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Lithium-niobate-based Cavity Resonator-Integrated Guided-mode Resonance Filters

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Introduction

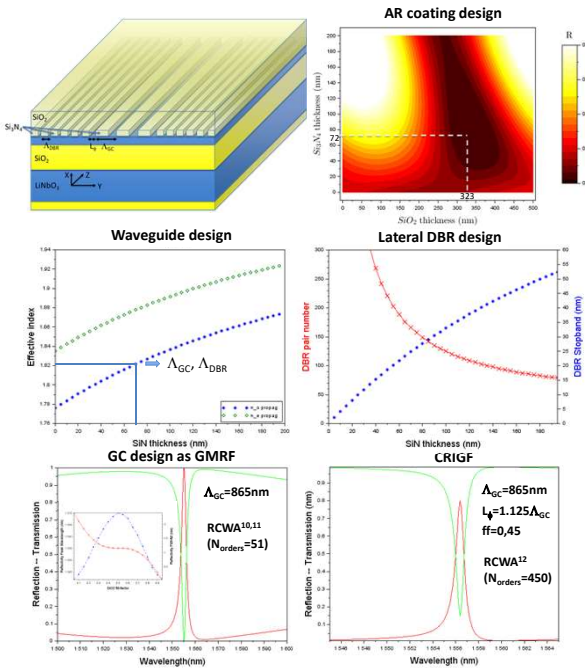
Context

- **Guide-Mode Resonance Filters (GMRFs - review paper ¹):**
 - Spectral filters with less complex layer structure than thin-films
 - Q up to 10^4
 - Angularly tunable response
 - Demonstrated enhancement of nonlinear interactions but with large beams ²⁻⁴
- **Cavity Resonator Integrated Guided-mode Resonance Filters (CRIGFs)**
 - CRIGF=GMRF section in a cavity ⁵
 - ✓ Spatial (mode) localisation (~1-100 μm)
 - ✓ Q up to 10^3
 - ✓ Wider angular acceptance than GMRF ⁶
 - ✗ Spectrally-fixed filters
 - ✓ Used as wavelength-stabilizing filters in extended-cavity diode lasers ⁷⁻⁹

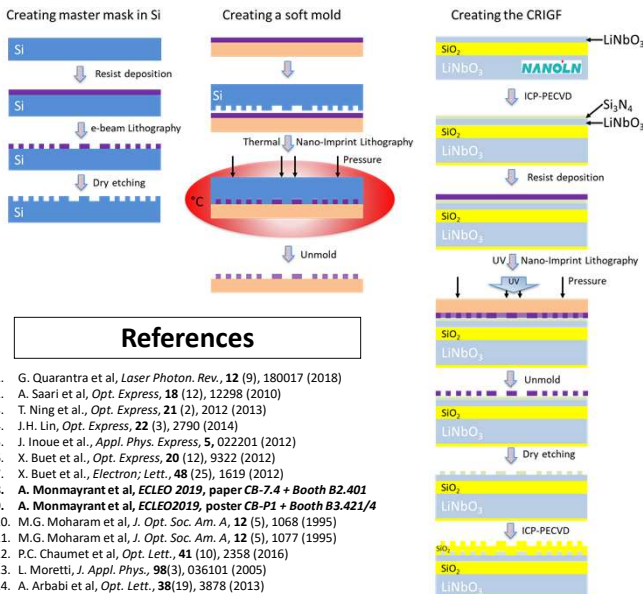
This work

- Fabrication of CRIGFs on a material platform compatible with nonlinear interactions
- Demonstration of tunability

Design



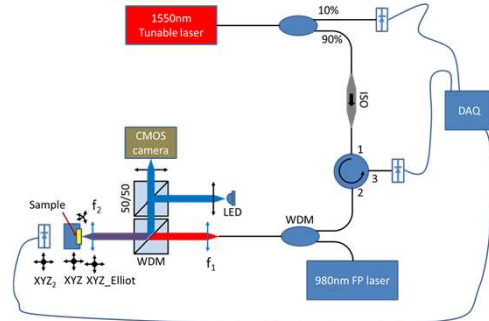
Fabrication



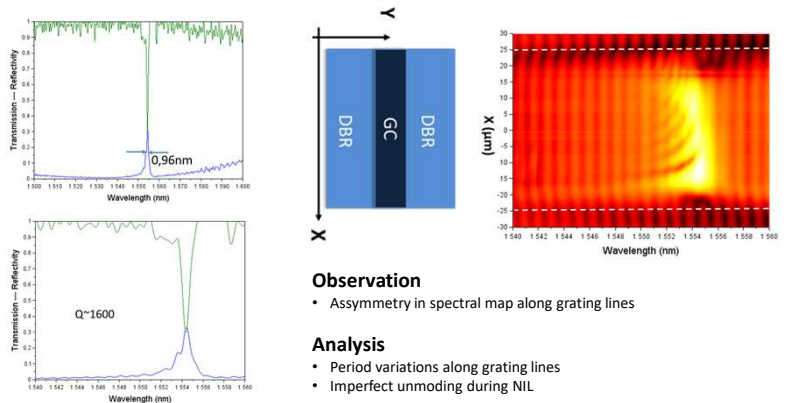
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Characterisation Setup



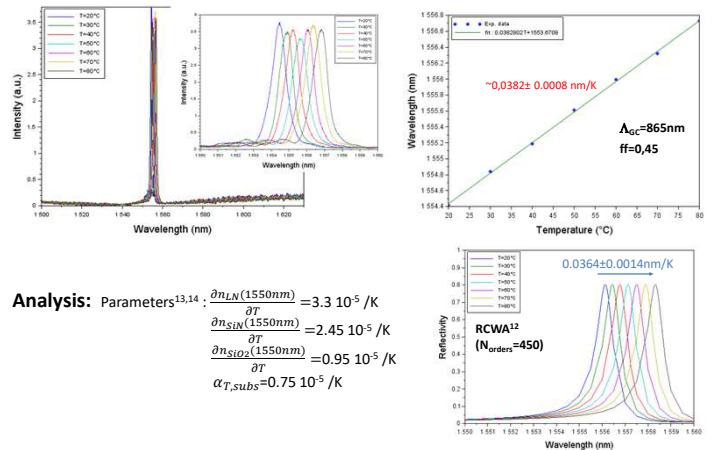
Spatially-resolved characterisation



Characteristics:

- $R_{max}=32\pm 2\%$.
- $Q\sim 1600$

Temperature tuning



Conclusions

- ✓ First demonstration of CRIGF on Lithium Niobate On Insulator (LNOI)
- ✓ Characteristics : $R_{max}=32\pm 2\%$ and $Q\sim 1600$ at 1554.5nm for $8.65\text{-}\mu\text{m}$ -wide grating-coupler structure
- ✗ Performance affected by NIL unmoding step
- ✓ Thermally tunable response over 1.2 nm with resonance shift rate of 0.038nm/K
- ✓ Tuning characteristics reproduced numerically using reported parameters

Future work

- Devices with integrated heaters / electro-optic tuning