Fabrication of low loss LNOI-based ridge waveguides with Bragg gratings using fluorinated RIE

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In the past decade, the fabrication of $LiNbO_3$(LN)-based photonic integrated devices has caught the interest of many research group further to the emergence of LNOI substrates. Obtaining reproducible low losses waveguides is not a trivial point since LN is difficult to etch. Several methods have been implemented to achieve waveguides with reduced sidewall roughness [1]. Among these techniques, the use of ICP-RIE is often reported. The present study reports the fabrication of high-quality ridge waveguides together with Bragg gratings realized by the RIE technique.

More specifically, we report the fabrication of ridge waveguides along with Bragg-mirror from X-cut SAW grade 600nm thick LNOI by means of a RIE equipment (Corial 200-R tool) using a mix of Ar, SF_6, and O_2. The etching rate is close to 21 $nm.min^{-1}$. The full 600 nm thickness of the LN film have been etched to form rib waveguides. Afterwards, e-beam lithography has been performed directly on the ridges with the CSAR13 resist to obtain periodic patterns with a period of 400 nm, playing the role of the mask for the future Bragg mirrors. The result is depicted in Figure 1, where we observe the patterned resist on top, perfectly fitting the geometry of the 600 nm ridge waveguide. Then, the RIE process is performed to dig a targeted depth of 30 nm into the LN ridge to form Bragg gratings. The total grating length is 500µm. After the resist removal and an SC-1 cleaning step, the propagation losses have been determined to be less than 1$dB.cm^{-1}$ (TM) at 1.55 µm using the Fabry-Perot method. Eventually, the mirrors characterization reveals sharp responses with typical bandwidth of 3nm and with a high reflectivity exceeding 20dB as expected from simulations.

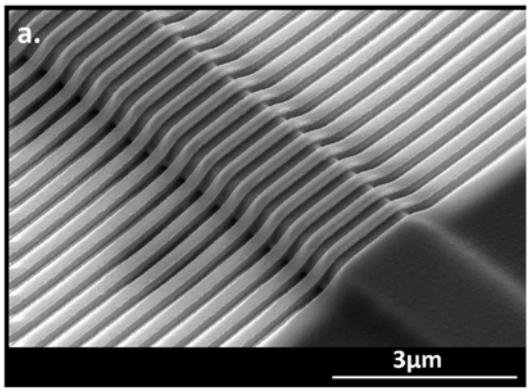

Figure 1 : SEM image of a LNOI Rib waveguide with a first order Bragg mirror at 1.55µm.

Références :

[1] Di Zhu, Linbo Shao, Mengjie Yu, Rebecca Cheng, Boris Desiatov, J. Xin, Yaowen Hu, Jeffrey Holzgrafe, Soumya Ghosh, Amirhassan Shams-Ansari, Eric Puma, Neil Sinclair, Christian Reimer, Mian Zhang, Marko Lončar, Integrated photonics on thin-film lithium niobate, Advances in Optics and Photonics, **Volume 13**, Page 254 (2021)

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