DETECTION OF VARIOUS THROMBIN CONCENTRATIONS USING ETCHED FIBER BRAGG GRATINGS FUNCTIONALIZED WITH DNA APTAMER

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Outline

Background:
Optical fibers
Fiber Bragg grating (FBG) sensors
Thrombin
Thrombin aptamers

Etched FBG biosensor for thrombin detection

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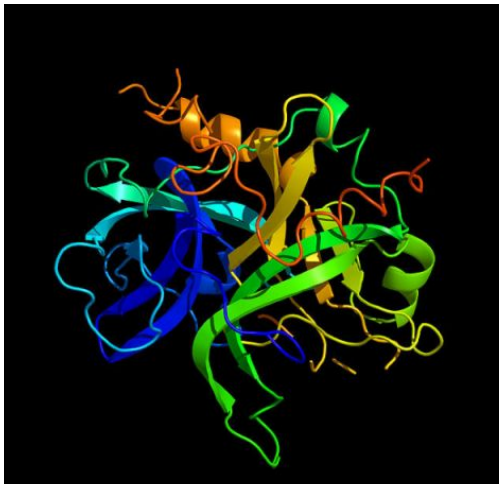
THROMBIN

- Thrombin is important during blood coagulation
- Thrombin levels can be elevated during extra- and intravascular activation of blood coagulation by tumor cells
- Thrombin is involved in diseases: atherosclerosis, thromboembolic disease, cancer and inflammatory disease
- Detecting and quantification of thrombin in a complex medium (serum or plasma) is important both for research and clinic applications
- Due to its clinical importance there is a wide range of works aimed to detect thrombin and most of them are based on aptamers



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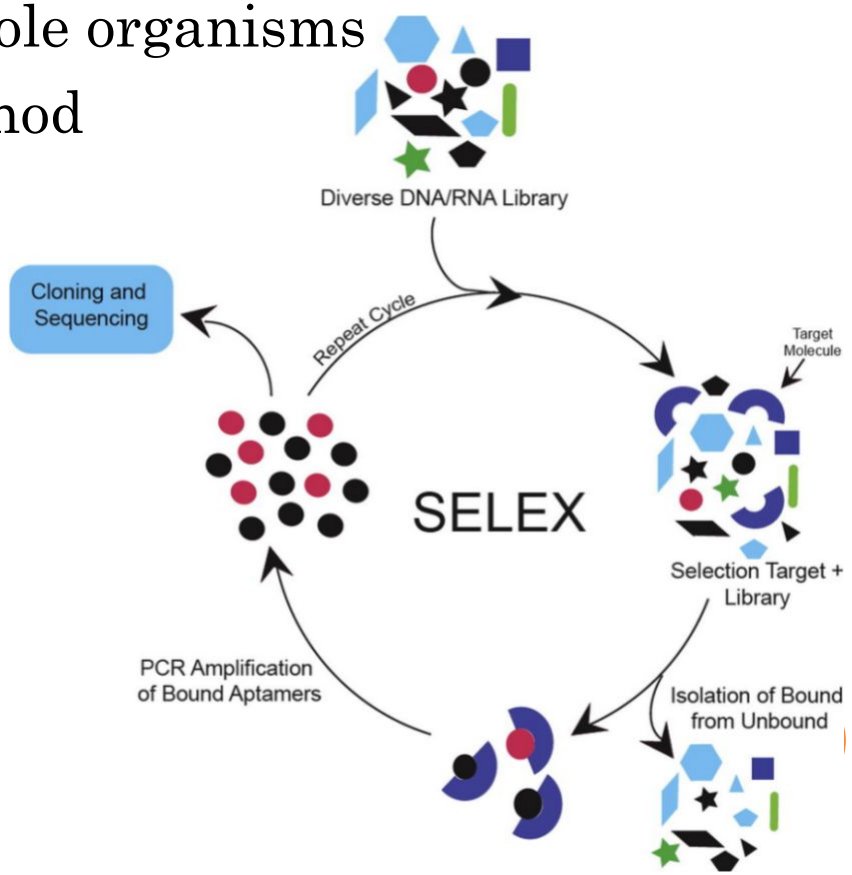
APTAMERS

- Aptamers – oligonucleotides (DNA or RNA) or peptides that bind to their target with high affinity and specificity
- Various targets: from ions to whole organisms
- Selected *in vitro* by SELEX method
- Advantages over antibodies:
- *In vitro* selection
- Non-immunogenic targets
- No batch-to-batch variation
- Longer shelf-life



Source of figures: Wu *et al* 2016

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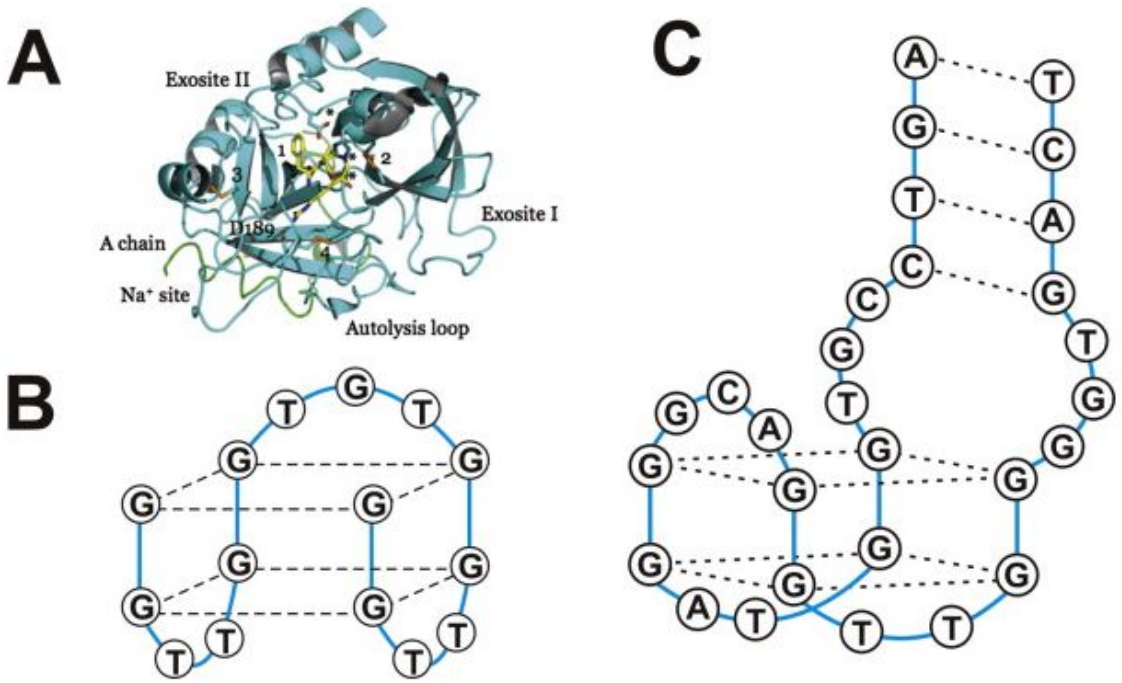
THROMBIN BINDING APTAMER (TBA)

- Two frequently used TBA: 15-mer and 29-mer
- Thrombin and its 15-mer TBA were selected as a ligand-analyte pair because it is a well-characterized system widely used in the development of different biosensors



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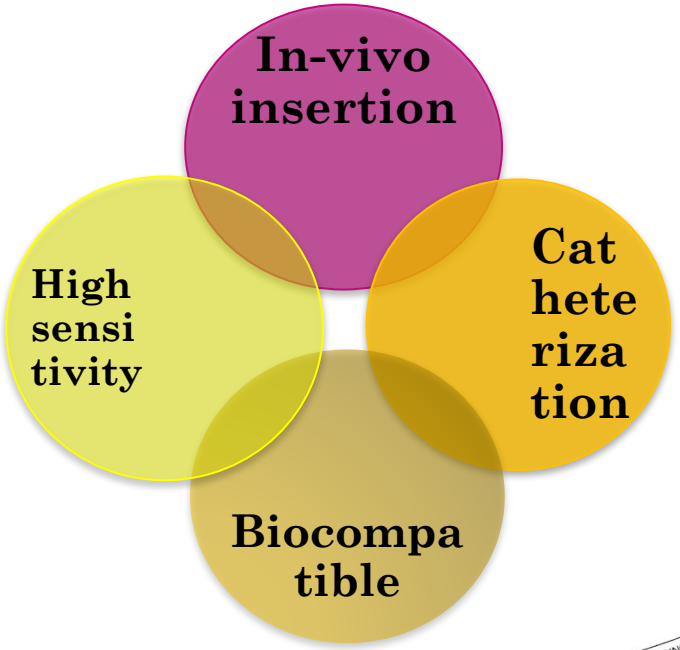
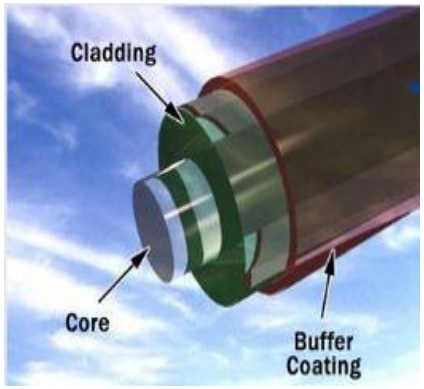
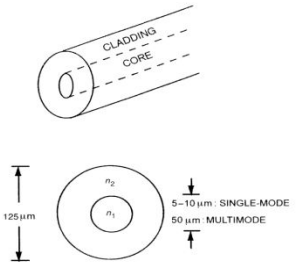
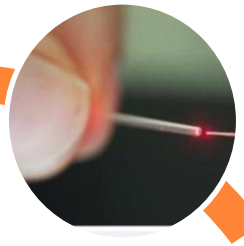
WHY FIBER OPTIC SENSORS (FOS) FOR THROMBIN SENSING









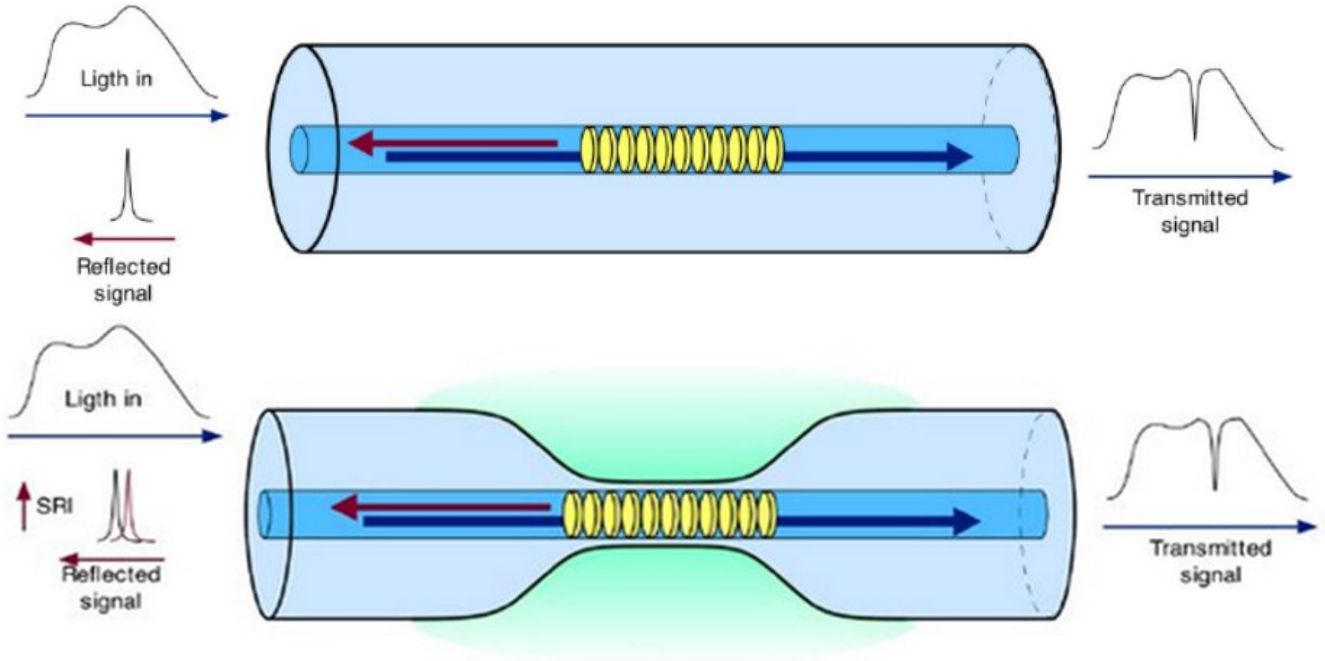
Miniaturized dimension

Multiplexing and distributed sensing

Immunity to electromagnetic interference

Stability in harsh environments

FIBER BRAGG GRATING (FBG) → ETCHED FBG



- Etching the cladding in hydrofluoric acid (HF)→ confers sensitivity to outer RI
- When the cladding is removed→ RI of the cladding is replaced by the RI of the surrounding medium
- The interaction between an analyte of interest and ligand changes the refractive index on the surface and thus Bragg wavelength is shifted and grating reflectivity is changed

Source of figures: Chiavaioli *et al* 2017

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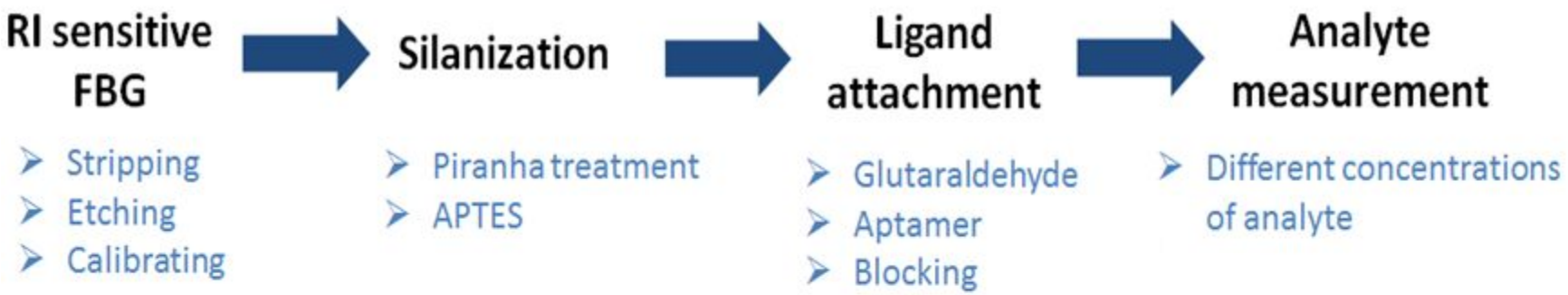
OBJECTIVES

We used a well-established pair of ligand-analyte system to build a biosensor based on functionalized EFBG



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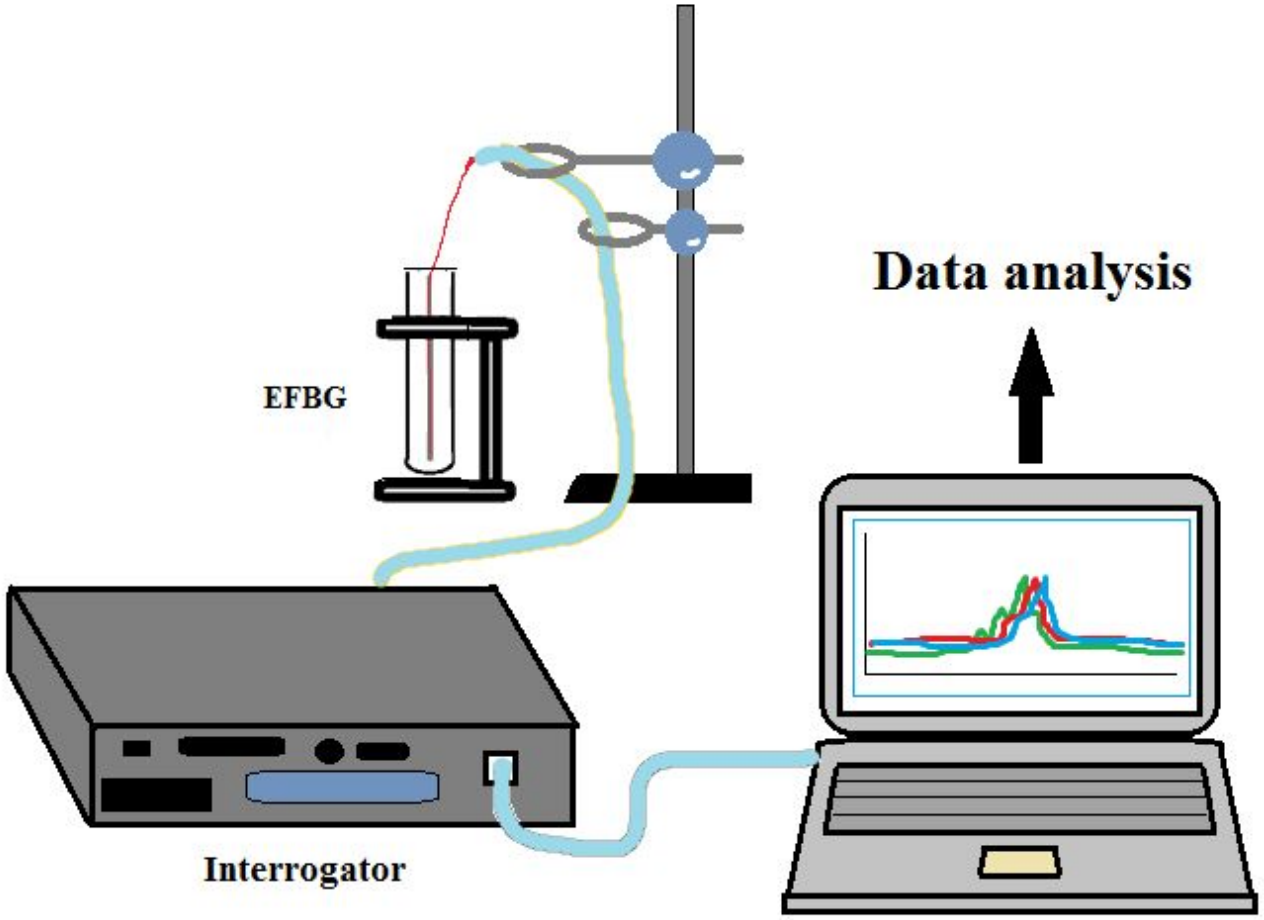
SETUP AND FABRICATION



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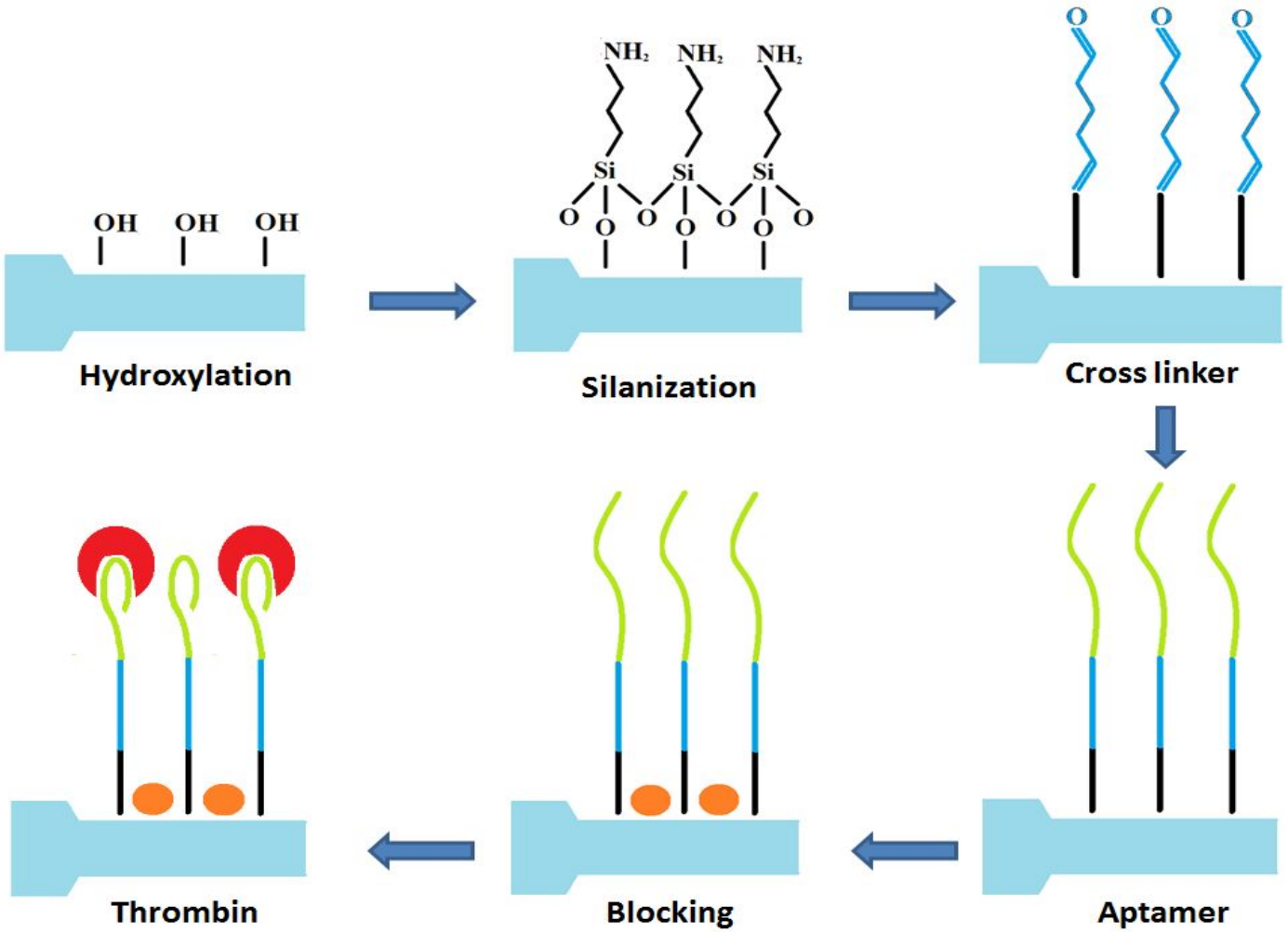
FUNCTIONALIZATION OF EFBG



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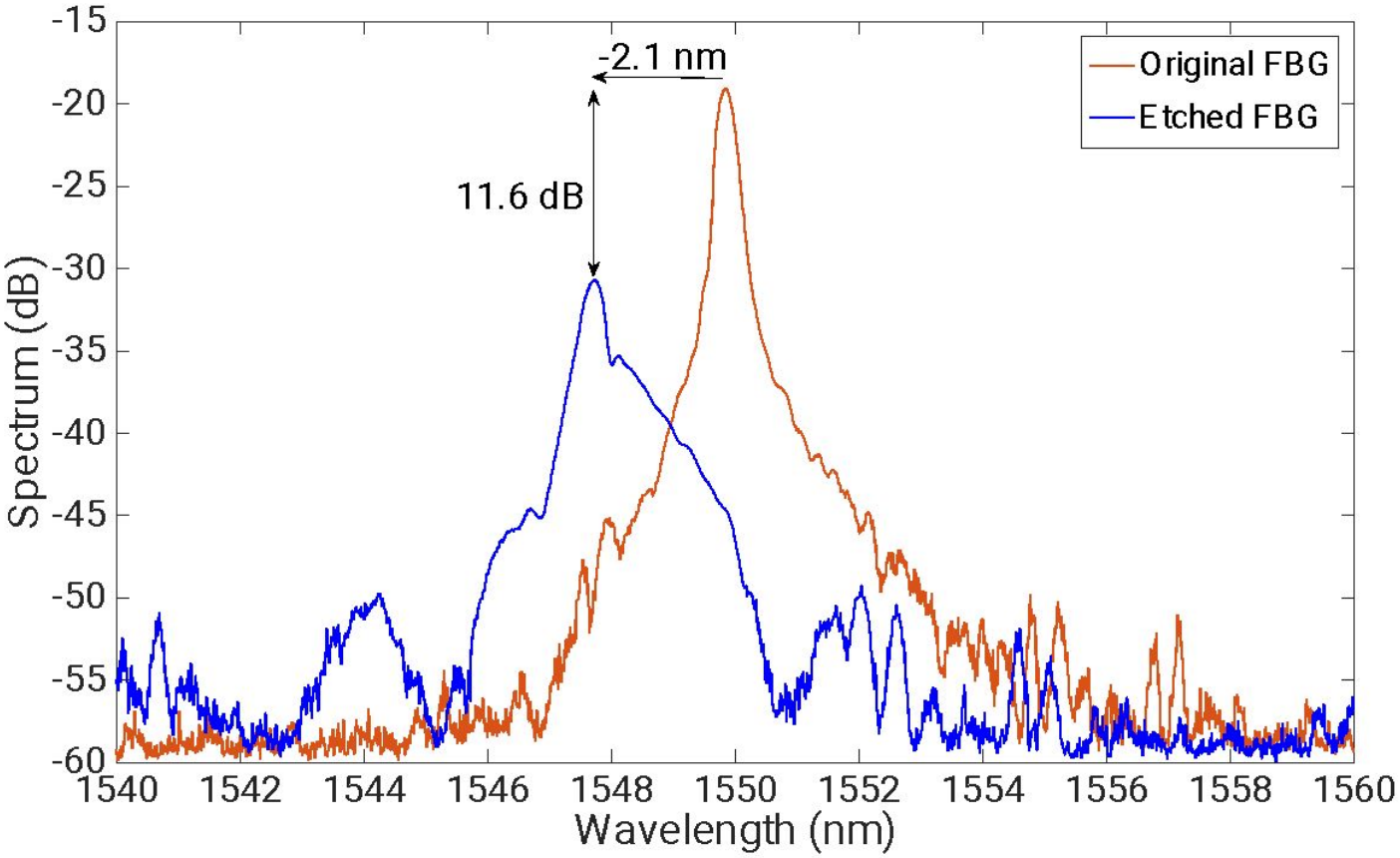
BEFORE AND AFTER ETCHING



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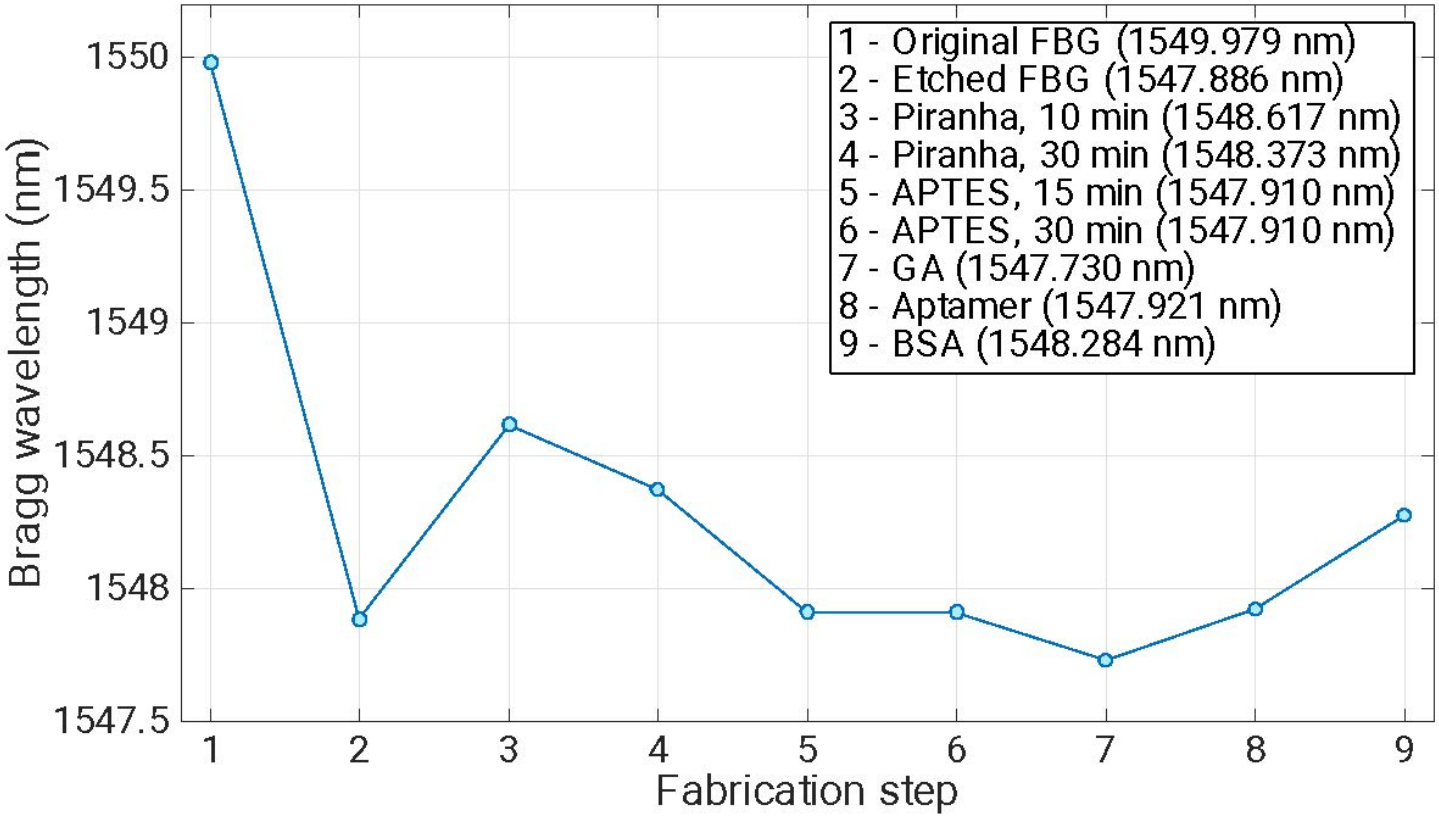
FABRICATION OF BIOSENSOR



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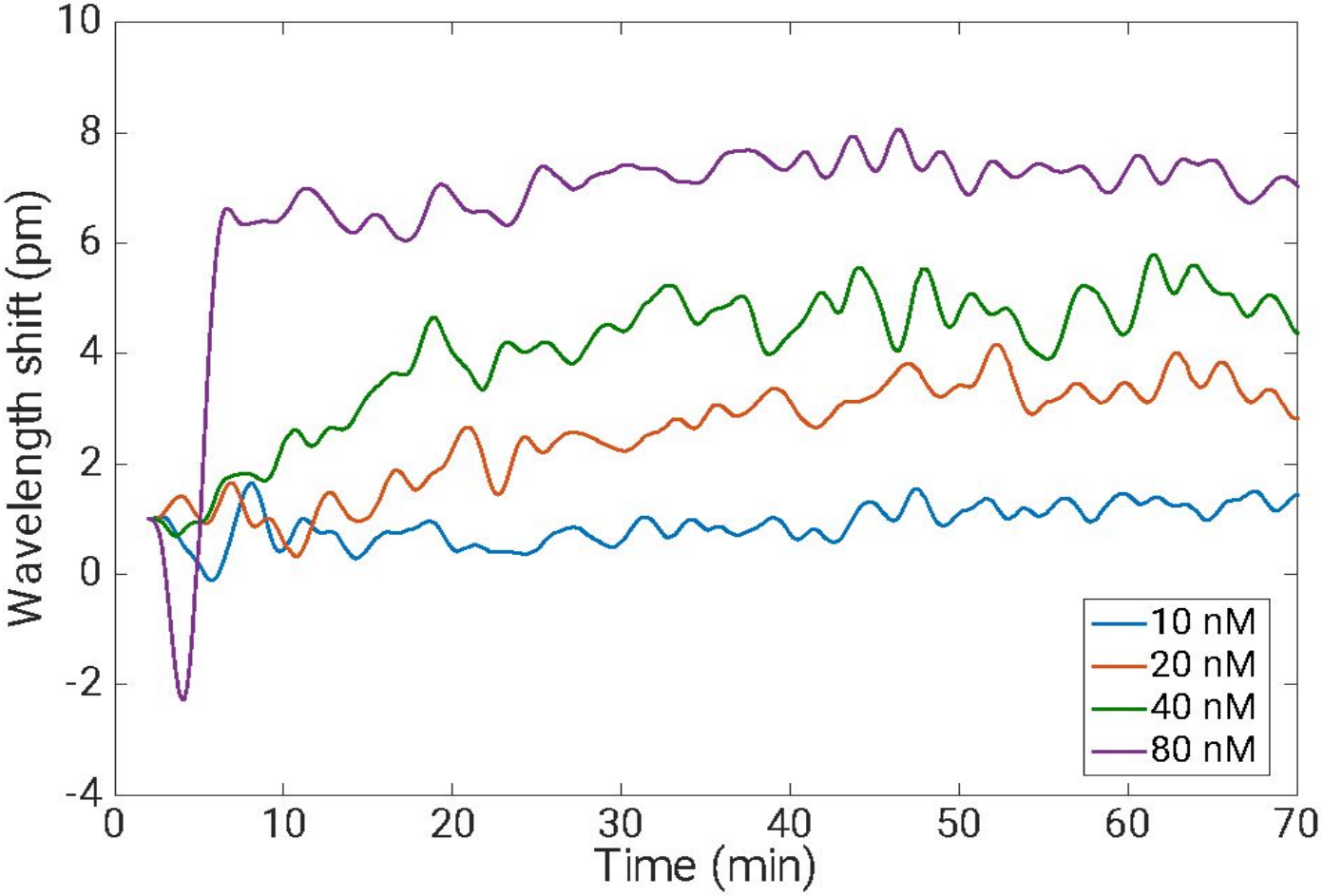
THROMBIN CONCENTRATIONS



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CONCLUSION

- The sensitivity of the EFBG biosensor to refractive index of 17.4 nm/RIU is reported
- Biosensor has been functionalized to selective thrombin detection
- Thrombin binding aptamers have been immobilized on the sensor surface using a silanization process
- We observed a different shift of the Bragg wavelength for each concentration value, reaching a final value of 0.5 (10 nM), 2 (20 nM), 4 (40 nM), 7 pm (80 nM) with standard deviation of 0.3 pm

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FUTURE WORK

Future work will be addressed to improve the fabrication process to a large batch of sensors, and functionalizing other aptamers for use in other biosensing applications such as for detection of biomarkers implicated in cancer or infectious diseases

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