Photonic integrated spectrometer-on-chip based on digital planar holograms

G. Calafiore*, C. Peroz
aBeam Technologies, 5286 Dunnigan Ct., Castro Valley, CA 94546, USA

S. Dhuey, S. Sassolini, S. Cabrini
The Molecular Foundry, LBNL, Berkeley, CA-94702, USA

Alexander Koshelev, Alexander Goltsov, Pavel Sasorov, Vladimir Yankov
Nano-Optic Devices, 333 Bowers Avenue (Suite 190), Santa Clara, California 95054, USA

*e-mail: gc@abeamtech.com

Computer-generated planar holograms offer a powerful alternative to control and manipulate the light onto planar lightwave circuits. In particular, digital planar holograms (DPH) represent a unique approach to encode almost any specific optical transfer function manipulating the light in the spectral and spatial domain with high flexibility[1]. Holographic elements are made of digitalized gratings that separate the spectral components of an incoming light beam and reflect them to a variety of different focal points corresponding to output channels. We have recently reported the fabrication of miniaturized spectrometer on chip based on planar hologram working in 160 nm bandwidth, with 1084 channels, a spectral channel spacing of 0.015 nm[2] and working in multiple customized bandwidths[3].

We extend here these results and demonstrate for the first time the monolithic integration of DPH elements connected with a full optical circuitry (Fig. 1). The light propagates into ridge waveguides (RWG) and is efficiently separated and directed by a light splitter (directional coupler) to the input of each hologram. Each DPH works in one specific spectral bandwidth and the light is reflected to the output plane. Nano-spectrometers are fabricated by electron beam lithography for prototyping and can be mass-produced at low cost by nanoimprint lithography. This work defines the state of the art for spectrometer on chip and demonstrates the high potential of our approach for developing a novel class of ultra-compact and low cost spectrometer for numerous applications.

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[3] C. Peroz et al, Optics Letters, 37, 695 (2012).

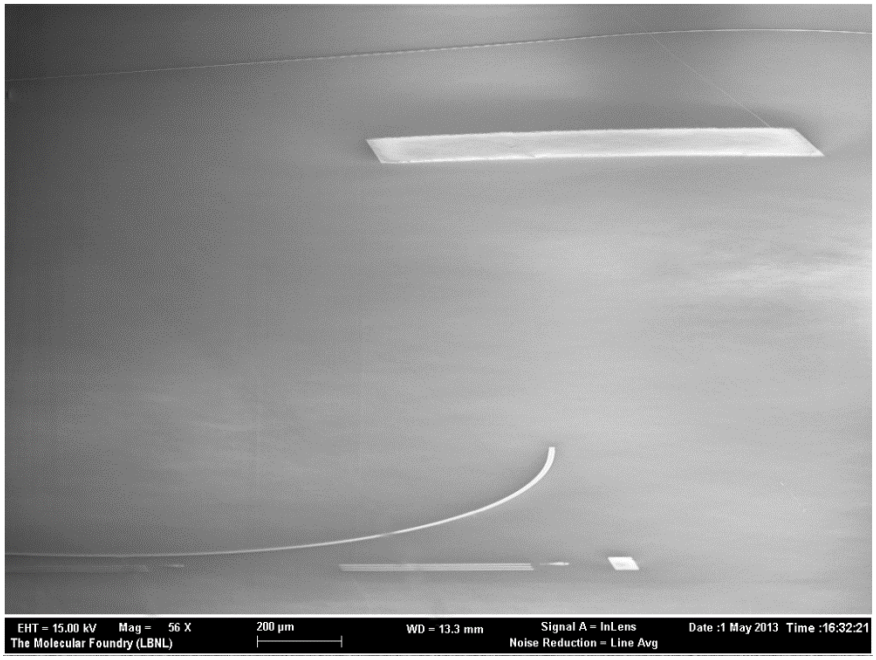

Fig. 1 – Scanning electron microscope view of the ridge waveguide etched through the entire substrate core, and the hologram (only 15 nm deep into the nitride).