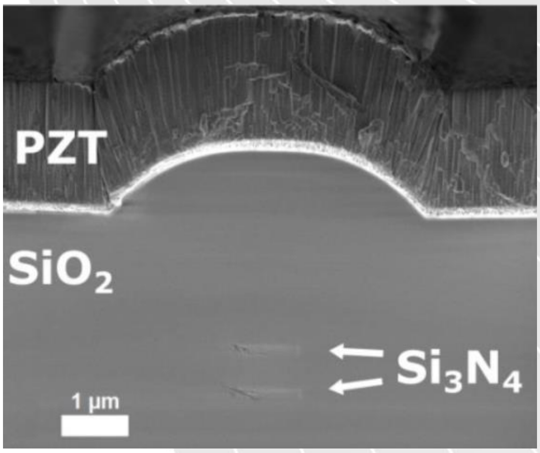
Low power, high speed actuation for SiN PICs.

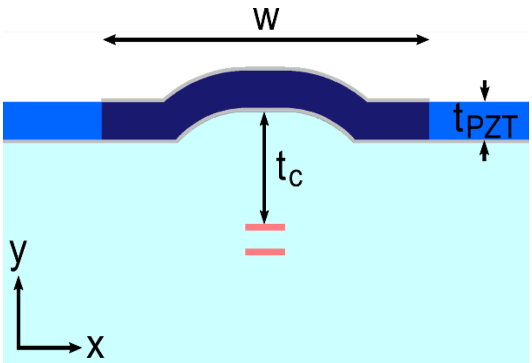
Introduction.

The big strength of Photonic Integrated Circuits (PICs) is that by, using validated basic building blocks, novel and complex systems can be created. One of the standard building blocks is the phase actuator that changes the phase of the light, depending on a control driver. By control and manipulation of the phase, other building blocks can be made that for example control the amplitude of the signal, or switch it between two channels.
For the TriPleX™ waveguide technology, a novel low power and high speed actuator has been developed using piezo-electric materials.



Stress-Optic actuation

For both visible light as well as near-infrared light, low power modulation is possible using stress-optic modulators. The stress-optic modulators are realized by harnessing the stress from an actuating piezoelectric material (lead zirconate titanate, PZT) on top of a standard silicon nitride-based TriPleX geometry. In the figure below a SEM picture of the standard double stripe TriPleX™ with the PZT material deposited on top.



The major advantage of our stress-optic modulators over thermo-optic modulators is their ultra-low power dissipation in a static state. The static power consumption is solely determined by tiny leakage currents through the piezoelectric layer resulting in a dissipated power in the µW-region.

The modulator is optimized as the PZT layer geometry employs a stress-focusing behaviour on top of the waveguide stack, and at the same time allows for a thinner top cladding to further increase the stress interaction at the waveguide core and as such keeping the excess loss per modulator minimal. Using a Mach-Zehnder interferometer, we measured a half-wave voltage, V_π, at 12 V at a wavelength of 1550 nm using a modulator with a total length of 15 mm.

Actuator	Tuning power	Tuning speed
Stress-optic	< 1 µW	< 1 MHz
Thermo-optic	250 mW	< 1 kHz

The actual footprint of stress-optic modulators is measured to be the same as conventionally used thermo-optic modulators. The increase in modulator length of stress-optic modulators goes in hand with a decrease of cross-talk to neighboring devices when compared with thermo-optic modulators due to the confined actuation of the PZT.

Conclusion

A stress-optic modulator building block is available now in the TriPleX™ waveguide platform. The modulator consumes less than 1 µW in the static case. This makes it an ideal actuator to realize sophisticated optical beamforming networks with 100s and even 1000s of modulators.

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