How to Fabricate the World's Smallest Polarization Converter?

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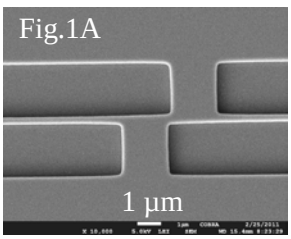
Recently, an ultra-short polarization converter in Indium phosphide membrane was proposed with excellent simulated performance. In this paper, we present experimental results showing that this device can be fabricated using high-resolution lithography and dry/wet-etch steps.

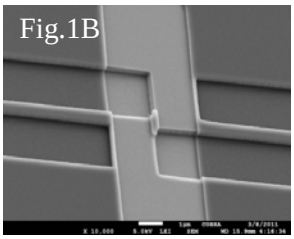
Introduction

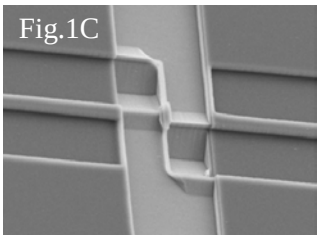
It is a secret for no one that Moore's law is heading toward hard times. Consumers want ever faster and smaller computers but the smaller you make electronic chips, the hotter they become… To prevent next generations' computers from melting after a few seconds usage, some of the electronic components need to be replaced by something less hot.
Light can transport signals while dissipating virtually no heat at all. Therefore, the IMOS (Indium phosphide Membrane on Silicon) platform, which promises integration of ultra-small active and passive photonic devices in a single layer [1], comes as a strong candidate to realize a photonic layer on top of computer chips, able to alleviate the IC industry heating problem.
To provide the IMOS platform with polarization handling capability, a polarization converter was recently designed [2], which could soon become the world's smallest.

Fabrication tests

The polarization converter is made of two oppositely-oriented triangular sections of about 2 µm length each (see Ref.[2] and Fig.1C). The fabrication tests realized to show the feasibility of the device are inspired by the process flow successfully applied in classical InP-based polarization converters.
The input and output waveguides are patterned along the (0$\underline{1}$1) crystallographic direction of an InP substrate by EBL lithography (Fig.1A). A 200-nm layer of Silicon nitride is deposited on top by PECVD and then dry-etched with a second EBL lithography (aligned with the previous one), keeping the sidewalls and a small protection rectangle in the middle of the device covered (Fig.1B). Finally, the sample is etched in a solution of $1HCl:4H_3PO_4$ for about 30 seconds to create the InP slopes (Fig.1C).







The tests showed successful fabrication of triangular waveguides with unprecedented small dimensions, both on pure InP and on the epitaxial layer-stack of a real device [2]. Presently, this technology is applied to realize this ultra-small polarization converter.

References

[1] J. van der Tol *et al.*, "Photonic Integration in Indium-Phosphide Membranes on Silicon (IMOS)," IET Optoelectronics, in press, October 2011.

[2] J. Pello *et al.*, "Design of a new ultra-small polarization converter in InGaAsP/InP membrane," in Proceedings of the ECIO 2010, (pp. WeB2-1/2), Cambridge, UK.