Micro Ring Resonators for Nanophotonics

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Introduction

Nanophotonics is the study of how light interacts with nonlinear materials. One way that researchers understand how photons interact with one another, is through optical microchips with with waveguides that lead to micro ring resonators. The waveguides and micro ring resonators are made of Lithium Niobate crystals which are most commonly found on optical microchips.

Objective & Impact of Professor's Research

Dr.Mengjie Yu's lab works on advancing the fundamental understanding of nonlinear sciences at nanoscale. The Yu Lab develops fully integrated photonic circuits which can be applied in parallel for classical and quantum applications, and novel nanofabrication techniques for hybrid optoelectronic platforms and integrating unconventional materials. In the Yu lab, the microchips are put under different conditions, like change in the frequency of the light, different temperature conditions, and also different degrees of polarization.

Device Fabrication

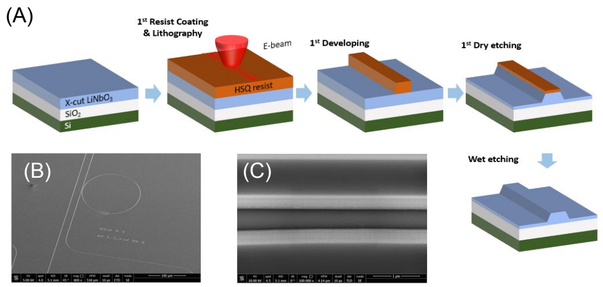

Figure 1: A) Process of microchip fabrication. B) Scanning Electron Microscope(SEM) image of wave guide and microring resonator C) SEM image of waveguide

Research & Methods

I was able to learn how to couple light into different lenses and then eventually sensors using table adjusters. In my research I found the Q Factor of micro ring resonators by using Excel,OriginPro, and Matlab. Micro ring resonators are frequently used in optics due to their low-loss property. Knowing the Q factor helps identify the loss from wave guides, which helps lead researchers into the right direction into making low -loss waveguides for optics.The fitted lorentz peak in Figure 6 was used to calculate the Q load.

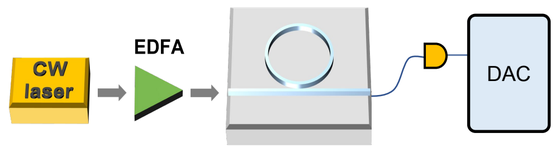

Figure 2:Representation of the light from a laser, to a sensor, through a lithium niobate waveguide and a micro ring resonator.

I was also able to see how temperature affected the pathway of infrared light. The set up included two different nodes, one which cooled the specimen table and one that heated it as shown in Figure 3.Through the process of heating up the specimen table at different increments I was able to collect data on the resistance that the temperature put on the microchip, and then use that to calculate the original temperature that was used. Figure 4 has the calculated temperature shift as a function of wavelength

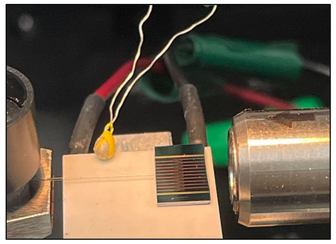

Figure 3: Image of the temperature probe on the sample stage with a microchip

Results

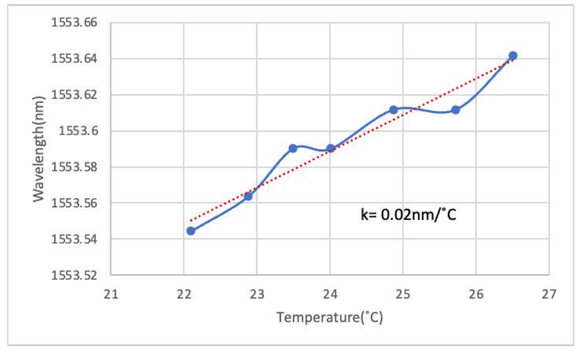

Figure 4:Frequency shift as a function of temperature variation

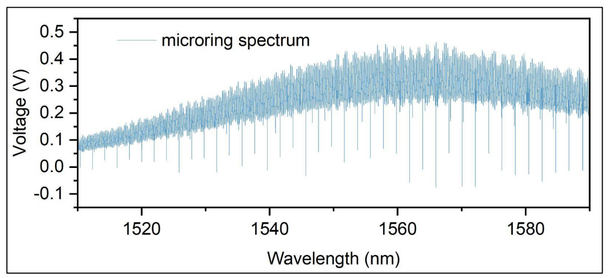

Figure 5: Resonance peaks of microring resonator.

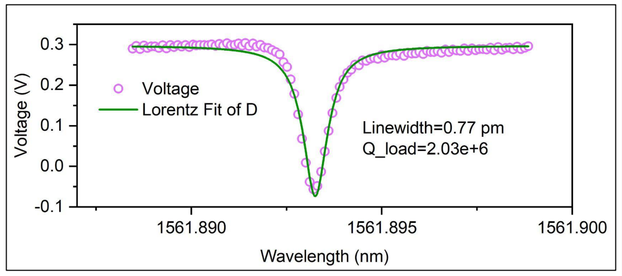

Figure 6: Zoomed in peak from figure 4 fitted with a lorentz peak. at a wavelength of 1561 nm.The Q-Load is 2.03e6.

Next Steps for me and Advice for Future SHINE Students

This year in school I will be taking a research in engineering class, where I am going to implement the lessons that I have learned at SHINE to make sure I succeed. At SHINE I learned how to find an read research journals that are relevant to the topic I am researching. I also hope to use the experience of working in a lab further in life, if I choose to do do research in undergrad or beyond.

I would also like to say to any future SHINE students that researches not an individual process, nor is it a quick one. Feel free to ask the people working in your lab for help, and also understand that sometimes you may be waiting around for a process to become completed, or for other reasons and just know that that is normal.

Acknowledgements

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Citations

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