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Arrayed waveguide gratings in lithium tantalate integrated photonics

Arrayed waveguide gratings (AWGs) are widely used as (de)multiplexers in wavelength-division multiplexed optical communication systems. Over the past decades, AWGs have been implemented in various photonic integrated platforms. Recently, interest has grown in integrating AWGs into ferroelectric material platforms, which simultaneously provide efficient electro-optic modulation and thus promise fully integrated WDM transmitters. Several demonstrations of AWGs on thin-film lithium niobate (TFLN) platforms have been reported [1,2], with X-cut TFLN noteworthy for its high Pockels coefficient. However, the large anisotropy of lithium niobate complicates AWG design and degrades performance. To overcome this limitation, we select thin-film lithium tantalate (TFLT) [3], which offers a similar Pockels coefficient to TFLN but with significantly reduced optical anisotropy (over a tenfold reduction in birefringence), as an alternative platform.

We designed and fabricated an 8-channel AWG comprising 13 arrayed waveguides with 100 GHz channel spacing on the TFLT platform [4]. Simulations were performed using both analytical methods [5] and finite-difference time-domain (FDTD) numerical modeling [6]. Fabrication was carried out on a 600 nm-thick X-cut lithium tantalate substrate using deep ultraviolet lithography at wafer scale, with ridge waveguides defined by etching 300 nm of the lithium tantalate layer. Fig 1a shows a microscope image and Fig 1b,c show the SEM images of the fabricated chip. The characterization results in Figure 1c reveal an average 3 dB bandwidth of 92 GHz per channel, adjacent-channel crosstalk around −14 dB, and a measured channel spacing of 116.4 GHz and insertion loss of 3.16 dB. Achieving the tight 100 GHz spacing requires high precision in waveguide dimensions, uniform effective refractive index, and accurate path-length differences among the arrayed waveguides.

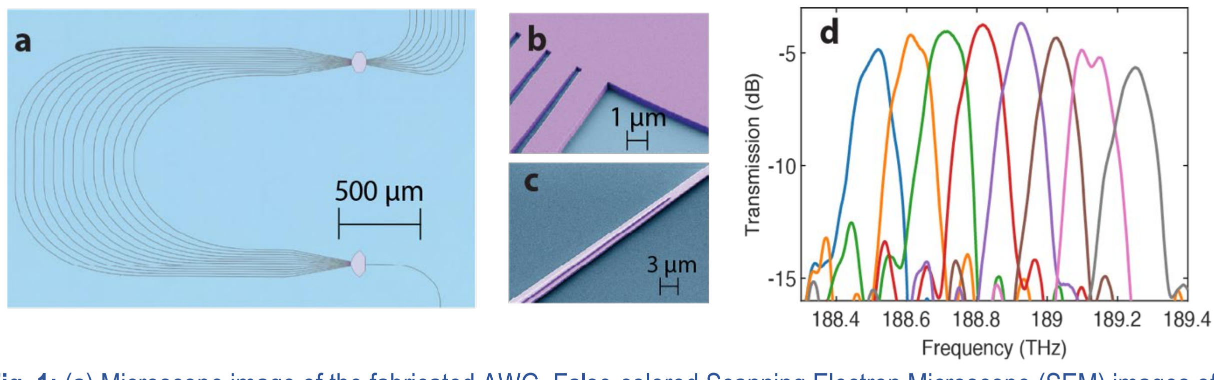

Fig. 1: (a) Microscope image of the fabricated AWG. False-colored Scanning Electron Microscope (SEM) images of the arrayed aperture spacing, (b) arrayed waveguide aperture (c) Double layered tapers. (d) Transmission spectrum of the 8-channel 100 GHz AWG.

References

1. Z. Wang et al., “On-Chip Arrayed Waveguide Grating Fabricated on Thin-Film Lithium Niobate,” Adv. Photonics Res. 5, 2300228 (2024).
2. J. Yi et al., “Anisotropy-free arrayed waveguide gratings on X-cut thin film lithium niobate platform of in-plane anisotropy,” Light. Sci. & Appl. 13, 147 (2024).
3. C. Wang et al., “Lithium tantalate photonic integrated circuits for volume manufacturing,” Nature 629, 784–790 (2024).
4. Hulyal SU et al., “Arrayed waveguide gratings on lithium tantalate integrated photonics”, arXiv preprint, https://doi.org/10.48550/arXiv.2504.12917 (2025)
5. M. Smit and C. Van Dam, “PHASAR-based WDM-devices: Principles, design and applications,” IEEE J. Sel. Top. Quantum Electron. 2, 236–250 (1996).
6. P. Munoz and J. Capmany, “Modeling and Design of Arrayed Waveguide Gratings,” J. Light. Technol. 20 (2002).