Bragg Diffraction in Thin Two-Dimensional Gratings

Qiong He,[1,2,3] Isabelle Zaquine,[1] Gerald Roosen,[2] and Robert Frey[1,2], Lei Zhou[3]

[1]*Institut TELECOM/Télécom ParisTech, Laboratoire de Traitement et de Communication de l'Information, CNRS,*

46 rue Barrault, 75634 Paris cedex 13, France

[2]*Laboratoire Charles Fabry de l'Institut d'Optique, Institut d'Optique Graduate School,*

CNRS et Université Paris Sud, Centre Scientifique Paris Sud, Bât 503, 91403 Orsay cedex, France

[3]*Surface Physics Laboratory (State Key Laboratory) and Department of physics, Fudan University, Shanghai 200433, P.R China,*

Corresponding author: qionghe@fudan.edu.cn, Phone: 0086-21-55665229

Abstract: Highly improved diffraction properties are demonstrated theoretically and experimentally in a two-dimensional grating formed by a thin transmission grating recorded in a Bragg reflector at the band edge of the reflection grating.

Summary: The optical signal processing requires compact and effective device with a good selectivity. The solution suggested here consists of the association between a thin transmission grating and a reflection grating or a Bragg mirror, with triple advantage at the band-edge of the device to obtain diffraction efficiency strongly amplified, a wavelength selectivity largely improved and Bragg diffraction regime. This principle was implemented in a transmission grating recorded in a Bragg mirror deposited on another mirror of Bragg. A very simple model employing a generalized 4x4 transfer-matrix method (TMM) has been developed to describe the diffraction properties of the 2D photonic crystal [1]. The design was validated by the experimental achievement of a transmission grating recorded in a semiconductor Bragg mirror (CdMgTe/CdMnTe) deposited on another Bragg mirror. The experimental setup was shown in Fig.1. Figure 2 shows bother the read beam reflectivity spectra recorded at high write fluence and in the linear regime with no write beams [Fig. 2(a)] and the net diffraction efficiency spectra of this read beam for the -1 and +1 diffraction orders [Fig. 2(b)]. The experimental results are in good agreement with numerical calculations resulting from the analytical model [2]. The comparison with the equivalent transmission gratings recorded in a homogeneous medium demonstrated the huge improvement in the diffraction properties when the read beam wavelength and incidence correspond to the band edge of the reflection grating or the Bragg mirror and satisfy the transmission grating Bragg condition: a huge enhancement of the diffraction efficiency (a factor of 40), a largely improved wavelength selectivity (a factor of 7060), and a Bragg diffraction regime with only one diffraction beam counter-propagating the read beam with a total thickness of 2.44μm. These results are very encouraging for the applications of optical signal processing: diffraction efficiencies very close to 100% can be obtained as well as high wavelength selectivity and a Bragg diffraction regime, despite the very small thickness of the sample and the low index modulation of the transmission grating.

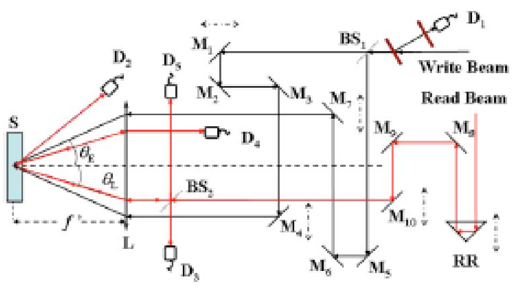

Fig. 1. Experimental setup

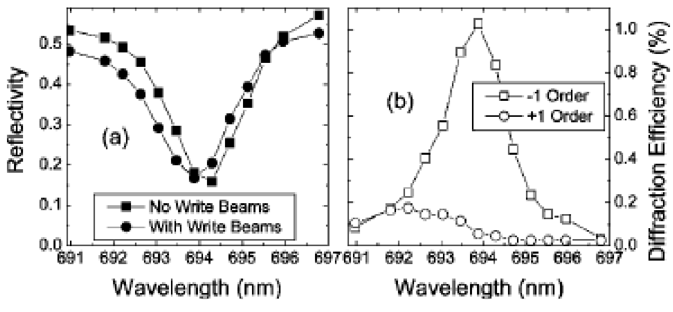

Fig.2. (a) Reflectivity and (b) diffraction efficiency spectra.

[1] Qiong He, et al, **J. Opt. Soc. Am. B. 26,** (2009) 390-396

[2] Qiong He, et al, **Opt. Letts. 33,** (2008) 2868-2870.