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Single molecule biological sensing is of great interest in many areas of science, from pure biological research to integrated lab-on-chip devices. Its applications include medical diagnostics, drug detection, and environmental monitoring. In this project, we seek to create a label-free biomolecular sensor using a tapered optical fiber and functionalized gold nanorod.

Optical fiber waveguides allow for cheap and simple environmental sensors. By tapering the fiber to single mode operation using the flame-pull method, a substantial portion of the electric field exists in the medium surrounding the taper. By monitoring the extinction profile of a light signal propagating in the tapered fiber, particle binding events can be detected.

Gold nanorods near the tapered fiber greatly increase the electric field strength around them compared to the bare fiber. This increases the extinction profile of the nanorod and any molecule that binds to it, increasing the sensitivity of the optical fiber. This setup allows for the detection of single proteins and short oligonucleotide binding kinematics.

Our work has shown transient detection of gold nanorods in a buffered, pH 7 aqueous environment in the form of downward signal spikes. We have also observed step changes in the transmitted signal due to single gold nanorods binding to the fiber when the pH is dropped below the isoelectric point of silica. When the pH is raised again to 7, the nanorods remain bound to the fiber, indicating that the binding of nanorods to the silica fiber is irreversible.

Our future work will build off of these promising results. We aim to functionalize the gold nanorods with human anti-IgG using a simple thiolating technique, bind them to the tapered fiber, and detect single IgG molecule binding events as a “proof of concept” of our platform.