Fabrication of Low-Cost Flow Cell and Tapered Optical Fibers for Aqueous Biosensing

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Abstract

The purpose of this research is to study the effectiveness of tapered optical fibers in sensing Volatile Organic Compounds (VOC). Using fiber optics to sense VOCs can be used for clinical, industrial and ecological applications.

Tapered Fiber Diagram

- Single mode and Polarization maintaining (PM) optical fibers are tapered in the manner shown above.
- PM fibers eliminate noise due to changes in the fiber outside of the tapered region.

Fiber Characterization

- The image above represents the electric field of light propagating through the fiber. Black arrows represent the magnitude of the electric field polarization.
- The light outside of the fiber will interact with molecules tethered to the surface of the tapered part of the fiber.
- This changes the refractive index which can then be used to detect protein-protein interactions.

Biological Interactions

- Schematic of fiber with IgG layer is not drawn to scale.
- A glutaraldehyde-activated aminosilane covalently tethers proteins to the fiber surface as shown above.
- The primary protein layer is composed of anti-rabbit IgG.
- Human IgG is used as a negative control treatment, no change in signal is expected.
- Rabbit IgG (primary layer antigen) is expected to bind to anti-rabbit IgG, thickening the biolayer.
- Tris blocks negative IgG from binding to tapered surface.
- No shift is seen when negative IgG is introduced.
- Positive IgG introduction results in redshift of ~1.5nm.

Flow Cell Design

- Pictured above is the current flow cell design.
- The small white box contains the tapered optical fiber.
- The top port allows inflow of solutions and analytes.
- Polydimethylsiloxane (PDMS) is used to secure the fiber and creates an airtight seal when fastened.

Conclusions

- Biological interactions between the immunoglobulin G (IgG) antibodies in the surface of the tapered region resulted in a measurable phase change in the output of the laser.
- The results suggest that this platform can be a viable biosensor for label-free detection in aqueous phase.

Future Work

- Determine threshold measurements for platform.
- Refine flow cell design with 3D printer.
- Proof-of-concept work for VOC testing.

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