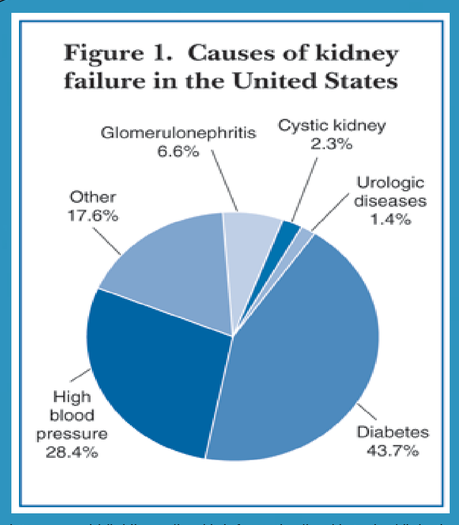
A Proposal for a Modified Attenuated Total Reflection (ATR)-FTIR System

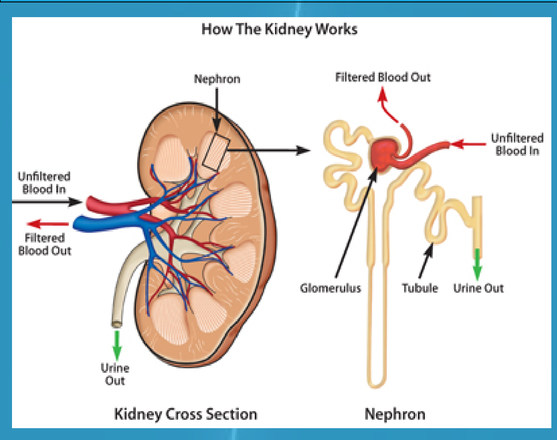
- Jessica Doyle[1, 2], Alexandra Werth[1], and Claire F. Gmachl[1]
- [1] Princeton University, Princeton, NJ 08544, USA
- [2] Permanent Address: Hunterdon Central Regional High School, Flemington, NJ 08822, USA

MOTIVATION



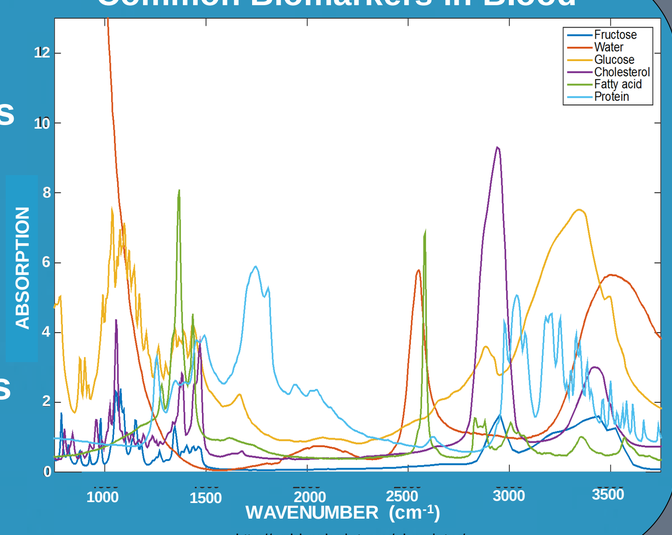
https:www.niddk.hih.gov/health-information/health-topics/diabetic-kidney-disease/Pages/index.aspx

- Today, there are currently 26 million Americans diagnosed with chronic kidney disease.
- Renal disease is most commonly associated with diabetes and hypertension.



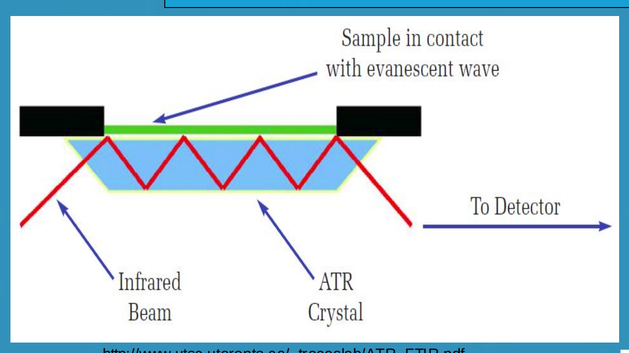
http://probecure.com/b/category/kidney-transplant-procedure/

- We want to investigate concentrations of biomarkers (glucose, proteins, etc.) using ATR-FTIR measurements as possible indicators for renal failure.



http://webbook.nist.gov/chemistry/

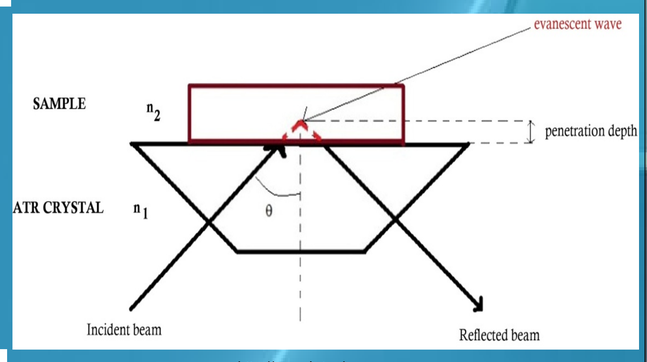
METHODS: What We Know



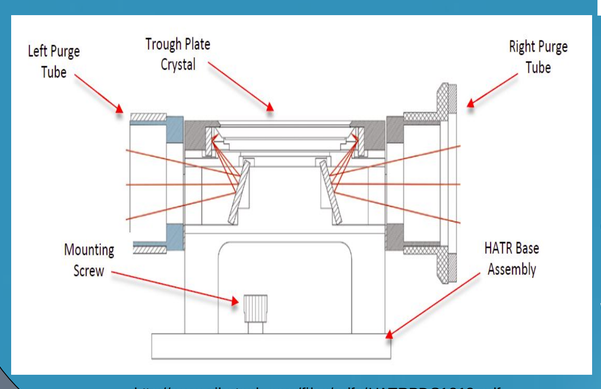
http://www.utsc.utoronto.ca/~traceslab/ATR_FTIR.pdf

Fig. 1: Illustration of Attenuated Total Reflection (ATR). Light enters a prism, comes in contact with a sample, and is completely reflected through the prism in an evanescent wave before exiting to the detector.

Fig. 2: Attenuated total reflection (ATR) works by calculating the critical angle to obtain total internal reflection (TIR) using the index of refraction of each medium, designated n_1 and n_2, which is 2.62 for ZnSe and 1.33 for water.



http://www.intechopen.com



http://www.piketech.com/files/pdfs/HATRPDS1313.pdf

Fig. 3: The HATR (Horizontal ATR) is commercially available through Pike Technologies, can accommodate a liquid sample, has a flow cell attachment, and works within a Fourier Transform Infrared Spectrometer (FTIR).

METHODS: What We Are Doing

For proof-of-concept, we wanted to design a more cost-efficient ATR-FTIR measurement system that would yield the same results as what is commercially available. All angles of a modified ZnSe prism were calculated using Snell's Law:

$$n_1 \sin\theta_1 = n_2 \sin\theta_2,$$

where n_1 and n_2 equal the refractive index of the material.

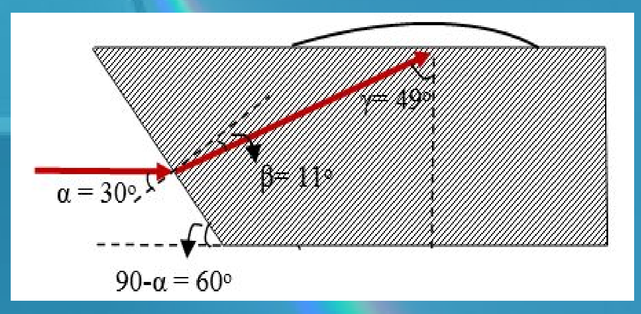


Fig. 1: In order to determine the optimum angles for a modified ZnSe prism, angles were found using the following derivation of Snell's Law: Given 90- (α+β) = γ, and β= arcsin (n_1/n_2 sin(α)), where n_1= 1.00 for air, and n_2= 2.62 for ZnSe.

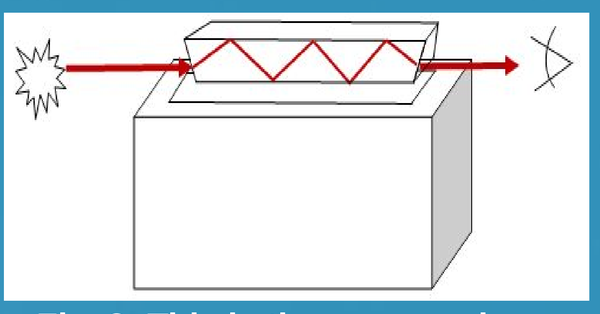
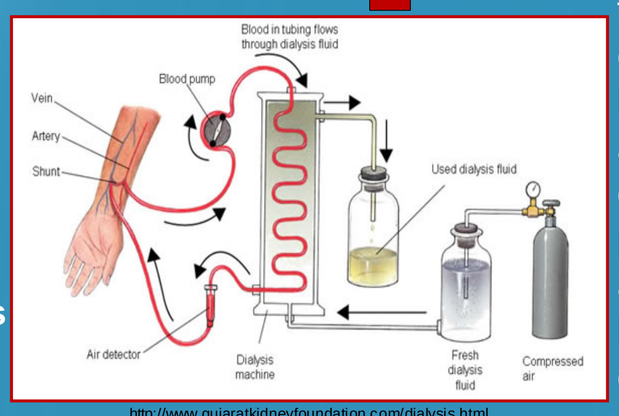


Fig. 2: This is the proposed modification to the traditional ATR-FTIR set-up, which normally utilizes two sets of mirrors. Here, the ZnSe prism can rest directly on a solid base, allowing the light to penetrate the crystal from the right side, and exit the crystal to be picked up by the detector on the left.

FUTURE WORK

- **In the future, we would like to explore the possibility of using the modified ATR-FTIR system to incorporate continuous flow measurements.**
- **Continuous flow measurements would serve as a means to measure biological fluids, such as blood or urine filtrate in patients undergoing kidney dialysis.**



http://www.gujaratkidneyfoundation.com/dialysis.html

Taking real-time, continuous flow measurements for various concentrations of biomarkers, such as albumin, or glucose can provide more accuracy in biomedical diagnostics.

REFERENCES

[1] National Kidney Foundation. National Kidney Foundation, Inc., 2016. Web. 11 July 2016.

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[3] Oliver, Katherine V., et al. "Attenuated Total Reflection Fourier Transform Infrared (ATR-FTIR) Spectroscopy as a Bedside Diagnostic Tool for Detecting Renal Disease Biomarkers in Fresh Urine Samples." Optical Diagnostics and Sensing XV: Toward Point-of-Care Diagnostics (2015): n. pag. SPIE Digital Library. Web. 08 July 2016.

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