Encapsulation of Tapered Fiber Optic Biosensors within Fluidic Chann

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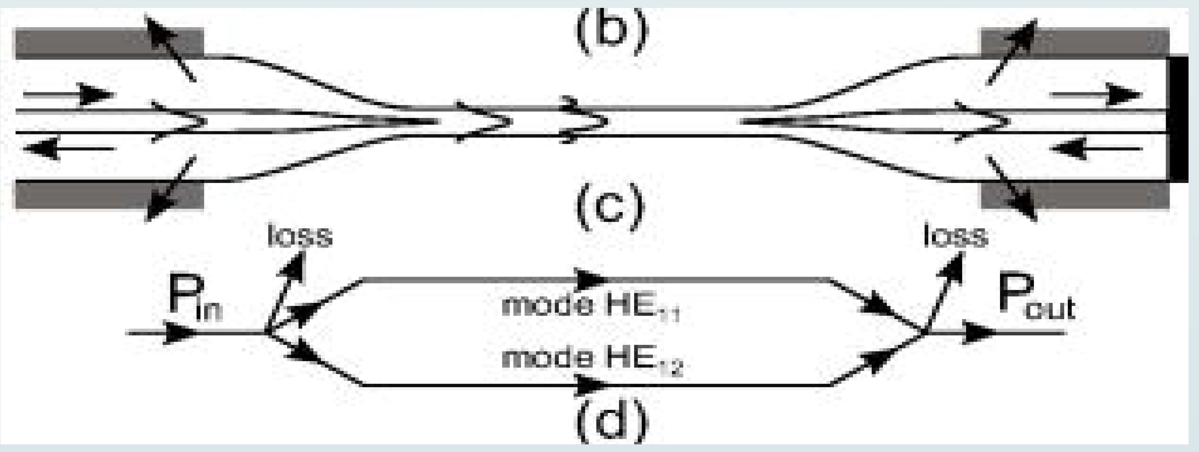
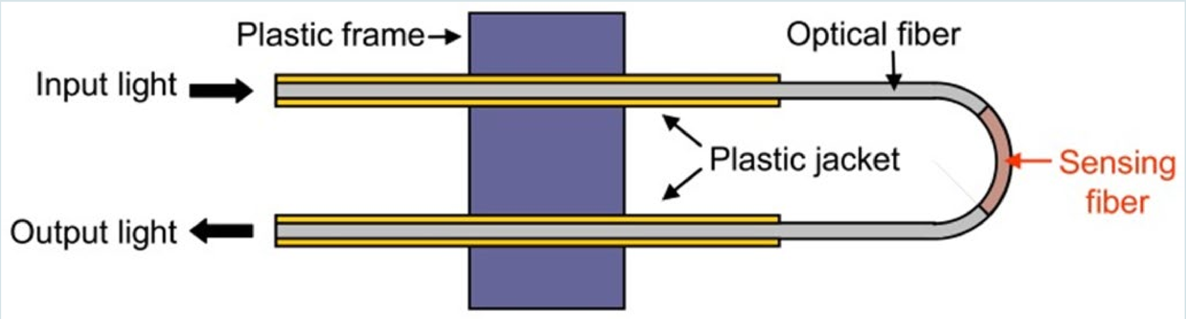
Abstract

Biosensor is an emerging area that has been attracting scientists for its applications in various fields such as food safety, detection of pathogenic bacterial strains, biomedical research, etc. Fiber optic biosensor developed in the lab utilizes U-shaped biconically tapered optical fiber with the core diameter of approximately 10 μm. A U-shaped sensor is fabricated by stretching and tapering fiber with applied heat. To retain the sensitive region of sensor from breakage and to preserve it for the long-term stability, the tapered fiber was embedded in an enclosed place with the integration of fluidic channels. For the encapsulation of biosensors, rectangular compartment was designed and built by utilizing polydimethylsiloxane, or PDMS, plasma adhesive bonding technique was employed for secure adhesion of glass slide to the PDMS surface. The compartment consists two holes in which the tubing system was integrated to inject desired amounts of solution into the compartments. The sensitivity and viability of encapsulated biosensor were measured with DI water. More data need to be taken for further determination; however, preliminary data suggests that the encapsulation step retains the sensitivity of the tapered fiber optic sensor.

Introduction



The light source from the SOA goes through the optical fiber, and the as the refractive index around the sensor is changed, the transmission spectrum will undergo a phase shift that is detected by the Optical Spectrum Analyzer.

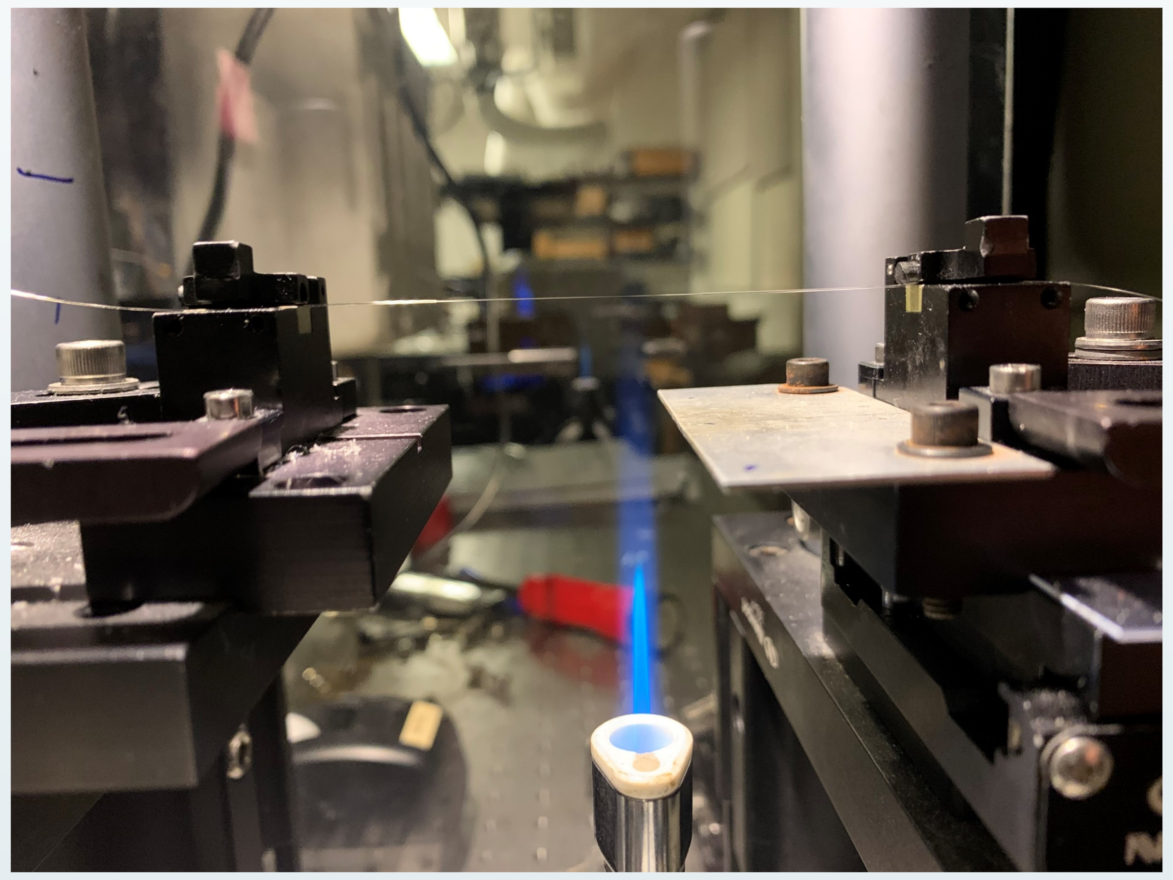


The sensitive region of the optical fiber is freely exposed It is preferable that the sensitive regions has a protective covering that maintains the sensitivity and that can readily accept fluid without disrupting the structure and the shape of the sensor and the compartment.

Methodology

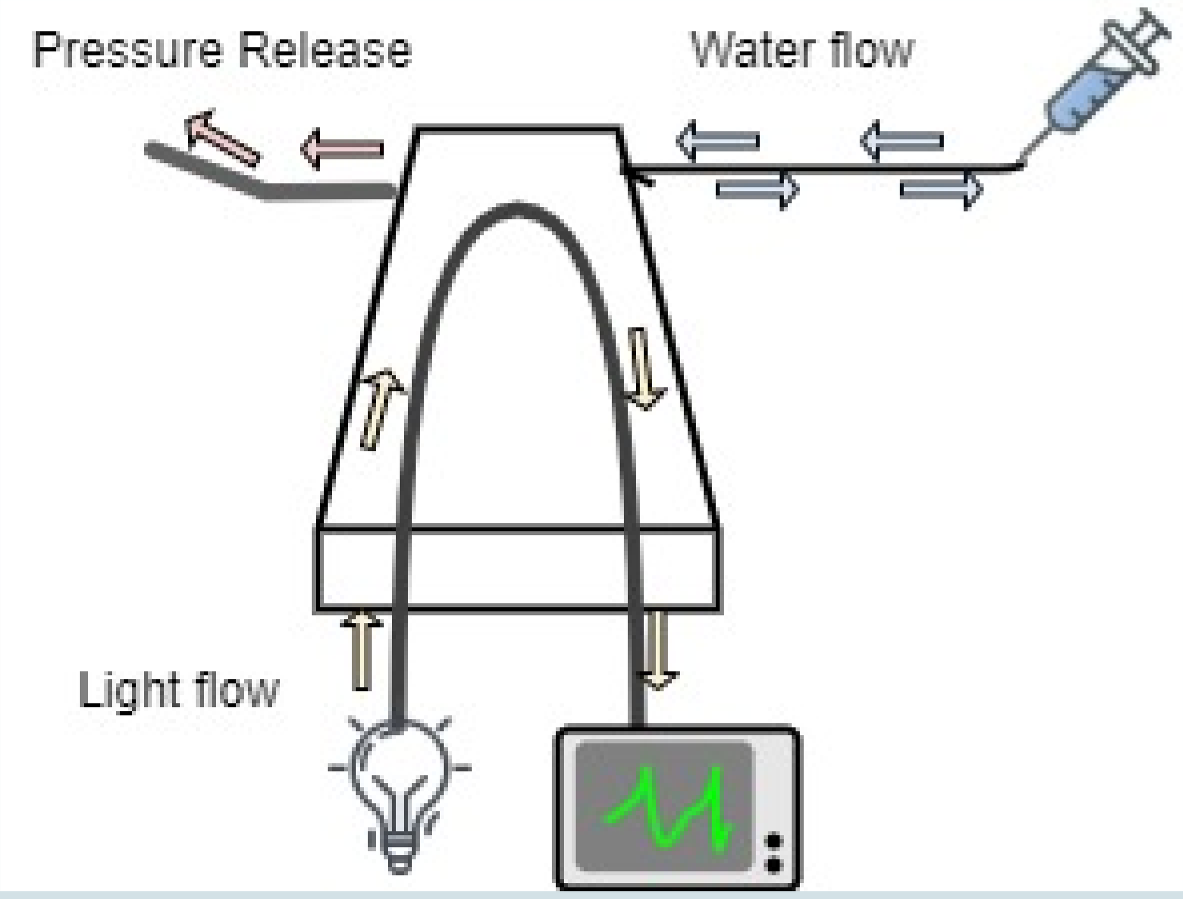
Developing U shaped biconically tapered optical fiber with a butane torch

Tapers were fabricated by pulling an optical fiber axially while heating. After drawing the desired length to fit into the chamber, about 1 inch, the tapers were bent into a U-shaped and secured to glass slides with tape.



Encapsulation of Biosensor with PDMS

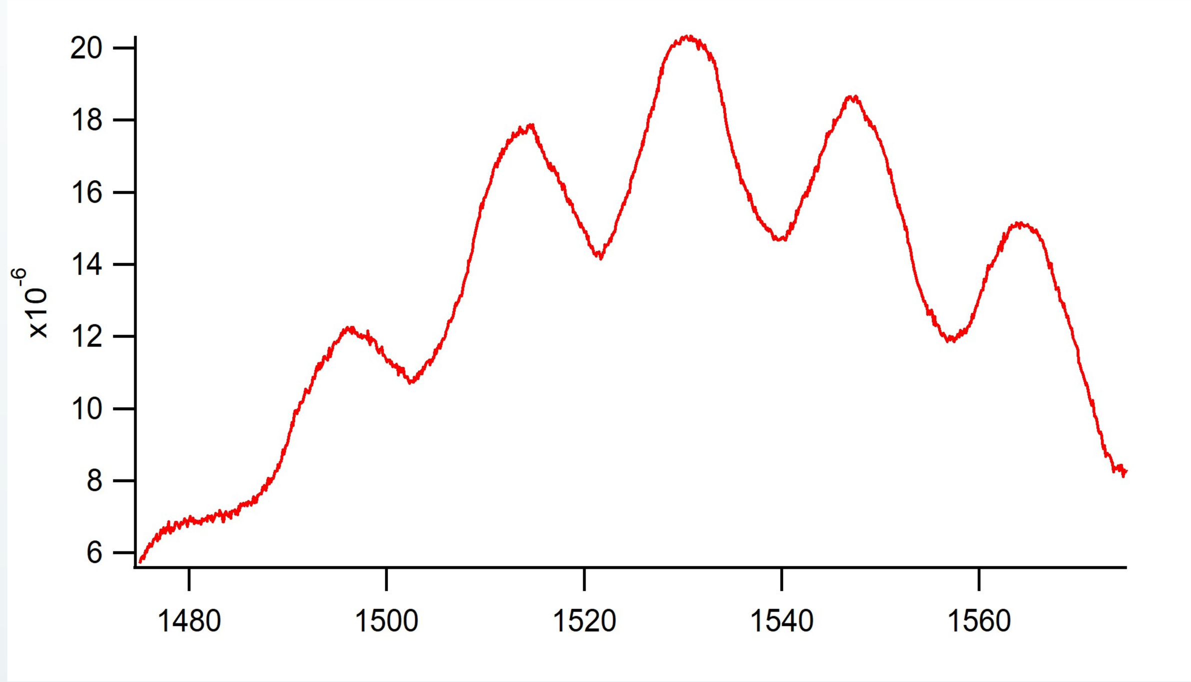
The design of the PDMS allows the U-shaped sensor to be placed on the surface without touching any sides of the compartment. The sensor is carefully placed and immobilized with epoxy glue. Plasma adhesion technique was utilized for attaching glass slide to seal the fluidic channel



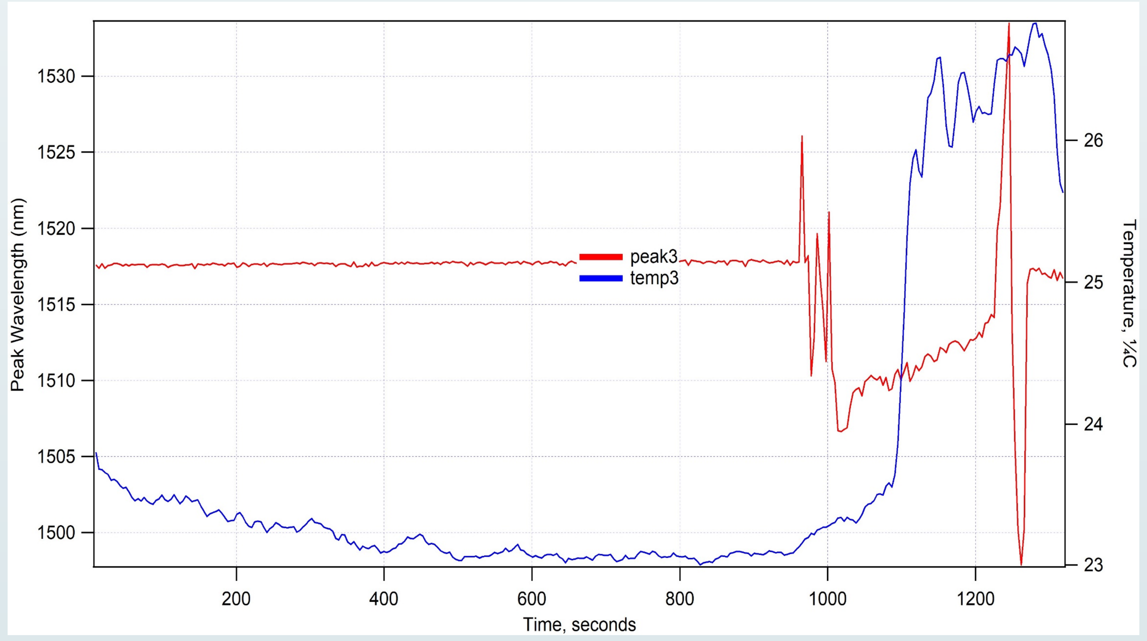
A small tube was inserted to release the pressure as water flows into the fluidic channel The sensor is connected to a light source and an Optical Spectrum Analyzer.

Results

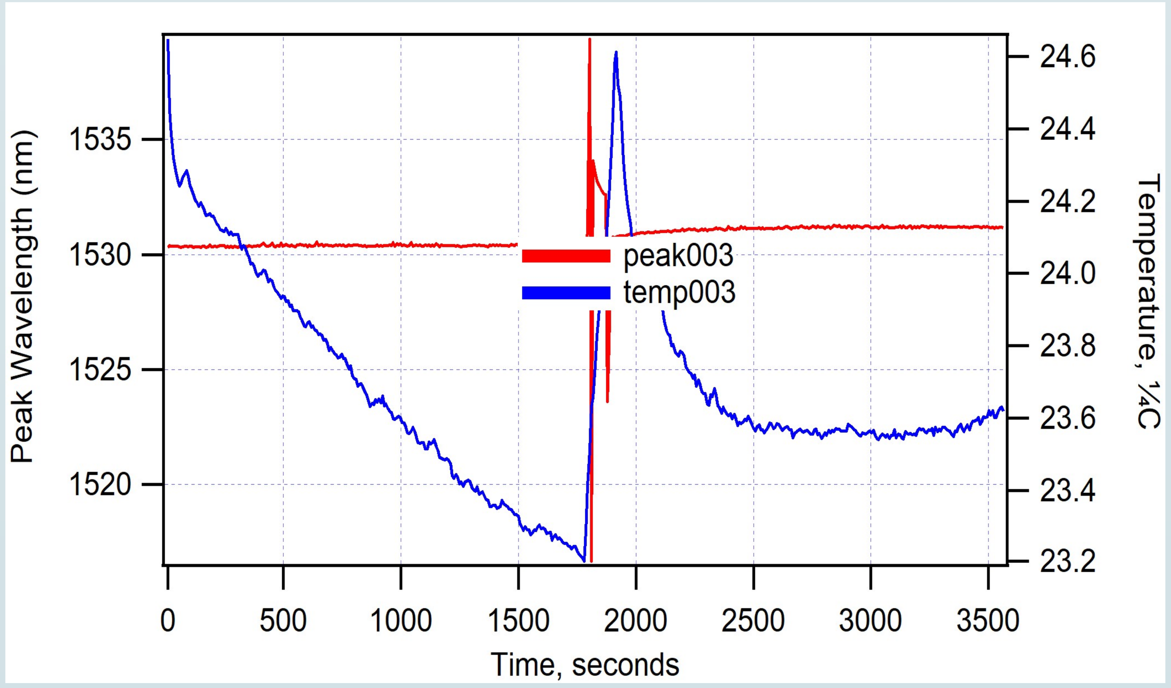
Optical spectrum of tapered fiber sensors within fluidic channel



Testing the sensitivity of the sensor to varying temperature



Sensor within fluidic channel tested with water reinjection at 30 minutes



Conclusion

- We have demonstrated the encapsulation of a tapered fiber optic sensor in a PDMS fluidic channel This process prevents the breakage of a tapered optic fiber sensor due to external forces.
- The sensor within the fluidic channel gave functional peaks Temperature vs. wavelength plot leads to a conclusion that the sensor is not sensitive to the slight changes in fluidic temperature.
- Our preliminary data suggests that the encapsulation of the sensor retains the sensitivity and the amplitude of the power before and after the injection of the water.

Future Directions

- For future experiments, we will be testing the sensor with different concentrations of alcohol solutions . This allows us to observe shifts in wavelengths and to measure the effective index of refraction.
- We had limitations on the design and manufacturing of the chamber. We are planning to continue with the current form of the compartment as well as creating one with linear shape rather than with a U-shaped sensor.
- Our goal is to immobilize antibodies on the sensitive region of the tapered fiber optic sensor within the fluidic channel to measure the robustness and reliability of the embedded sensors.
- The possibilities of the sensing of biological components can be widely varied from genetic material detection of pathogenic strains, binding activities of protein-to-ligand and antigen/antibody complex, water and environmental control and monitoring, etc. are the areas that we are interested in investigating.

References

[1] Salik, E. et al. (2015). Biconically Tapered Fiber Optic Probes for Rapid Label-Free Immunoassays. *Biosensors*, 5(2), 158-171.

[2] Ortiz, A. et al. (2013). Embedding Tapered Fiber Biosensors within Microfluidic Channels for Bacterial Sensing

Acknowledgements

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