Thermo-optic reconfiguration is preferable to free-carrier-based methods since it does not induce any additional optical loss, which, considering the number of tunable elements, can be significant especially for higher-order filters. There are nine microheaters per unit cell and each of them has a power consumption of 20–30 mW per π phase shift. However, the required phase shifts are typically much smaller than π. Hence, the average total tuning power per unit cell is about 100 mW. As for the reconfiguration time, the step response of the microheaters has a rise time of about 4 μs. We can use a pre-emphasis driver to reduce this to less than 1 μs [22]. Both the speed and the power consumption of reconfiguration can be further improved by one order of magnitude through using novel resonator-based phase shifters implemented with miniaturized microdisks (e.g., 2 μm radius) [28].

We have observed a thermal crosstalk of up to 5% between the microheaters. The effect of crosstalk can be compensated by measuring the crosstalk coefficients and considering them in the reconfiguration algorithm, so that the applied current for each microheater is adjusted accordingly. The crosstalk can be considerably reduced by etching deep micro-trenches around the heaters in order to thermally isolate them [29].

6. Conclusion

We have demonstrated a fully reconfigurable fourth-order (i.e., four-pole, four-zero) filter on thin SOI with a large FSR (~650 GHz), high out-of-band rejection (>38 dB optical), tunable bandwidth (0.9–5 GHz), and compact size (total area 0.25 mm^2). Full reconfigurability is achieved by using a flexible unit-cell based architecture with full control over the placement of poles and zeros. Optimally-designed microheaters are used to achieve fast reconfiguration (~1 μs) with low power consumption (<100 mW per unit cell). A major factor in facilitating the demonstrated performance is the use of high-*Q* microdisk resonators to realize compact and low-loss delay lines (0.7 dB/cm). Small SWaP (size, weight and power) enables the use of such filter chips in several systems applications in RF photonics including channelizers and LIDAR systems.

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