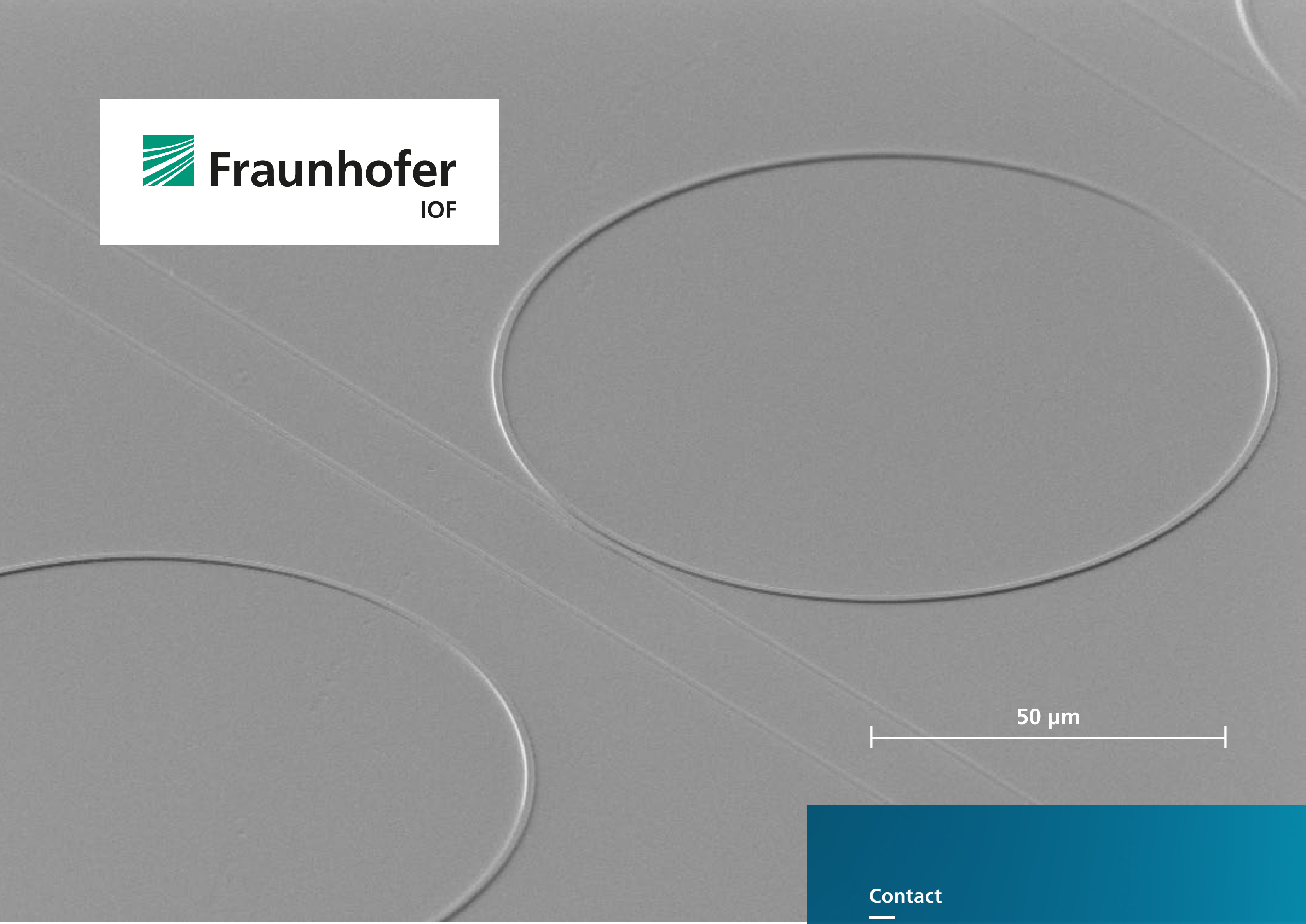

Top: Scanning-electron microscope image of micro-ring resonators with bus waveguides

Cover: LNOI multi-project wafer (MPW)

Outlook and Future Research – Quantum Technologies

Low-loss waveguides offer a promising platform for complex quantum photonic integrated devices.

Current research focuses on integrating active optical elements via wafer-scale erbium doping and domain engineering. Hybrid integration approaches, such as membrane transfer and chip-to-chip bonding between LNOI and SiN, are being pursued to combine the strengths of different material platforms.

How we can help further your projects

We invite you to collaborate with us in exploring how our LNOI platform can be seamlessly integrated into your project. We are looking forward to collaborating with you realizing your PIC projects as part of an upcoming MPW run.

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Lithium niobate integrated optics

Wafer-scale production of integrated optics based on lithium niobate on insulator (LNOI)

Modulator network for quantum optical applications made from thin film lithium niobate on insulator (LNOI) with fiber optical and electronic connectors

Lithium niobate integrated optics

Wafer-scale production of integrated optics based on lithium niobate on insulator (LNOI)

Lithium Niobate: Enabling integrated nonlinear optics

Discover the potential of lithium niobate (LN) in integrated nonlinear optics. With its exceptional properties, LN enables highly efficient optical signal processing and modulation.

Key features

- Enhanced nonlinear frequency conversion and parametric amplification.
- Broadband operation: Wide transparency range from UV to MIR.
- High electro-optic coefficient for modulation of intensity, phase, and polarization.
- Low optical losses: Minimal signal degradation, high transmission efficiency.
- Compact integration with waveguide structures and chip-scale platforms.
- Wafer-scale production capacity: Lithium niobate on insulator (LNOI) ideal platform for the realization of photonic integrated circuits (PIC) up to 8-inch diameter.

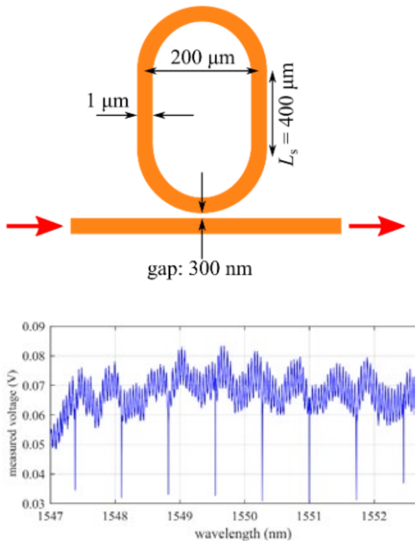
Waveguide fabrication for optimized losses

LNOI PIC devices are usually operated at near-infrared wavelengths. Typically, LNOI substrates with 600 nm LN layer with 2 µm silicon dioxide on a silicon carrier substrate are used. Waveguiding structures are partially etched into the LN layer to have a height of 400 nm and widths of approximately 1 µm depending on the specific application. The patterned LN layer is cladded by another 2 µm silicon dioxide.

Waveguide losses originate mostly from sidewall and surface roughness. To produce low-loss waveguides all fabrication processes must be adjusted:

- Electron beam lithography: high-yield variable shaped beam tool, multi-pass operation with chemically amplified resist.
- Dry etching processes optimized for reduced redepositions, smooth surfaces and steep sidewall angles.
- Post-processing: Additional cleaning processes for the redeposition removal must be used. Furthermore, internal losses related to process-induced modifications of the crystalline structure must be addressed by temperature annealing.

To continuously monitor device performance, especially waveguide losses, fabrication is aided by wafer-scale optical characterization. The characterization method accounts for different loss channels yielding losses for curved and straight waveguide sections. Typical results are 9.7 ± 5.1 dB/m (curved) and 0.37 ± 1.74 dB/m (straight).



Above: To verify process quality, transmission losses are measured through racetrack resonators.

Non-standard, LN-specific fabrication processes

Electric field poling was developed for X-cut thin-film lithium niobate, with poling periods ranging from 1–4 µm. By optimizing the poling process parameters, such as electric field strength and poling pulse duration, we achieved high-quality poling patterns with excellent homogeneity and consistency over large areas.

Components and devices on multi-project wafers

Our foundry services offer the following components on MPWs:

Waveguides: Low-loss LNOI waveguides, consistently below 5 dB/m.

Passive Devices: 1 × 2 and 2 × 2 Multimode Interference Couplers (MMI), X- and Y-Splitters, Ring- and Racetrack resonators.

Active Devices: Mach-Zehnder-Modulators, Microring-Resonators (MRR) as frequency comb sources, MRR and periodically poled waveguides for nonlinear frequency conversion and spontaneous parametric down conversion (SPDC).

LNOI Foundry

Wafer-scale fabrication available with monthly multi-project multi-project wafer (MPW) runs. Automated wafer-scale characterization. PDK development with experimentally verified components.