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Tapered Optical Fibers for Detection of Volatile Organic Compounds

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Abstract

The study of volatile organic compounds (VOCs) has seen applications in clinical, ecological, and industrial settings. For example, certain VOCs in human breath have been used to detect the presence of breast cancer. The purpose of this study is to explore the VOC sensing capability of tapered optical fibers.

Results of Wavelength Sweeps

- Each line is an average of 10 wavelength sweeps.
- The coefficients of variation ranged from $10^{-3}$ to $10^{-4}$.
- High variability exists between different fibers.
- Within a fiber, the output remains constant.

Flow Cell Design

- Pictured above is an early flow cell design.
- Small flow space contains tapered region of fiber.
- Flow space is between four glass slides which are connected and sealed with epoxy.
- Also presented is an updated polydimethylsiloxane (PDMS) flow cell which will replace the cell pictured above.
- Feel free to touch it!

Fiber Characterization

- Fibers are characterized to ensure accurate modeling.
- Pictured above are microscopy images of tapered region.
- We can measure the diameter of the fiber to 1/3µm.
- Fiber dimensions will be used for modeling.
- Loss estimation can be made based on irregularities.

Effect of Surface Environment

- Blue represents output with air surrounding the taper.
- Red represents output with water surrounding the taper.
- When introduced to water, output decreases.
- Expected since water has a higher refractive index than air.

Conclusions

- The beat phenomena seen in the spectra is an interference pattern of different modes through the tapered region.
- The pattern is determined by the propagation constants between the different modes.
- Once the taper parameters are collected, we hope to be able to model these results.

Future Work

- We intend to use the PDMS flow cell for aqueous and VOC sensing experiments as it allows for a more repeatable construction than the cell pictured on the left.
- For aqueous sensing, we seek to recreate published results which detected antibody/antigen binding.
- Furthermore, we wish to characterize the effect of thickness of aqueous biolayers on output.
- We will characterize the threshold of detection for VOCs.

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