

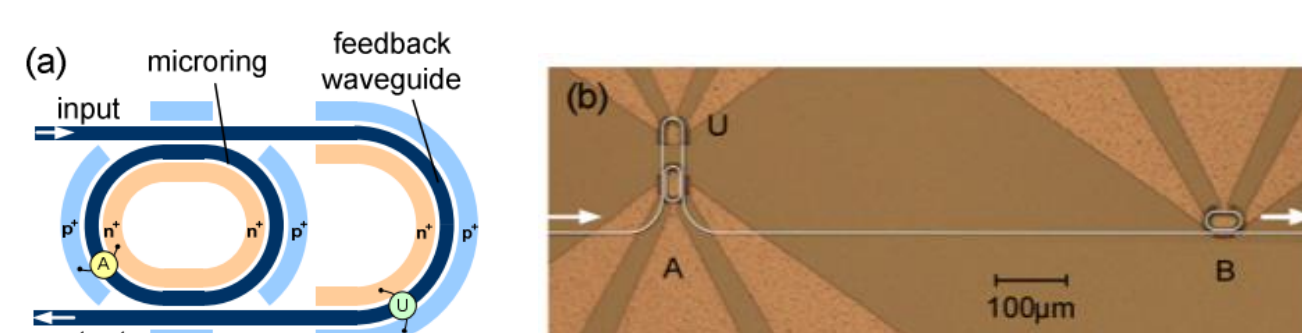
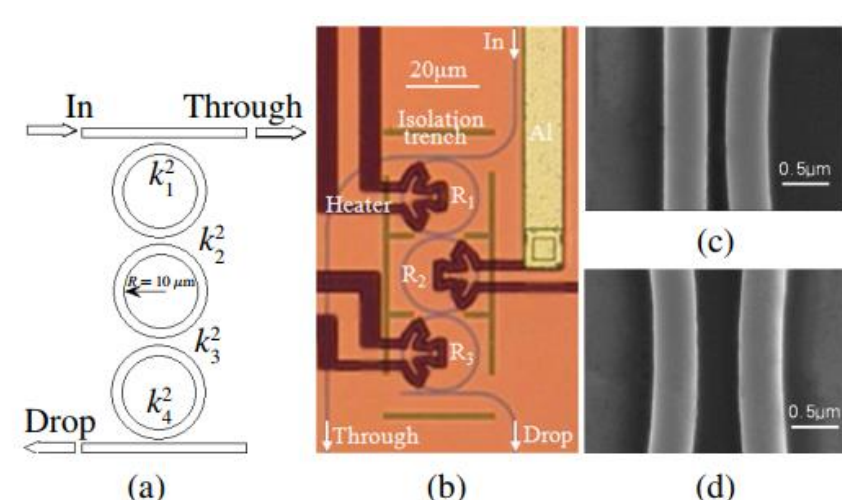
Resonant Frequency Drifting of the Mach-Zehnder Interferometer Coupler Assisted Reflective-Type Microring Resonator

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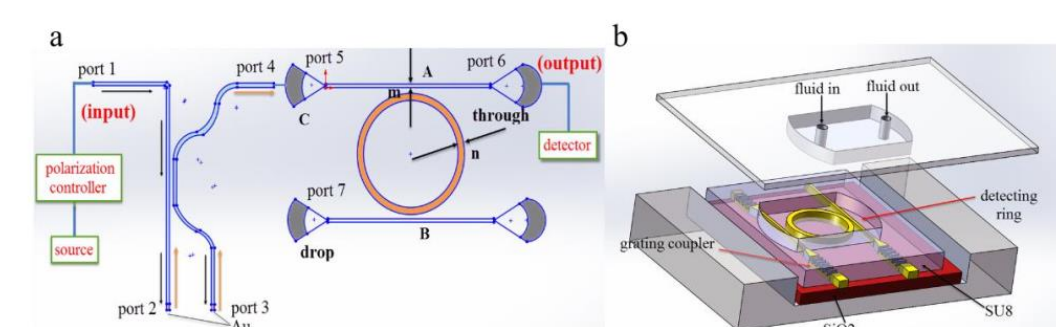
Abstract: We analyze the wavelength drifting of a Mach-Zehnder Interferometer coupler assisted reflective-type microring resonator (RT-MRR) based on the transmission matrix formalism. An experiment is carried out to validate our analysis. The results show that the resonant wavelength of the RT-MRR periodically drifts as a function of the control signal, which helps us to understand the wavelength drifting mechanism and to find solutions to avoid the wavelength drifting effect.

BACKGROUND

- **Microring resonator (MRR):** fundamental building block in photonic integrated circuit (PIC)



MRR-based thermally tunable filters



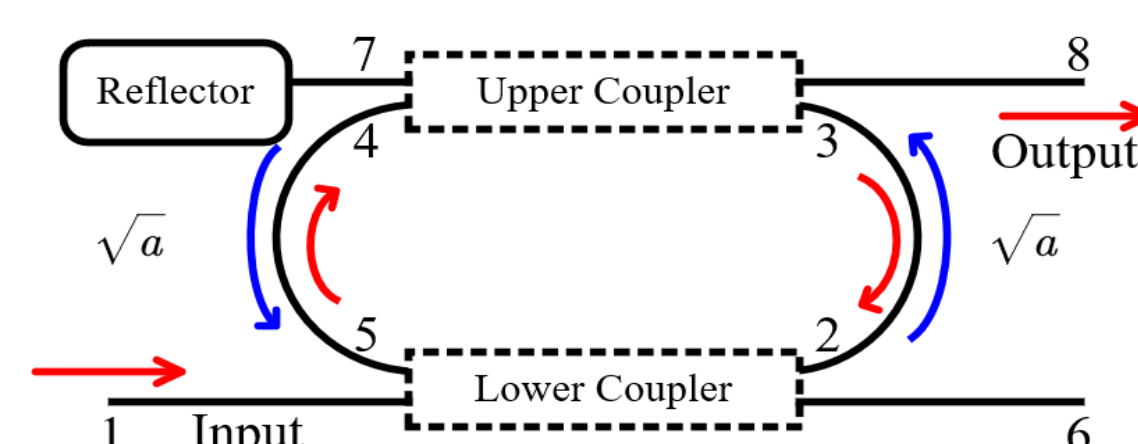
MRR-based biosensing

- **Challenge:** resonant wavelength of the MRR may drift because of some circumstantial disturbance, which may degrade the performance of the PIC based on MRR.

- Applications are usually resonant wavelength sensitive;
- MRR stimulates a Lorentzian magnitude limiting the feasibility of wideband applications

THEORY

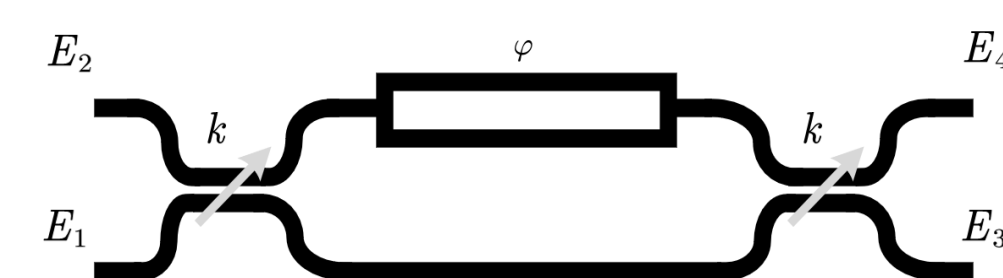
- **Reflective type microring resonator (RT-MRR)**



Model of the reflective type microring resonator

Light injected from the Input port will undergo both a clockwise and a counterclockwise procedures.

The response at the Output port will be a superposition of the two procedures and affected by both the Upper coupler and the Lower Coupler.



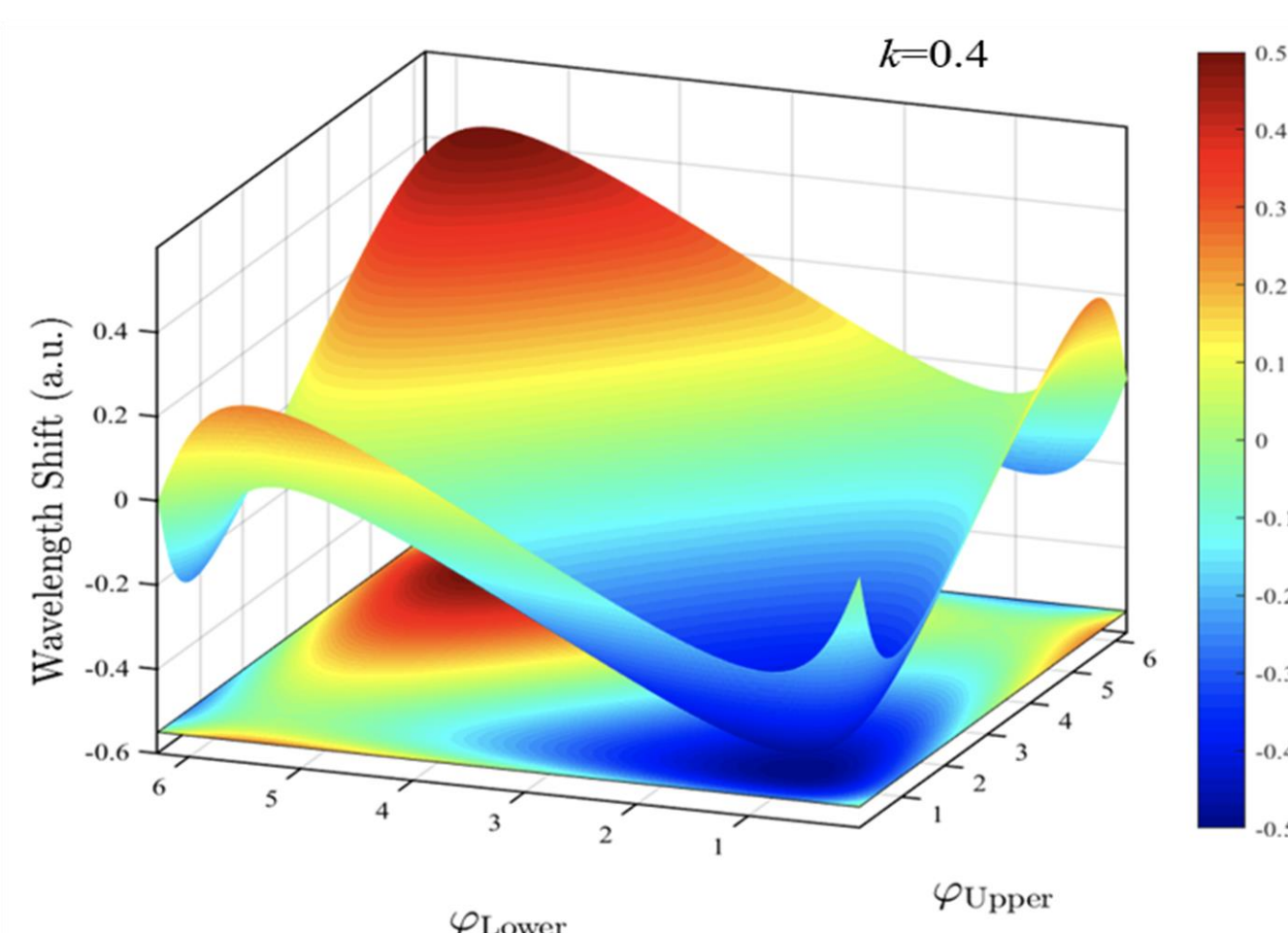
Schematic of a signal-arm phase-shift MZI coupler

- Mach-Zehnder interferometer coupler are widely used as the couplers to tune the coupling coefficients of the MRR.
- Labeled as the Upper Coupler and the Lower Coupler, two thermo-optical single-arm phase-shift MZI couplers are employed to adjust the coupling coefficients.

SIMULATION AND MEASUREMENT RESULTS

Simulation result:

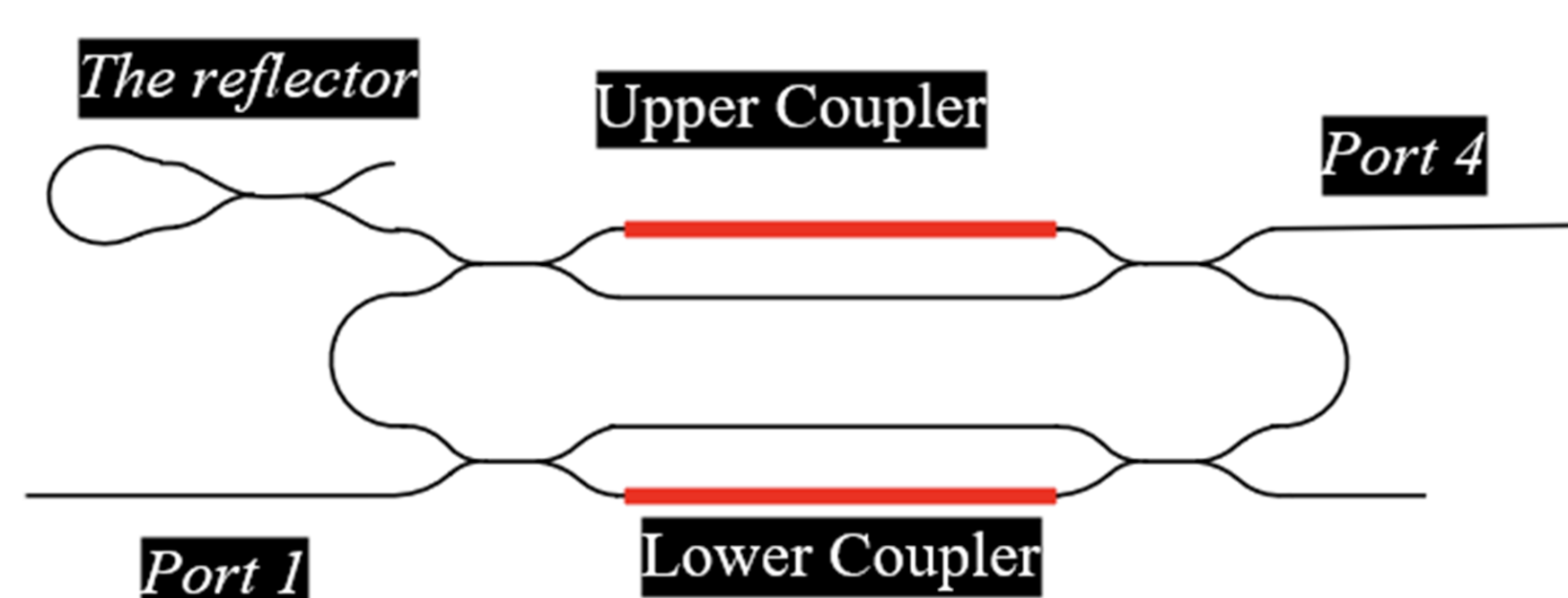
- We simulate the resonant wavelength drifting as a function of the phase shift of MZI couplers



Relationship between the wavelength drifting and the phase shifts of each MZI coupler

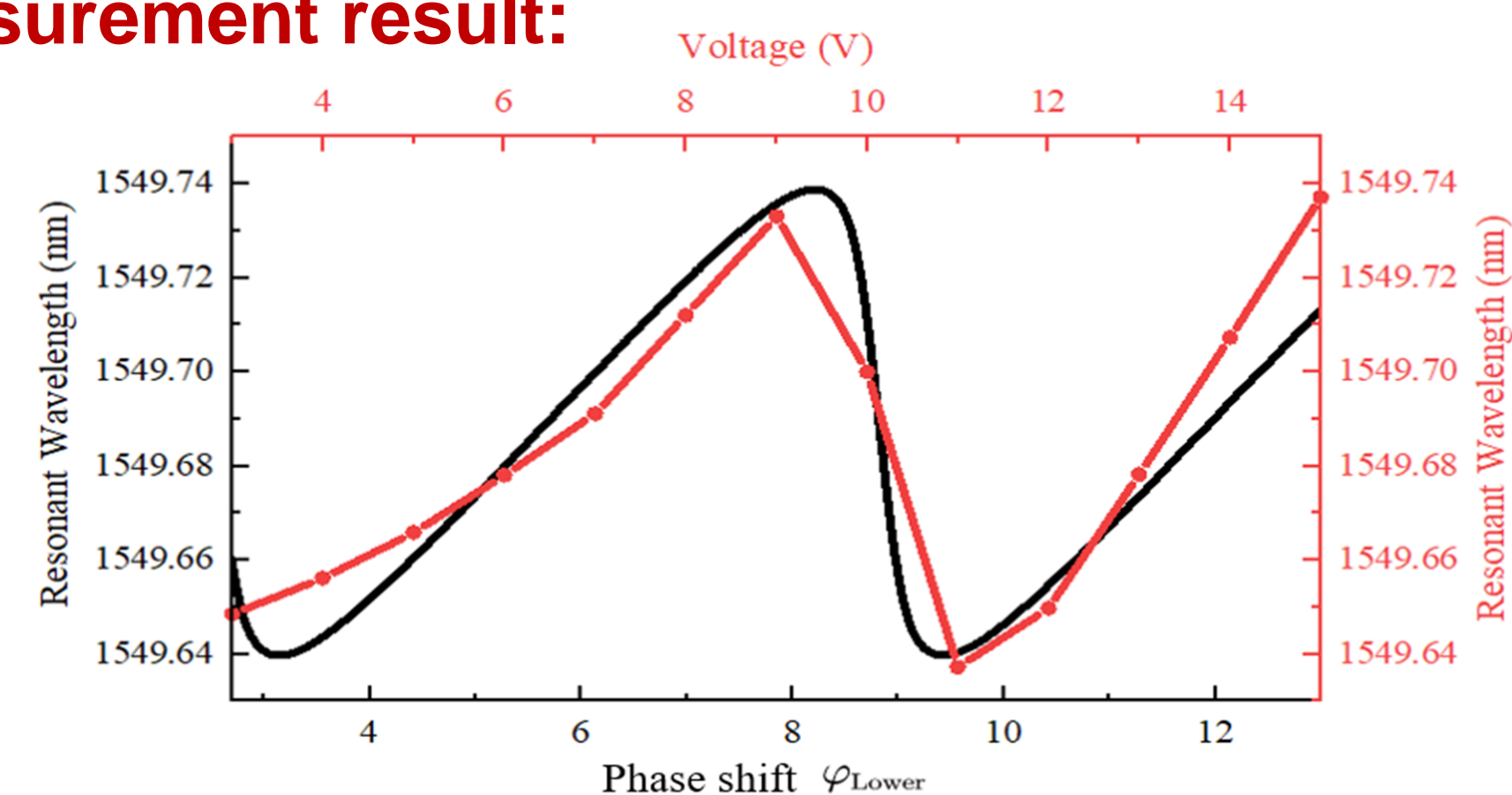
Fabricated chip:

- To verify the analysis, an integrated RT-MRR circuit is fabricated on the TriPleX™ silicon nitride platform.



The structure of the fabricated silicon nitride RT-MRR circuit.

Measurement result:



The resonant wavelength as a function of the phase shift (black curve and the bottom axis) and the measured resonant wavelength as the function of the voltage added to the lower heater. The voltage applied to the upper coupler is preserved at 11V. For simulation, $k = 0.4$.

CONCLUSION

- In this work, we modeled, evaluated, and measured the resonant wavelength drifting properties of an RT-MRR.
- Using the transmission matrix formalism, we calculated the effect on the resonant wavelength of the RT-MRR introduced by the MZI couplers.
- An experiment is carried out to validate our analysis. The results show that the resonant wavelength of the RT-MRR periodically drifts as a function of the control signal.
- This work will help us to understand the wavelength drifting mechanism and to find solutions to avoid the undesirable drifting effect in future implementations.