Direct Printing of Planar Photonic Circuits with High Refractive Index

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The nanopatterning of high refractive index optical films promises the development of novel photonic nanodevices such as optical integrated circuits or imaging sensors. As a first step, we report here for the first time a printable photonic circuit fabricated by direct imprinting of inorganic films with high refractive index.

Hybrid organic/inorganic printable materials based on TiO2 sol-gels were developed for crack free films with high transparency. Printed nanophotonic devices with sub-10 nm resolution (Figure 1) were achieved in a single UV-imprinting step by applying low pressure (<3 bar) [1]. The imprinting was performed with flexible PDMS and hard Ormostamp templates. The patterned films were annealed to transform the hybrid material into inorganic TiO_2 with high refractive index. The optical properties of the printed nanostructures can be tuned over a wide range of values; a refractive index higher than 2.1 was achieved in the visible wavelength range. We will present and discuss the optical properties of the first printable planar optical circuits (Figure 2). The printed circuit is composed of curved multi-modes ridge waveguides (RWG), wavelength demultiplexers based on digital planar holograms (DPH) and directional light couplers.

Our technology opens an original route for fabricating novel printable photonic devices at low cost and high throughput.

References:

[1] C. Pina-Hernandez, V, Lacatena, G. Calafiore, S. Dhuey, S. Cabrini, C. Peroz, Nanotechnology 24 (2013) 065301.

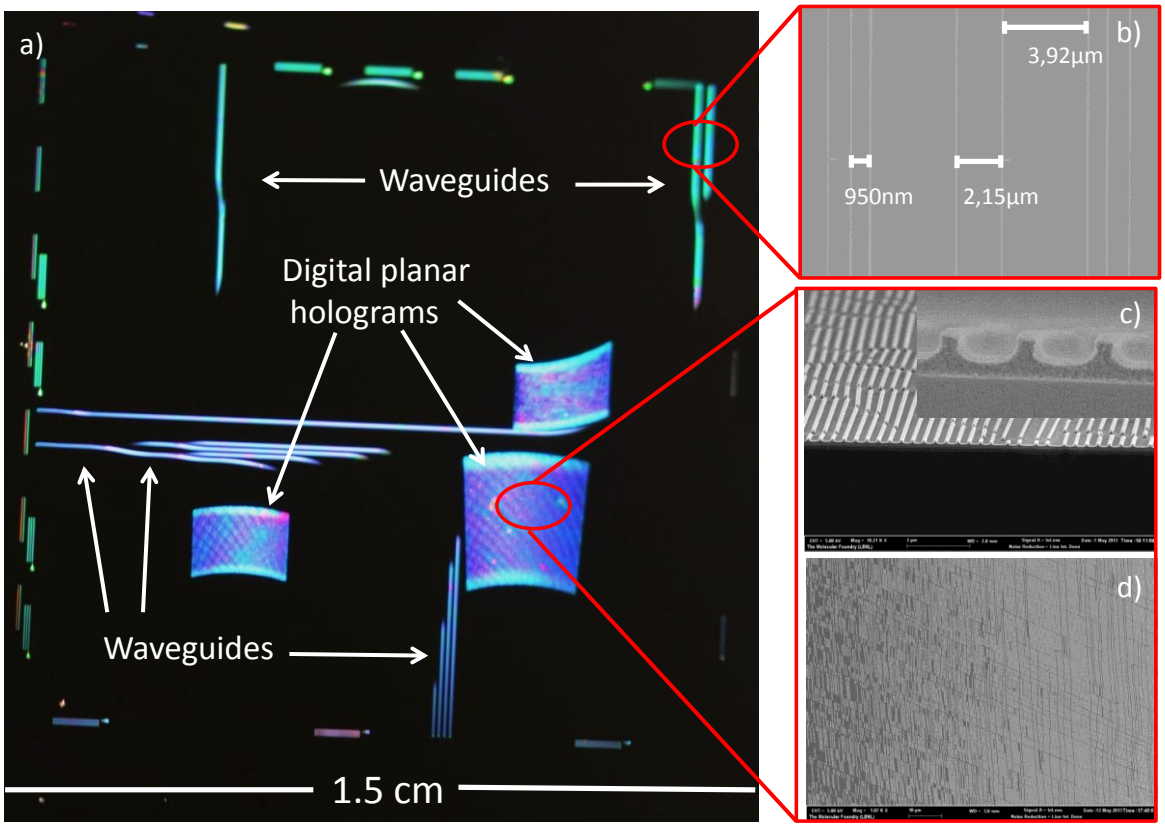

Figure 1. (a) Optical picture of printed photonic circuit; Scanning Electron Microscopy images taken from the printable integrated photonic chip, (b) top view of a waveguide, (c) cross-section and (d)top-view of a digital planar hologram.

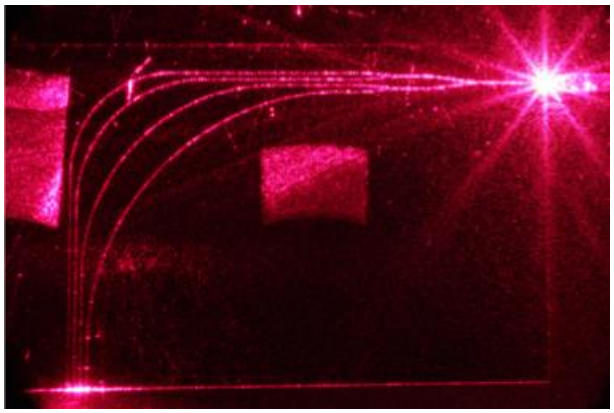

Figure 2. Top view of the 660 nm laser light propagating inside the printed chip.