Fabrication of High Resolution Optical Spectrometer-on-Chip

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Spectrometer-on-chip based on Digital Planar Holography (DPH)[1] is a new promising type of miniature optical device for spectral sensing. The spectrometer involves millions of lines specifically located and oriented in order to direct the output light into the designated focal points according to the wavelength. The first fabrication and testing of digital optical spectrometer-on-chip has been reported the last year.[2] In this paper, we present further improvements of this technology in order to achieve high spectral selectivity of spectrometer-on-chip.

The fabrication was done using electron beam lithography and dry etch. Spectrometers were made using silicon wafer with deposited thick SiO_2 cladding and SiO_2Ge^x core waveguide. 100 kV Gaussian beam electron beam lithography system was used for patterning. Inductively coupled plasma etching was used for pattern transfer into Ge-doped silicon dioxide film. The etch depth was in the range of 100 nm which had to be fabricated accurately without having a stop layer. An example of gratings in the planar waveguide is shown in Figure 1: The device is composed of etched grooves on the top of a planar waveguide's core. The etched linewidth was typically about 80 nm and the area of devices was several tens square millimeters.

The optical performance of fabricated DPH devices was measured. High spectral resolution of 0.03 nm in the visible range of spectra was confirmed experimentally, see Figure 2. It was found that the optical performance is in a good agreement with designed characteristics of these devices.

1. V. Yankov et al, IEEE Photonics Techn. Lett. 15 (2003) 410
2. S. Babin et al, J. Vac. Sci. Technol., B6 27 (2009) 3187

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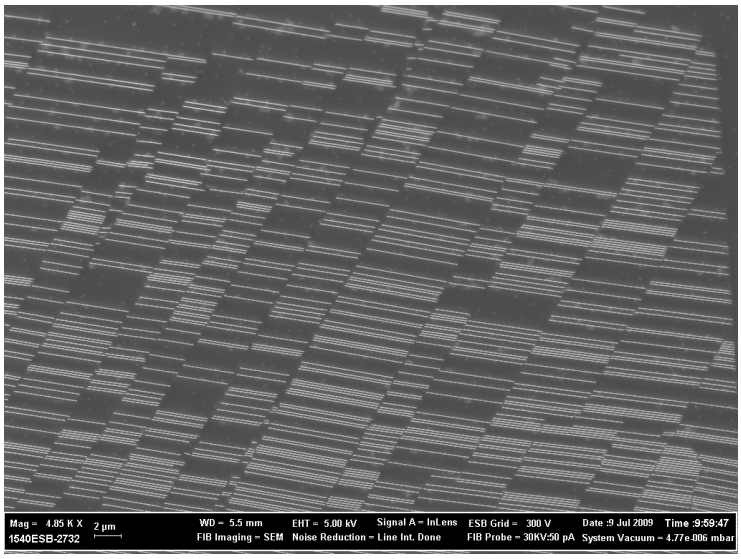

Figure 1. SEM image of a part of DPH spectrometer.

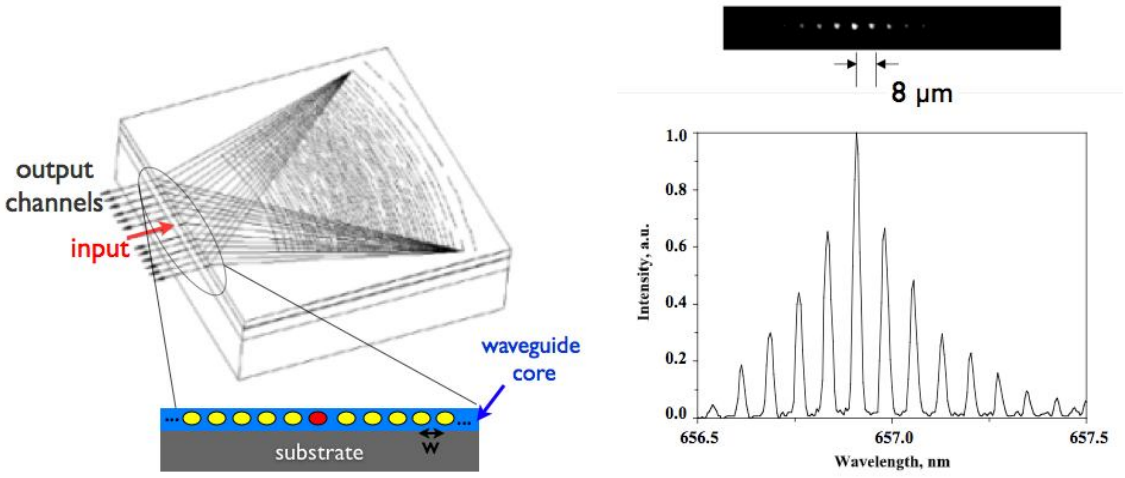

Figure 2: a) Schematic view of spectrometer-on-chip based on DPH gratings. b) Response of a 64-channel DPH spectrometer to a probe laser. The probe laser bandwidth is ~0.3 nm and the spectral width of channel is 0.03 nm. The distance between channels at the output is 8 μm.