Versatile Bragg mirrors on lithium niobate nanowaveguides

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Biography: Théo Dutron is a Ph.D. student at FEMTO-ST institute in Besançon, France, studying emerging photonic passive components based on thin film lithium niobate (TFLN). His expertise includes photonic design, fabrication and characterization with a focus on filtering and coupling devices. In 2025, he received the Best Poster Award at the MIMENTO Day (MIMENTO is the cleanroom facility at FEMTO-ST institute) for his work on Bragg mirrors on TFLN nanowaveguides. Théo holds an M.Sc. in Physics and Materials Engineering, from the Institut National des Sciences Appliquées in Rennes, France, where he specialized in photonics.

Summary: This work reports the fabrication and characterization of Bragg gratings on thin-film lithium niobate (TFLN) nanowaveguides. Shallow-etched first-order Bragg gratings were realized using electron-beam lithography and Capacitively Coupled Plasma Reactive Ion Etching (CCP-RIE). Performances were assessed at telecom wavelengths for various grating and waveguide geometries for both TE and TM polarizations. Filter response exhibits extinction ratios below -30 dB and bandwidths below 10 nm. The proposed design demonstrates tolerance to etching imperfections and enables straightforward integration of Bragg gratings subsequent to waveguide fabrication. Additionally, Bragg-mirror-based cavities were implemented, achieving Q-factors above 10^5. These results validate a simple and robust approach for integrating Bragg mirrors into TFLN waveguides.

Keywords: Bragg mirror, Bragg grating cavity, thin film lithium niobate, lithium niobate

Abstract: Lithium niobate ($LiNbO_3$) is a key material for photonic devices due to its wide transparency window and remarkable electro-optic and nonlinear properties. The emergence of thin-film lithium niobate (TFLN), obtained through ion slicing, enables the fabrication of compact, high-performance devices compatible with large-scale integration [1]. In this context, the present work contributes to the growing field of integrated optical chips based on TFLN. More precisely, we introduce a fabrication-tolerant Bragg mirror design on TFLN nanowaveguides. This design has been experimentally validated for selective spectral filtering and high-quality-factor optical cavities applications.

Unlike conventional Bragg mirrors on TFLN, which rely on periodic waveguide width modulation, and demand precise anisotropic etching [2], our approach enables straightforward integration of Bragg grating after TFLN waveguide fabrication. The periodic structures were fabricated using electron-beam lithography and shallow etching via Capacitively Coupled Plasma Reactive Ion Etching (CCP-RIE) following ridge waveguide processing.

This architecture mitigates sensitivity to sidewall angle and roughness, achieving extinction ratios below –30 dB and bandwidths under 10 nm at telecom wavelengths. Moreover, the filter responses are found to be in good agreement with theory for various grating and waveguide geometries for both TE and TM polarizations, confirming accurate control of grating characteristics. We further present measurements of resonance in Bragg-mirror-based cavities, revealing Q-factors exceeding 10^5, validating the proposed device.

These results demonstrate a simple and robust method for integrating Bragg mirrors into TFLN nanowaveguides with tailored performance, paving the way for scalable wavelength filters and high-Q resonant cavities in integrated photonic chips.

[1] D. Zhu et al., Adv. Opt. Photon., June 2021.

[2] A. Prencipe et al., ACS Photonics, Oct. 2021.

Acknowledgement: This work is funded by the NanoFiLN project (Grant No. ANR-23-PEEL-0004), the EIPHI Graduate school (Contract No. ANR-17-EURE-0002), and the French RENATECH network through its FEMTO-ST technological facility MIMENTO.