

Measurement Sheet

Lab #5: Paper-based Microfluidics

MIT Nanomaker_Spring 2013

Experiment #1: Design Parameters

- a) Determine the appropriate bake time (120°C) and wax line width required to make a microfluidic channel on paper. You may use the table below to record your results. *Hint: ensure that the paper test structure is not tilted and that the back of the paper does not come into contact with the table.*

↓Wax line width	Bake time→	1'	2'	4'
0pt (=100μm)				
0.25pt (=200μm)				
0.5pt (=300μm)				
0.75pt (=400μm)				

- b) Using the results from above, characterize the performance of different channel widths on the rate of flow. Record your results below. *Hint: use the micropipettor to ensure uniform droplet size.*

↓Microfluidic channel width	Flow rate (mm/min)
0.75mm	
1.25mm	
1.75mm	
2.25mm	
2.75mm	
3.25mm	

Experiment #2: Testing Chemical Indicators

Using the three chemical indicators listed below, record in the data table how each of the unknown solutions reacts with the indicators.

Turmeric solution (acid/base indicator). The turmeric solution turns from yellow to red in the presence of a strong base ($\text{pH} > 7.5$)

Benedict's solution (reducing sugar indicator). Benedict's solution reacts with reducing sugars, causing it to turn from blue to brown when heated (120°C)

Ninhydrin solution (amine indicator). Ninhydrin solution reacts with amines, causing it to turn from light pink to a dark purple.

Solution →	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
Turmeric										
Benedict's										
Ninhydrin										

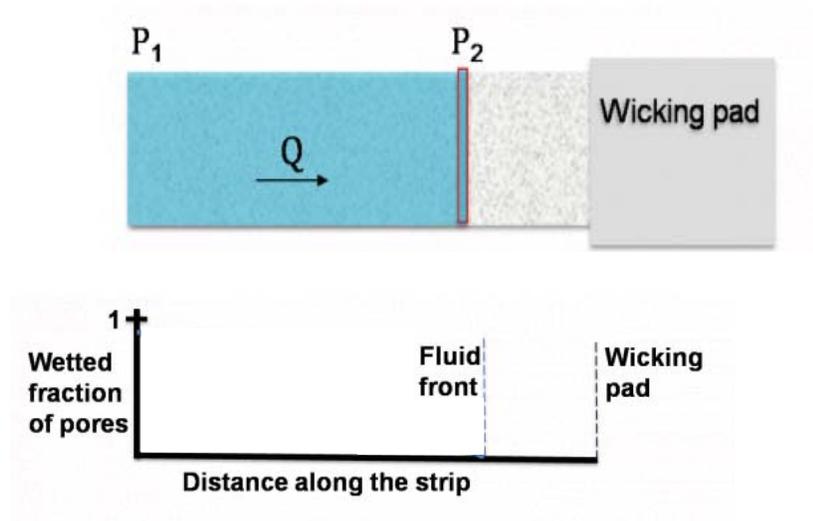
Experiment #3: Designing a Microfluidic Sensor

Break up into groups. Discuss with your group a design for a mult-chemical sensor that includes each of the three indicators.

A couple of goals to keep in mind: 1) Make your designs as small as possible to use the least amount of paper, wax, and liquid. 2) Be creative! Remember, you can print almost any design with the wax and the ink indicators.

Follow-up Questions:

- Please plot the wetted fraction of pores for the case of wet-out strips of porous material.



- Can you use paper microfluidics we make with wax printers to test alcohol content of liquids? Why or why not?
- Tests with paper microfluidics are very slow. What could you do to speed it up?

- Darcy's law is a simple proportional relationship between the instantaneous discharge rate through a porous medium, the viscosity of the fluid and the pressure drop over a given distance.

$$Q = \frac{-kA}{\mu} \frac{(\Delta P)}{L}$$

where the total discharge, Q [m³/s] is equal to the product of the permeability of the medium, k [m²], the cross-sectional area to flow, A [m²], and the pressure drop ΔP [Pa], all divided by the viscosity, μ [Pa.s] and the length L [m] the pressure drop is taking place over.

Use the electrical circuit analogy, what is the fluidic resistance according to Darcy's law?

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