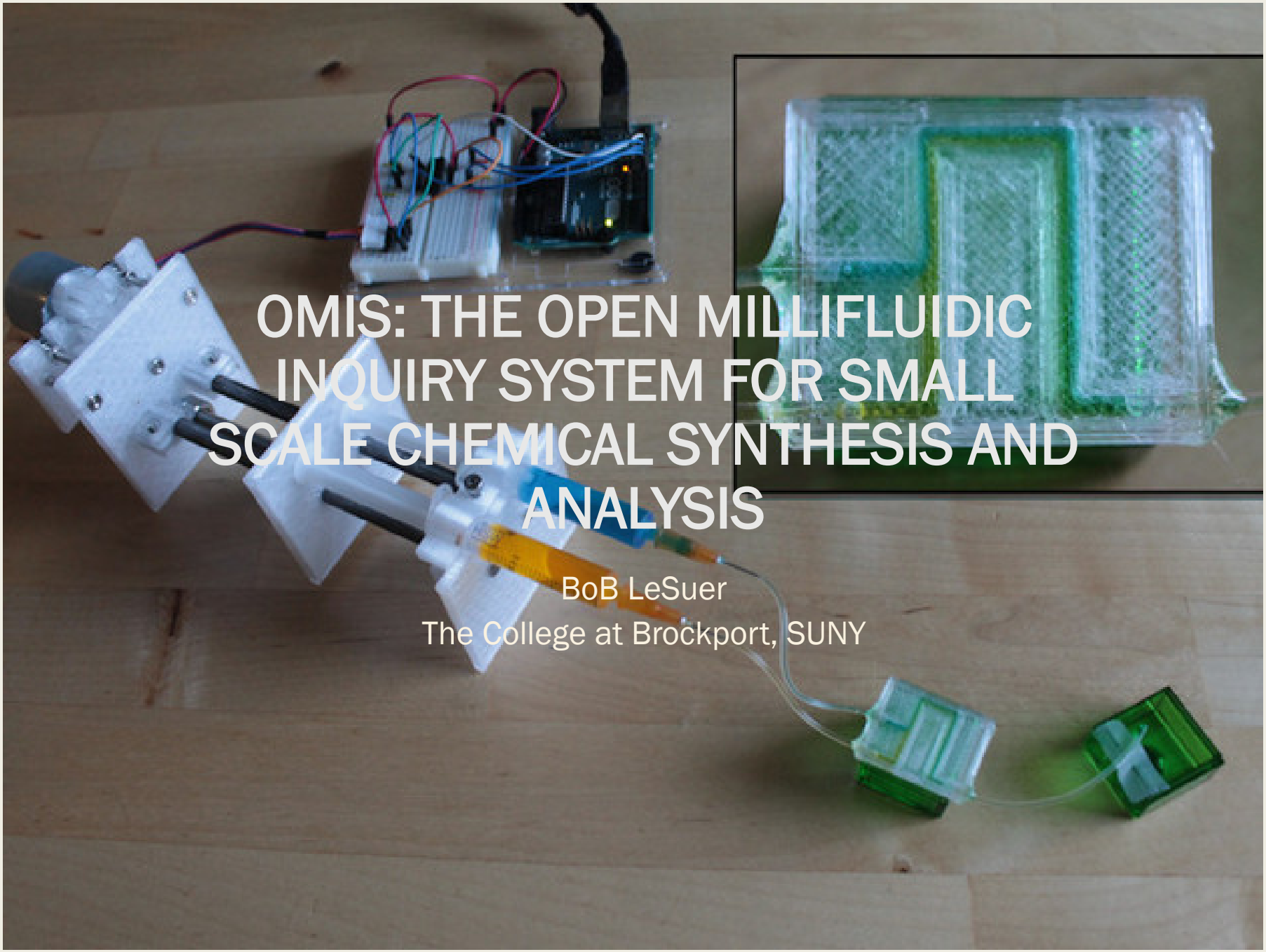


OMIS: THE OPEN MILLIFLUIDIC INQUIRY SYSTEM FOR SMALL SCALE CHEMICAL SYNTHESIS AND ANALYSIS

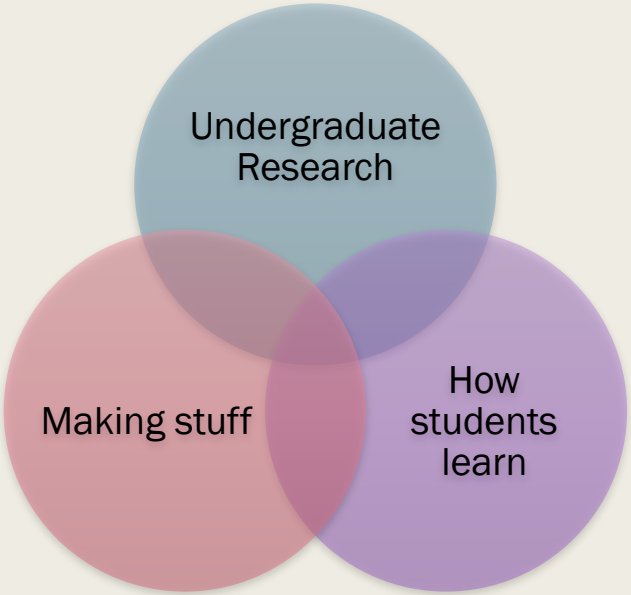
BoB LeSuer
The College at Brockport, SUNY

An Analytical Chemist

- Performs qualitative/quantitative analysis
- Manipulates samples (e.g. separation, concentration, preservation)
- Evaluates the uncertainty in measurements
- Validates results through calibration and standardization
- Creates new ways to make measurements
- Interprets data in proper context
- Communicates their results

https://www.acs.org/content/acs/en/careers/college-to-career/areas-of-chemistry/analytical-chemistry.html

Purpose: To explore new ways to make scientific measurements, and make them broadly accessible

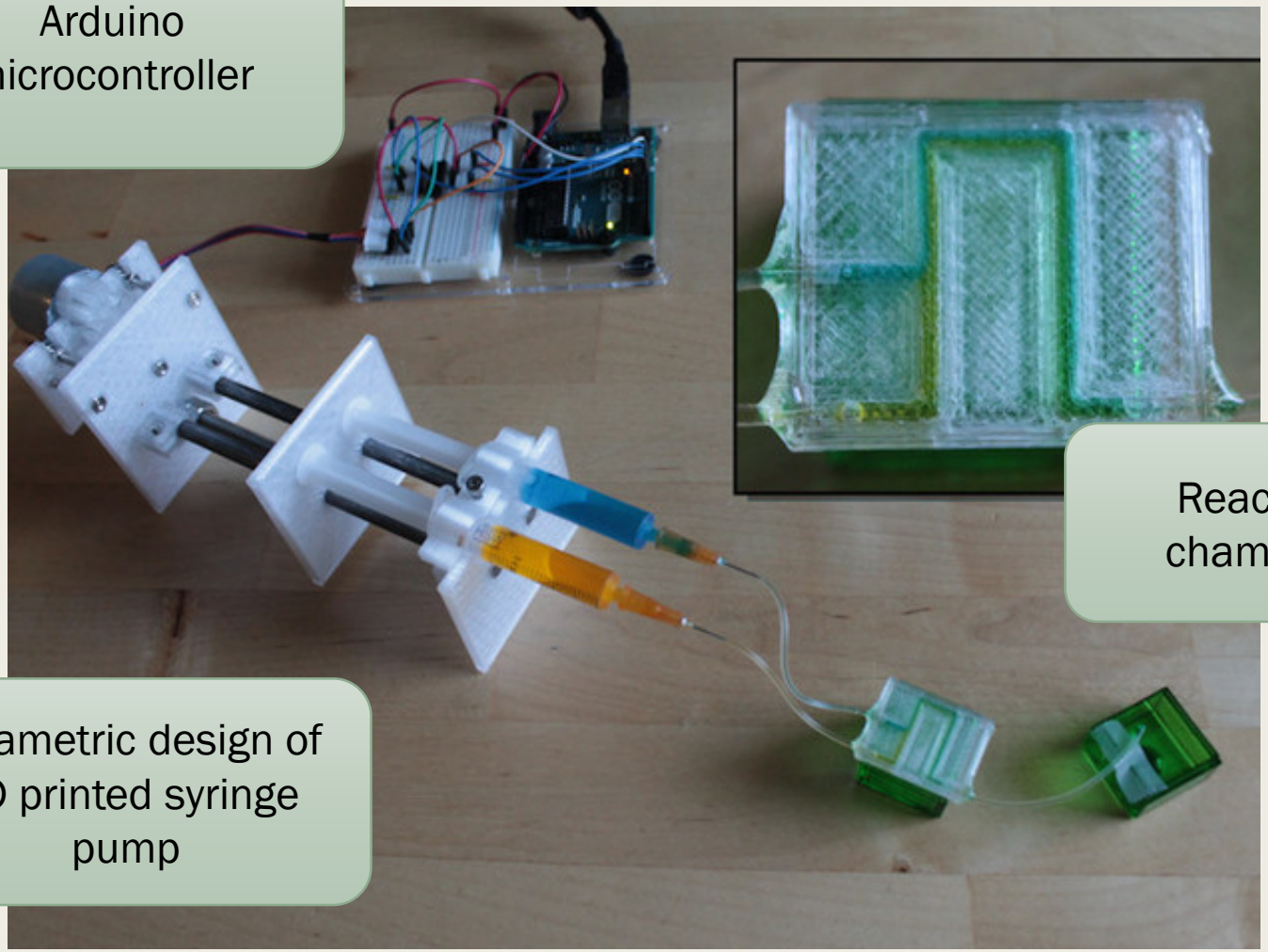


How can we leverage digital fabrication in chemical education and research?

Can we achieve better control of biomolecular reactions?

Open Millifluidic Inquiry System

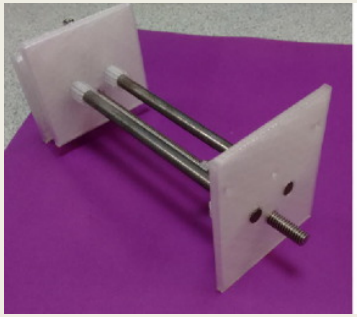
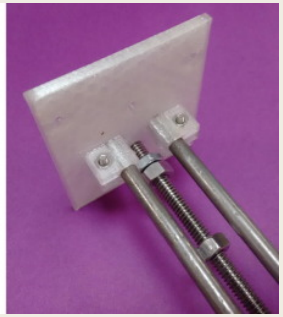
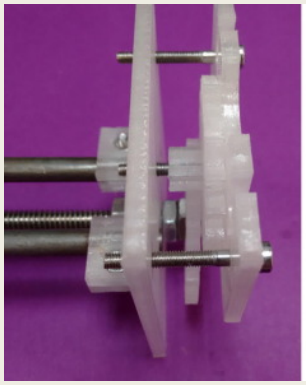
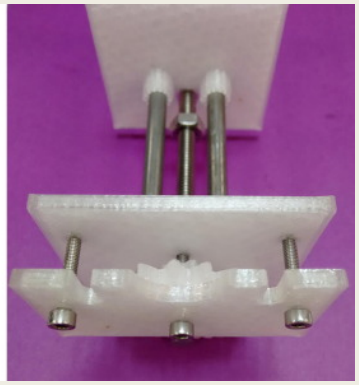
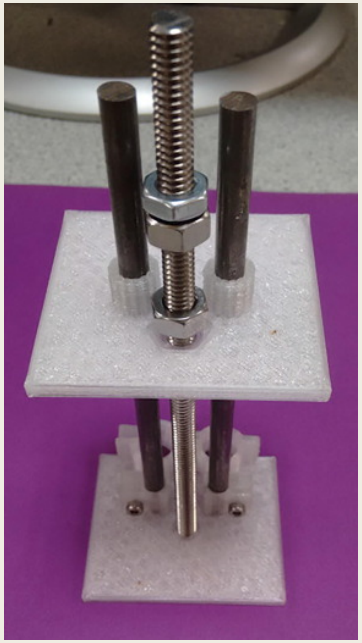
Arduino microcontroller



Reaction chambers

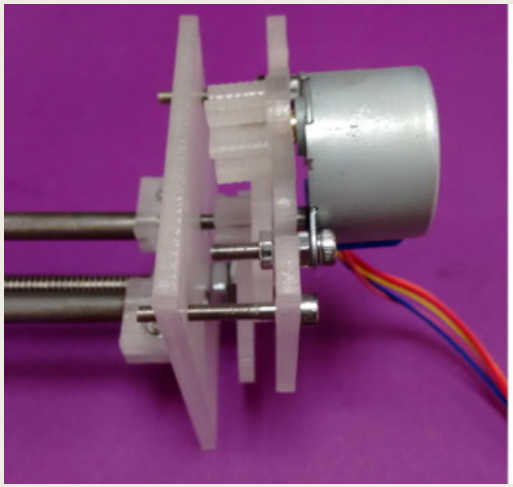
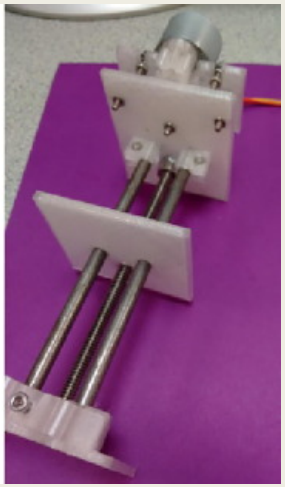
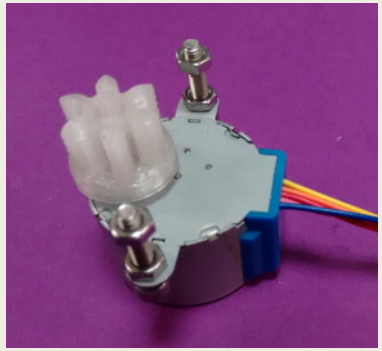
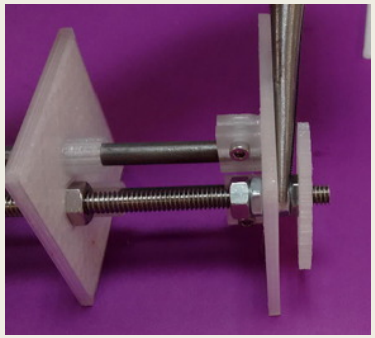
Parametric design of 3D printed syringe pump

Idler

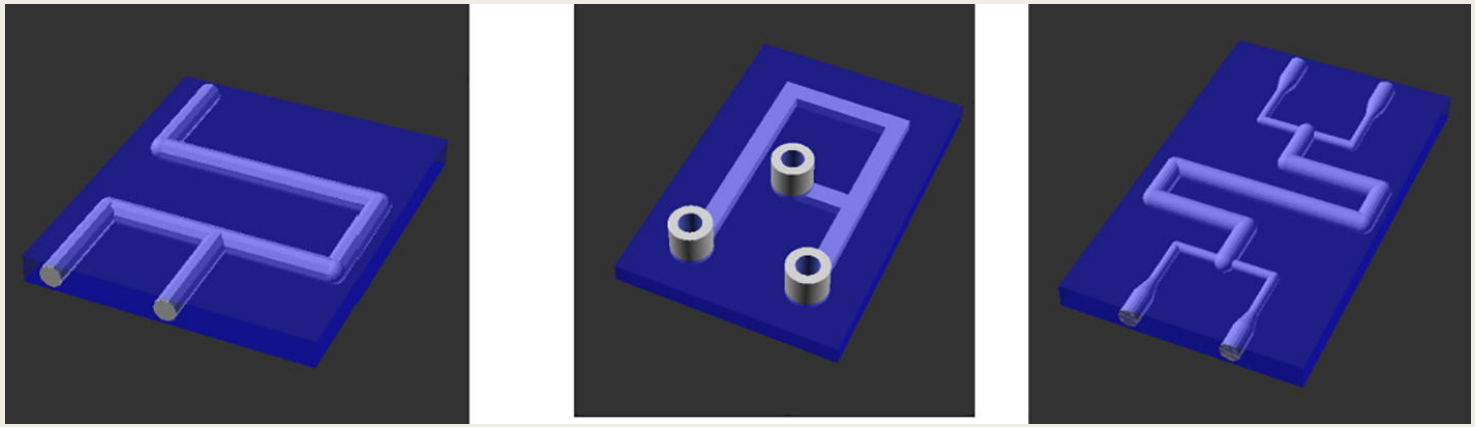
Bobthechemist.com/omis



Printing quality reaction chambers

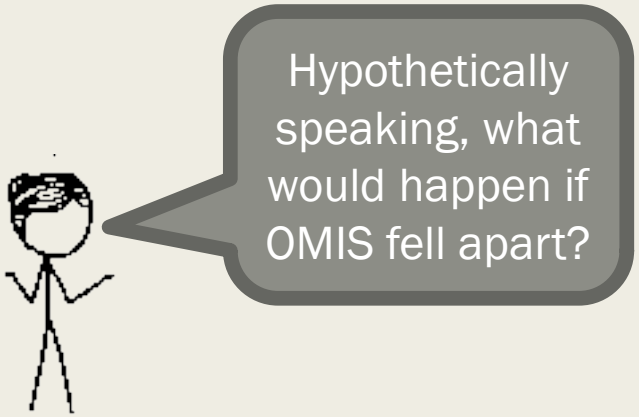
- For the 3D printing wonks in the crowd
- 100% infill
- 80% speed
- Smallest layer height
- Calibrate bridges
- Two types of PLA out there

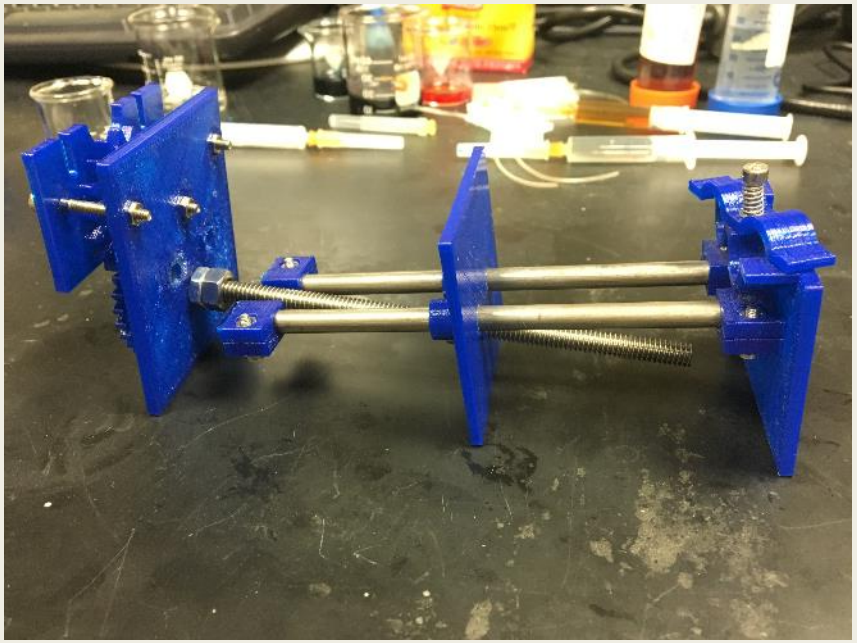


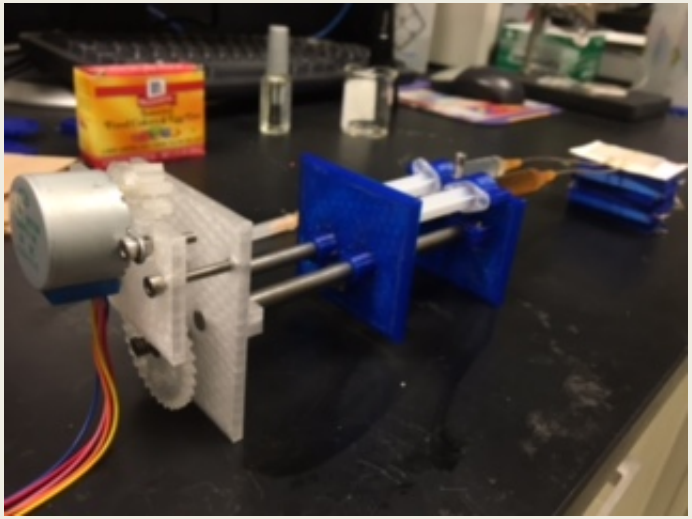
Introducing: Katie

Dr. LeSuer, now you wouldn't make your wife do stupid poses, would you?

Of course not, never.

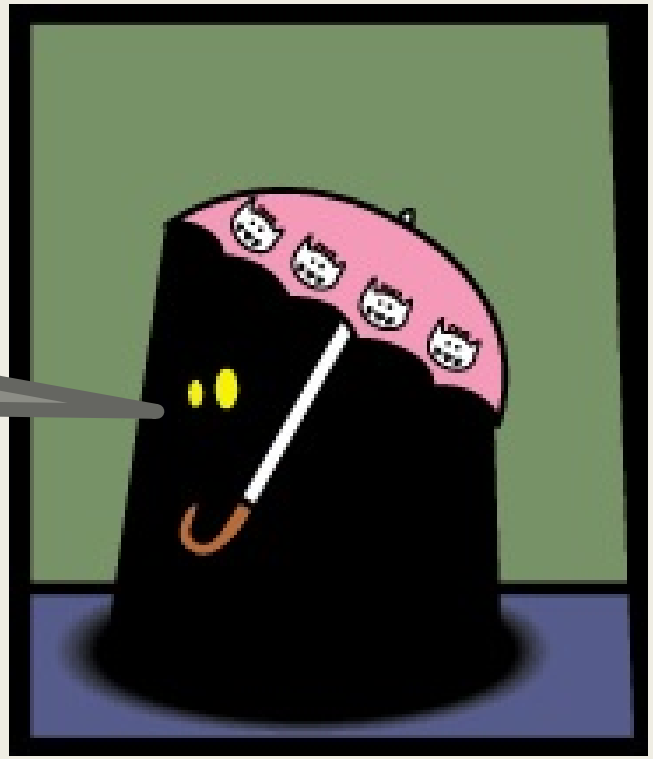




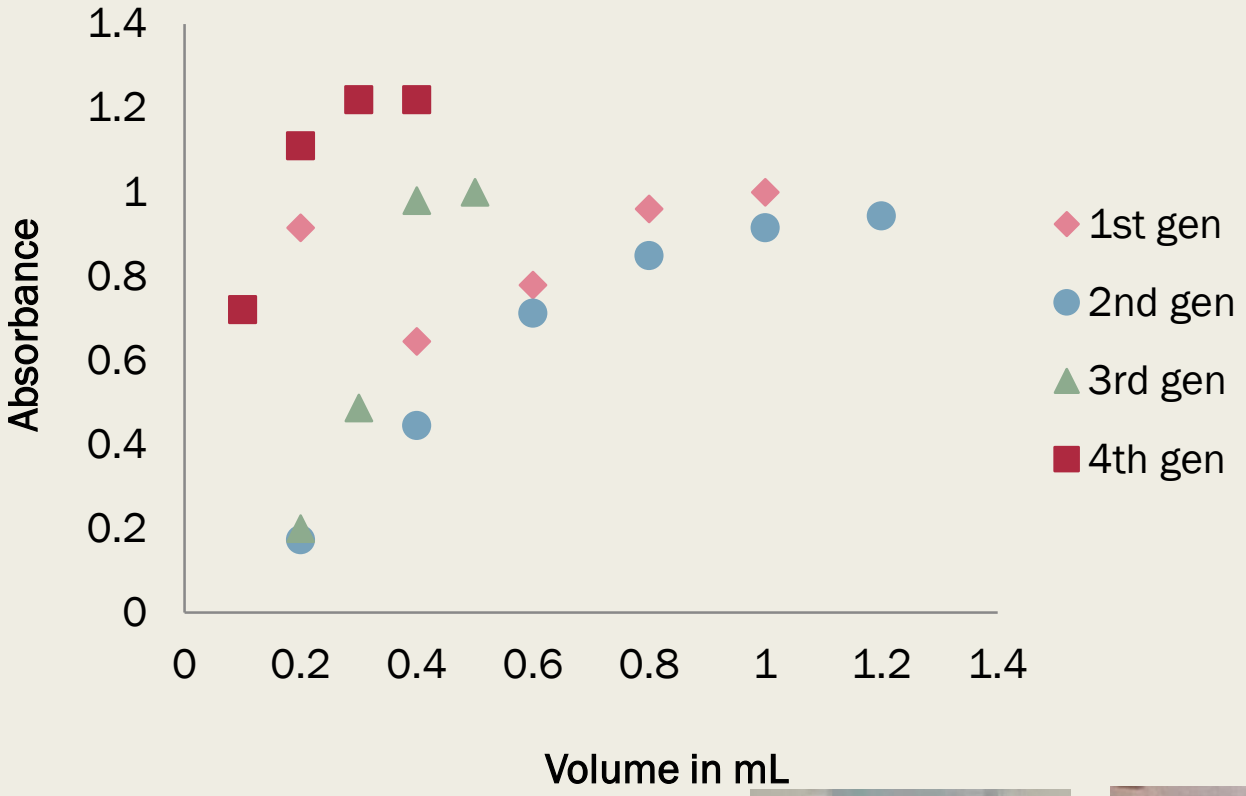


New lab motto: You break it, you make it (after you propose an improvement)

Introducing: Jose

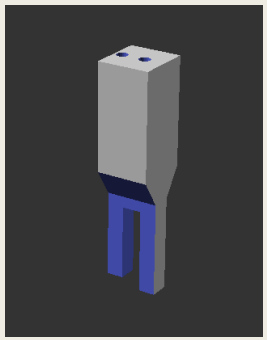


Custom visible flow cells



Volume needed to reach absorbance of stock solution

- A measure of the *mixing* volume of flow-through cell



CAD design

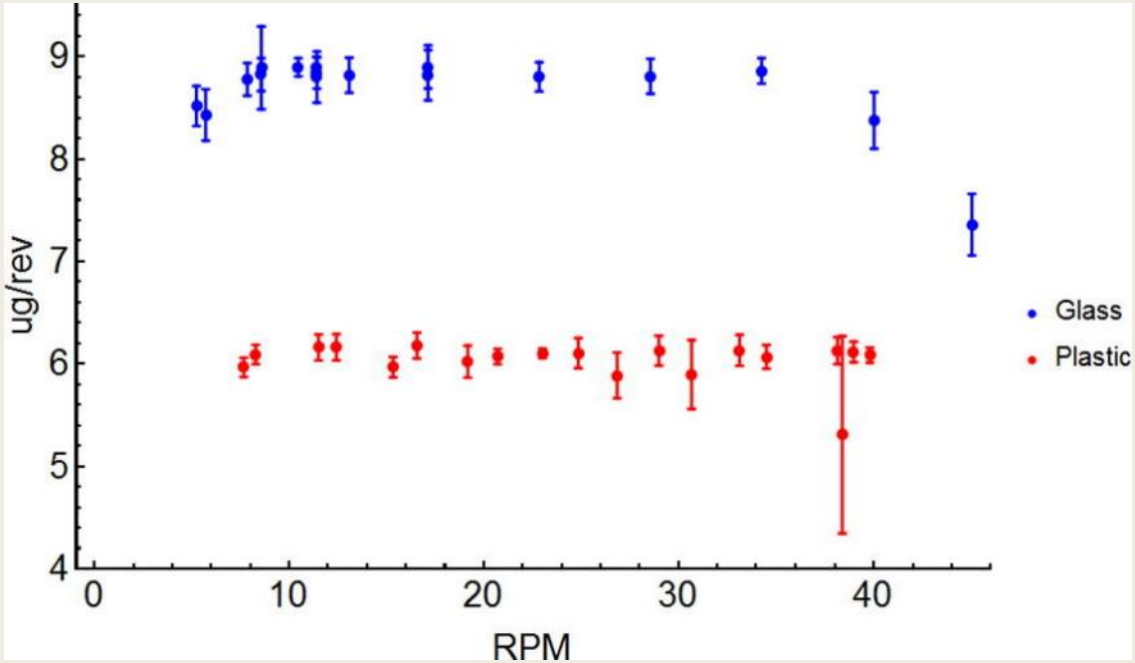
1st gen

2nd gen

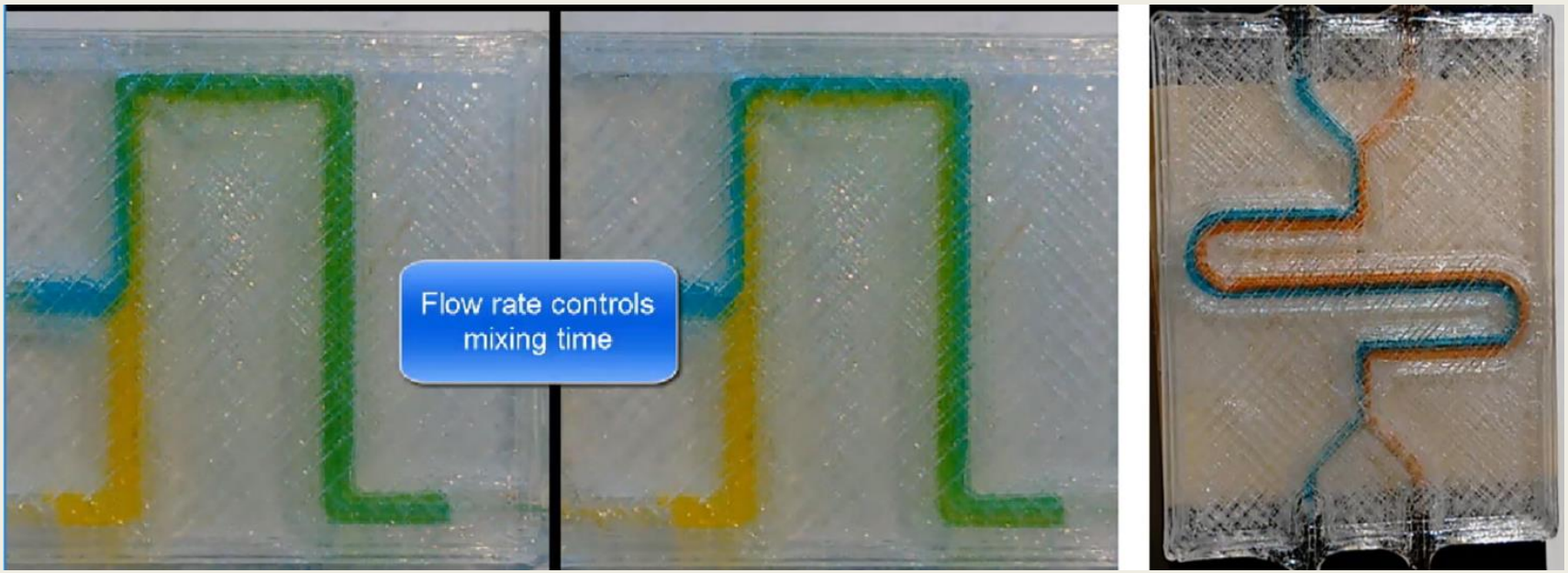
3rd/4th gen

Introducing: Keith

My whole research experience can be boiled down to one figure?!?!?



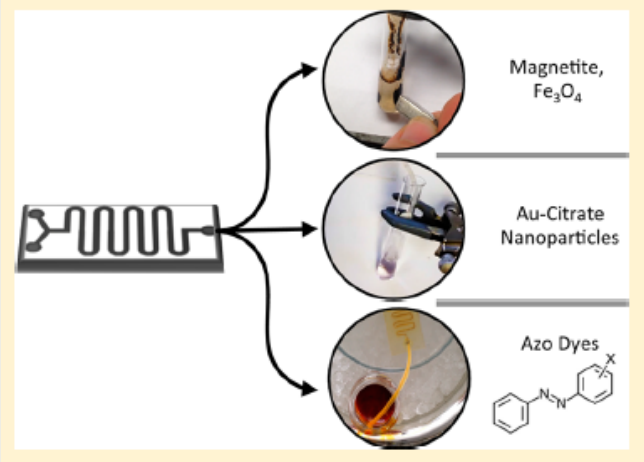
Laminar flow

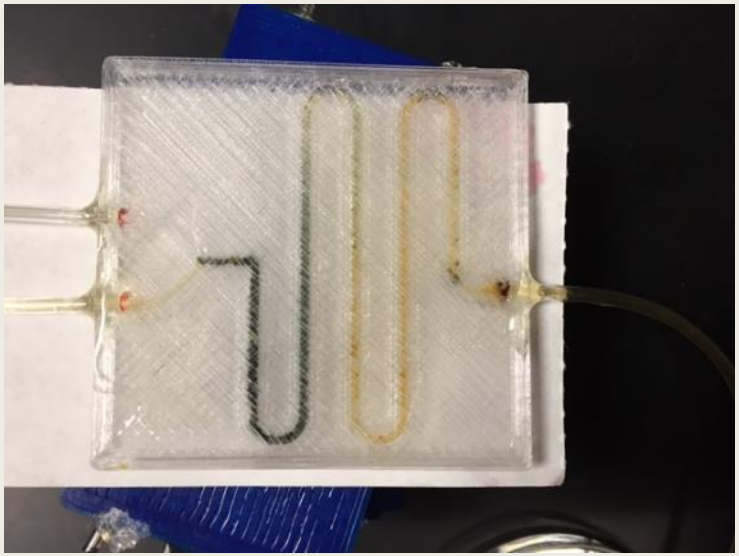


https://ars.els-cdn.com/content/image/1-s2.0-S246806721830052X-mmc3.mp4

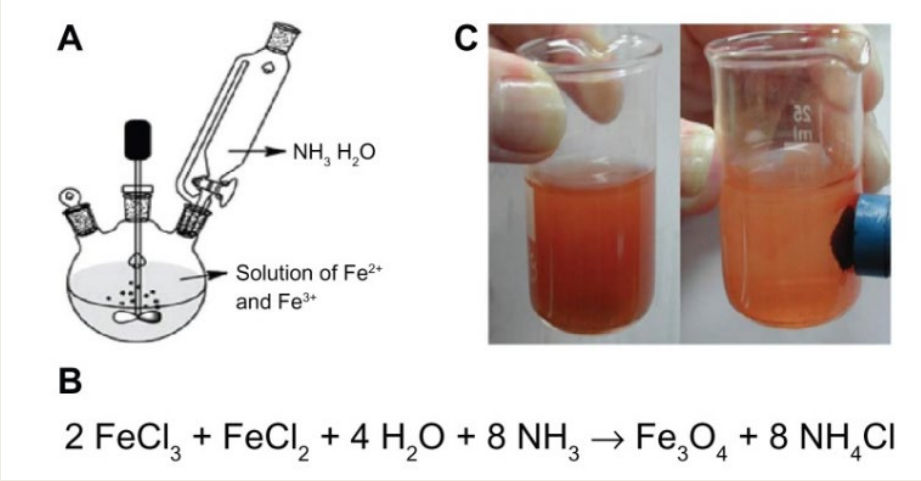
Using OMIS

Question: Can our OMIS – 3D printed millifluidic devices do microfluidic chemistry?

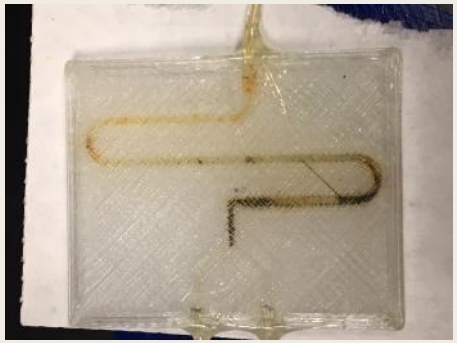


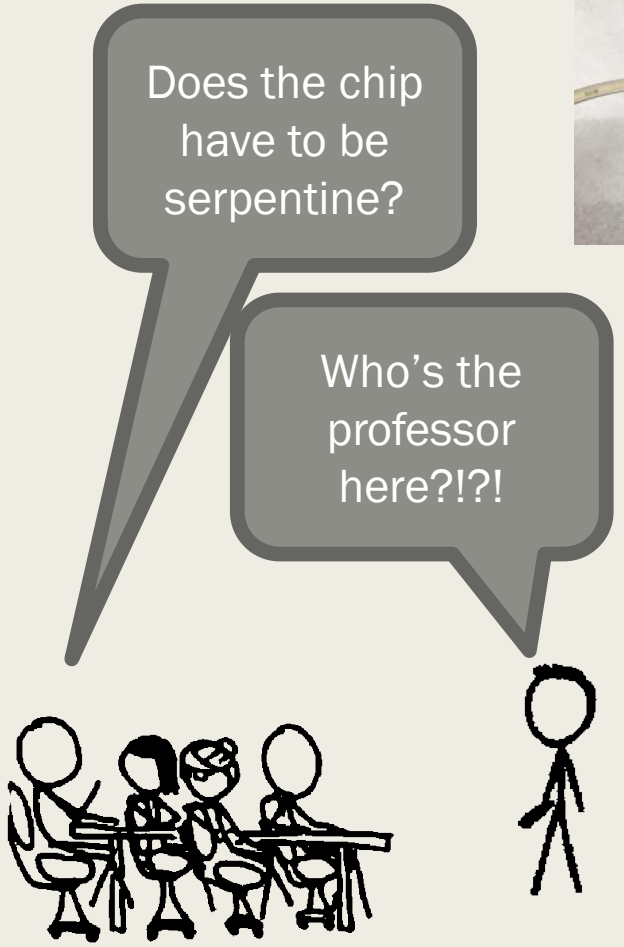


J. Chem. Educ. 2015, 92, 723



Critical thinking in the laboratory





Introducing: Megan

Quick connect for break seq.scad - OpenSCAD

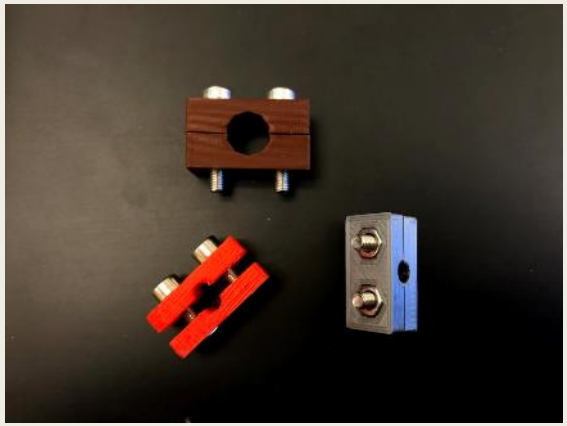
File Edit Design View Help

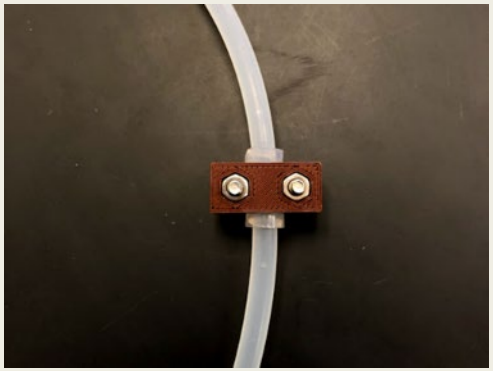
Editor

```
quickConnectX=10; //x-length of device
quickConnectY=22; //y-length of device
quickConnectZ=12; //z-height of device
nutDiameter=6.4; //nut trap diameter
nutHeight=2.35; //thickness of nut trap
boltHole=3.6; //bolt hole diameter
tubingDiameter=8; //inner tubing hole diameter
lipDiameter=7.6; //diameter of lip
moveHoleX=quickConnectX/2; //x-distance for nut trap and bolt holes

difference(){

cube([quickConnectX,quickConnectY, quickConnectZ]);
    //entire quick connect device

union(){

    translate([2,quickConnectY/2, quickConnectZ/2])
    rotate(90,[0,1,0])
    cylinder(h=quickConnectX-4,d= tubingDiameter,$fn=10);
    //tubing hole-inside

    translate([-1,quickConnectY/2,
```

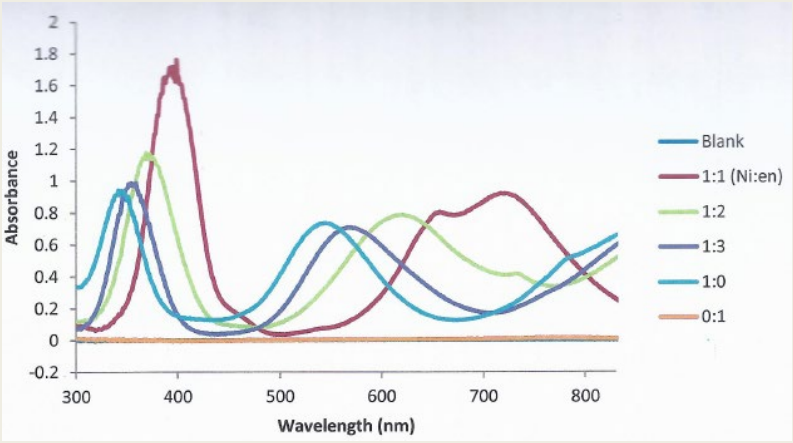
Viewport: translate = [2.93 2.27 1.17], rotate = [55.00 0.00 25.00], distance = 140.00

OpenSCAD 2015.03





$$Ni^{2+} + n(NH_2CH_2CH_2NH_2) \rightleftharpoons [Ni(NH_2CH_2CH_2NH_2)_n]^{2+} \quad (n = 1..3)$$

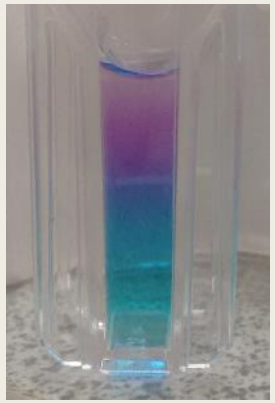


EXPERIMENTAL

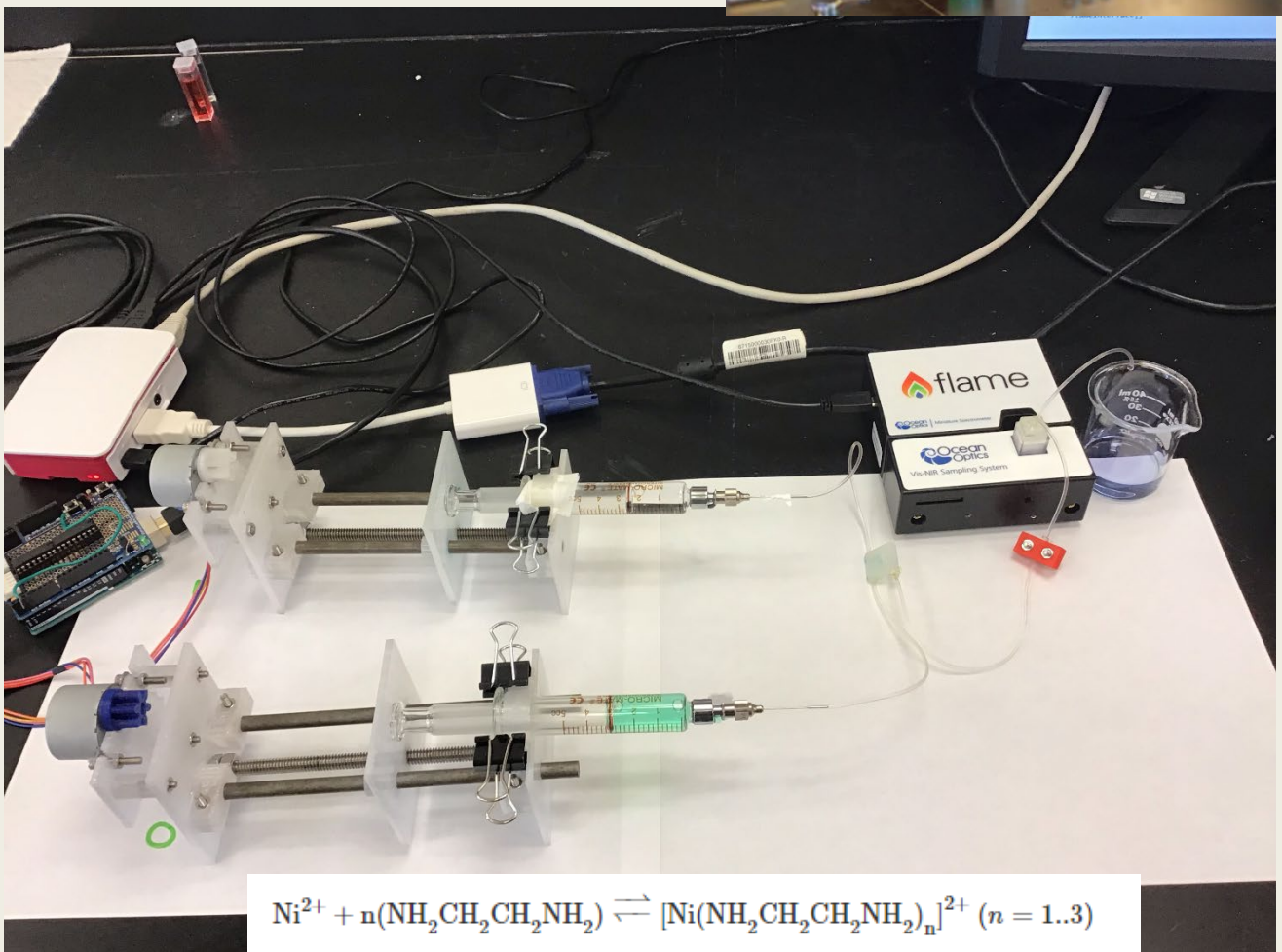
Data Collection

(1) Using deionized water, prepare 100 ml of a 0.40 M solution of nickel sulfate hexahydrate ($NiSO_4 \cdot 6H_2O$) and 100 ml of a 0.40 M solution of ethylenediamine ($H_2NCH_2CH_2NH_2$, density 0.899 g/ml).

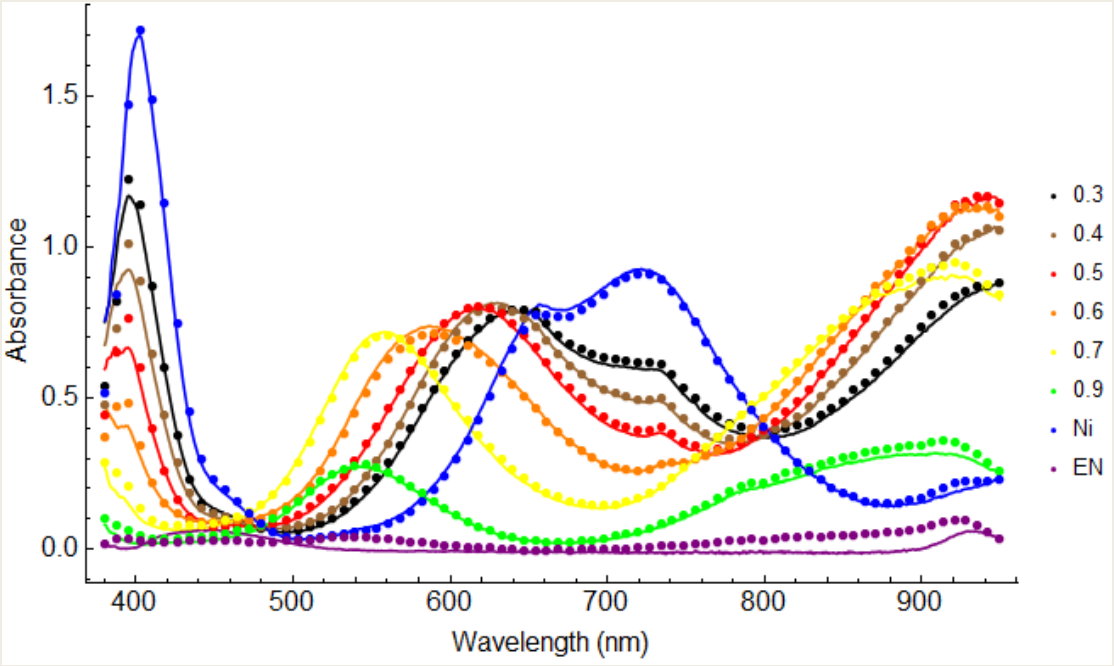
(2) Using pipets and these nickel(II) and en solutions, prepare 10 ml each of solutions in which the mole fraction of ethylenediamine is 0.3, 0.4, 0.5, 0.6, 0.7, 0.8 and 0.9.



Introducing: Calli

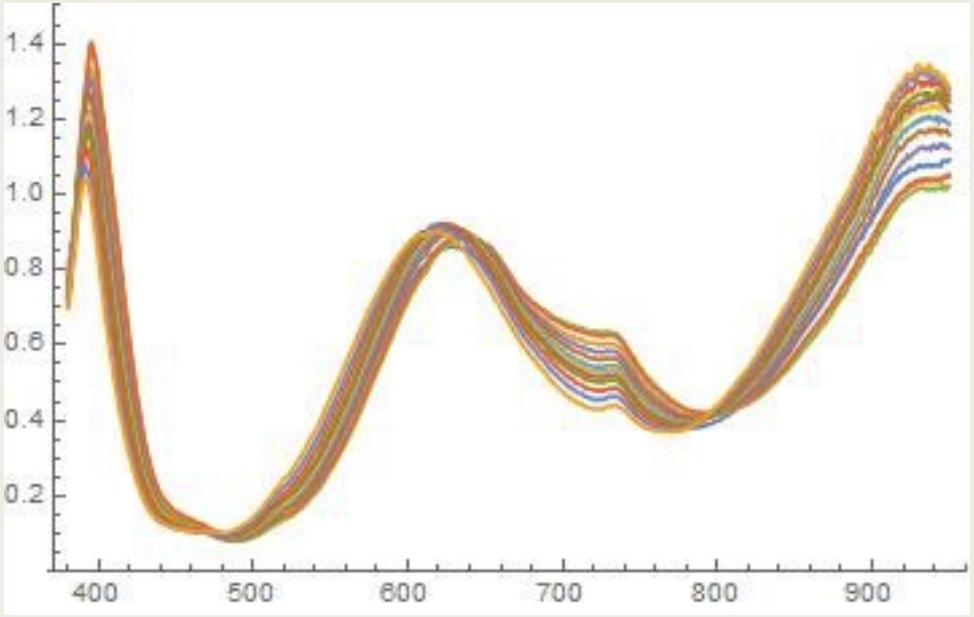


$$Ni^{2+} + n(NH_2CH_2CH_2NH_2) \rightleftharpoons [Ni(NH_2CH_2CH_2NH_2)_n]^{2+} \ (n = 1..3)$$



Spectra obtained with cuvette insert (dots) correspond to a ‘normal’ cuvette.

- Spectra obtained under continuous flow
- Measured every 30 s
- 240 uL/min total flow rate
- Pumps adjusted from 1:1 to 1:3 flow ratio

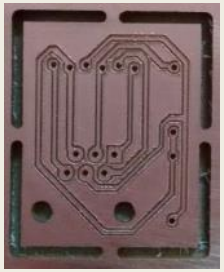


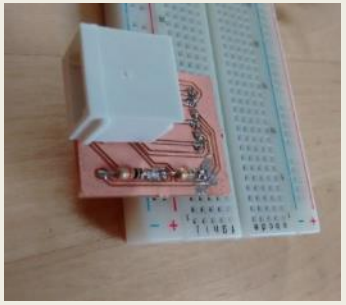
Bespoke data acquisition systems for increased flexibility

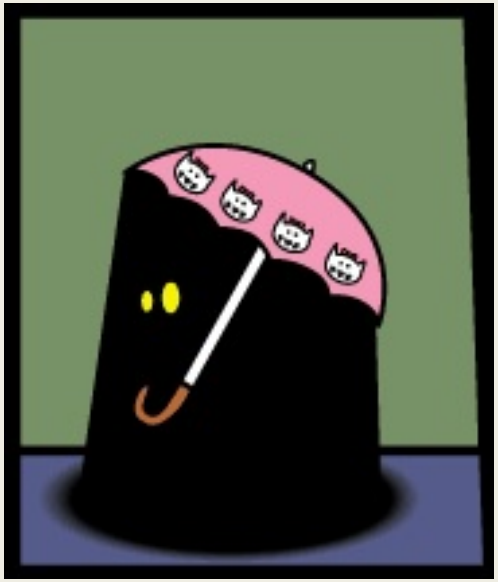
Build your own

~ $100 in parts

“Print” circuit boards with a CNC mill







Scientific measurements, reimagined