California, San Diego] at 22:02 20 August 2012

drop is redistributed between the ZnSe layer and the adjacent LC layer, resulting in the local reorientation of the LC molecules and, hence, the local light transmission decrease.

By the proper choice of the control voltage the SLM is adjusted to a certain threshold illumination produced by blinding objects in the image plane, beyond which the local light modulation is performed in the peaks of light relief, other unexposed areas remaining transparent. It should be emphasized that with SLM placed in the intermediate image plane of optical system, the local modulation is performed automatically, wherever the blinding source is located in the field of view of the observational device.

NEW MODIFICATION OF SAFETY GOGGLES WITH SPATIAL MODULATION

The first prototype of safety goggles was produced and studied [3]. The results corroborated the efficiency of the design principle of the optical system with local light modulation. At the same time, tests revealed two shortcomings of the goggles. First, the cost of the goggles with binocular optical scheme, consisting of two SLMs, exceeded the permissible price of a commercial device. For example, the price of one SLM produced by Meadowlark Optics (Boulder,Colorado) in 1995 was 9500 $ US. In addition, the technological spread of SLM's parameters could not garantee equal protection for right and left eye in response and contrast. Second, the twist-effect in NLC could not provide necessary response, thus resulting in stray effects: observer's blinding at the first moment of light flash and blurring after-effect of the moving blinding object image.

In a new modification of safety goggles we took steps to avoid these disadvantages. First of all, the new optical scheme with a single SLM based on ferroelectric Sm* was developed (Figure 2). It comprises of objective lens 1, mirror system 2, lens turning system 3, lens 4 and eyepiece 5. SLM 6 operating from both optical channels, is placed at the focal plane of objective 1 between polarizing films 7. Such modification of optical scheme exclude the use of pentaprisms and facilitates reduction the system overall dimensions.

To obtain necessary response the ferroelectric Sm* materiales were used instead of NLC. The comparative performance characteristics of the SLM different ZnSe layers and types of LC are given in Table [5]. The use of Sm* improves the response by order of

Downloaded by [University of California, San Diego] at 22:02 20 August 2012

magnitude. High performance parameters permit the use of SLM for local spatial modulation in different optical instruments and recording systems.

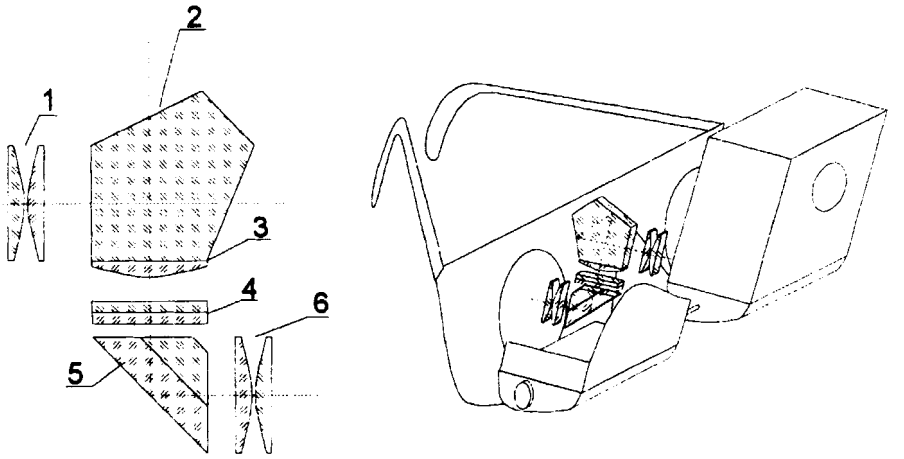

FIGURE 1 The basic binocular optical scheme of safaty goggles with local light modulation: 1-objective lens, 2-pentaprism, 3-collective lens, 4-SLM, 5-prism, 6-eyepiece

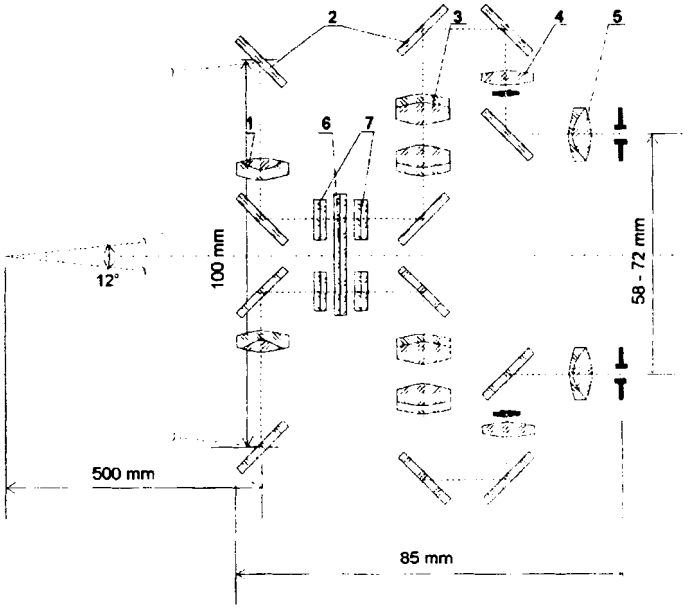

Figure 2 Modification of optical scheme with a single SLM, operating in transmissim mode: 1-objective lens, 2-mirror system, 3-lens turning system, 4-lens, 5-eyepiece, 6-SLM based on Sm*, 7-polarizing films.

Downloaded by [University of California, San Diego] at 22:02 20 August 2012

TABLE The state-of-art photoactive SLM performance

Parameter	Monocrystalline ZnSe	Polycrystalline ZnSe	Polycrystalline ZnSe
Type of LC	NLC	NLC	Sm*
λ write (nm)	530	530	white
λ read (nm)	633 (white)	633 (white)	white
Sensitivity (threshold) W/cm2	1.10^{-7}	1.10^{-6}	1.10^{-6}
Diffraction efficiency η max (%)	10	10	-
Resolution at η =0,5 η max (mm-1)	40	45	40
Resolution at η =0,1 η max (mm-1)	>100	150	>100
Switch -on time (ms)	10	20	2
Switch-off time (ms)	20	100-500	20
Contrast ratio	100:1	100:1	100:1
Operation mode	S-effect	S-effect	DGH
Power supply mode	Sin	dc	meander
Aperture, mm	35	35	35

CONCLUSION

A new modification of the LC goggles with local spatial modulation and with improved parameters, compact optical scheme and lower cost, based on the singe transmissive SLM, is discussed. The application of new LC materials, photosensitive layers, modern technology and optimized optical scheme opens the possibility not only to produce precise safety goggles with local spatial modulation as a new commercial product, but also to develop new trend for wide family of observational and recording optical systems.

REFERENCES

1. L.N.Itseleva, D.Yu.Polushkin, D.G.Sykharulidze,Yu.B.Stepanov and M.G.Tomilin Optico-Mekhanitcheskaya Promyschlennost, 1, 38 (1990), in Russian.
2. M.G.Tomilin, A.P.Onokhov and D.Yu.Polushkin, Book of Abstracts 4 International Topical Meeting on Optics of Liquid Crystals, Cocoa Beach, Florida, 85 (1991). Mol. Cryst. Liq. Cryst., 222, 119 (1992).
3. A.P.Onokhov, I.N.Tarnakin, M.G.Tomilin, Proceed.of Japan Display'92, 543 (1992).
4. A.A.Vasiliev, D.Casasent, I.N.Companetz, A.V.Parfirnov, Spatial Light Modulators, (Radio and Svyaz, Moscow, 1987), 320 p., in Russian.
5. N.L.Ivanova et al. Proceed. of Aerosense'96, Orlando

Downloaded by [University of California, San Diego] at 22:02 20 August 2012