SMALL@SUNYBuffalo
Sensors & MicroActuators Learning Lab

University at Buffalo
The State University of New York

An Innovative Wax Based Approach to Low Cost, Rapid Prototyping of Microfluidic Devices

Liam Christie, Phil Schneider, Tyler Siskar, Nicholas Eadie, Dr. Kwang Oh*
SMALL (Sensors & MicroActuators Learning Lab), Department of Electrical Engineering
University at Buffalo, The State University of New York (SUNY at Buffalo), Buffalo, New York, 14260, USA

Introduction

- Automated ideology and technology from traditional pysanky (Fig. 1.) to create a microfluidic manufacturing machine

Fig. 1. Depicts Pysanky Easter eggs. This is a Polish tradition involving the painting of Easter eggs using microscopic wax channels and tools.

Objective and Approach

- Rapid Prototyping of microfluidic devices
- Minimizing Cost and Time of production
- Eliminates use of harmful chemicals found in the clean room
- Allows for versatility in the production through a set of variable drawing parameters

System Overview:

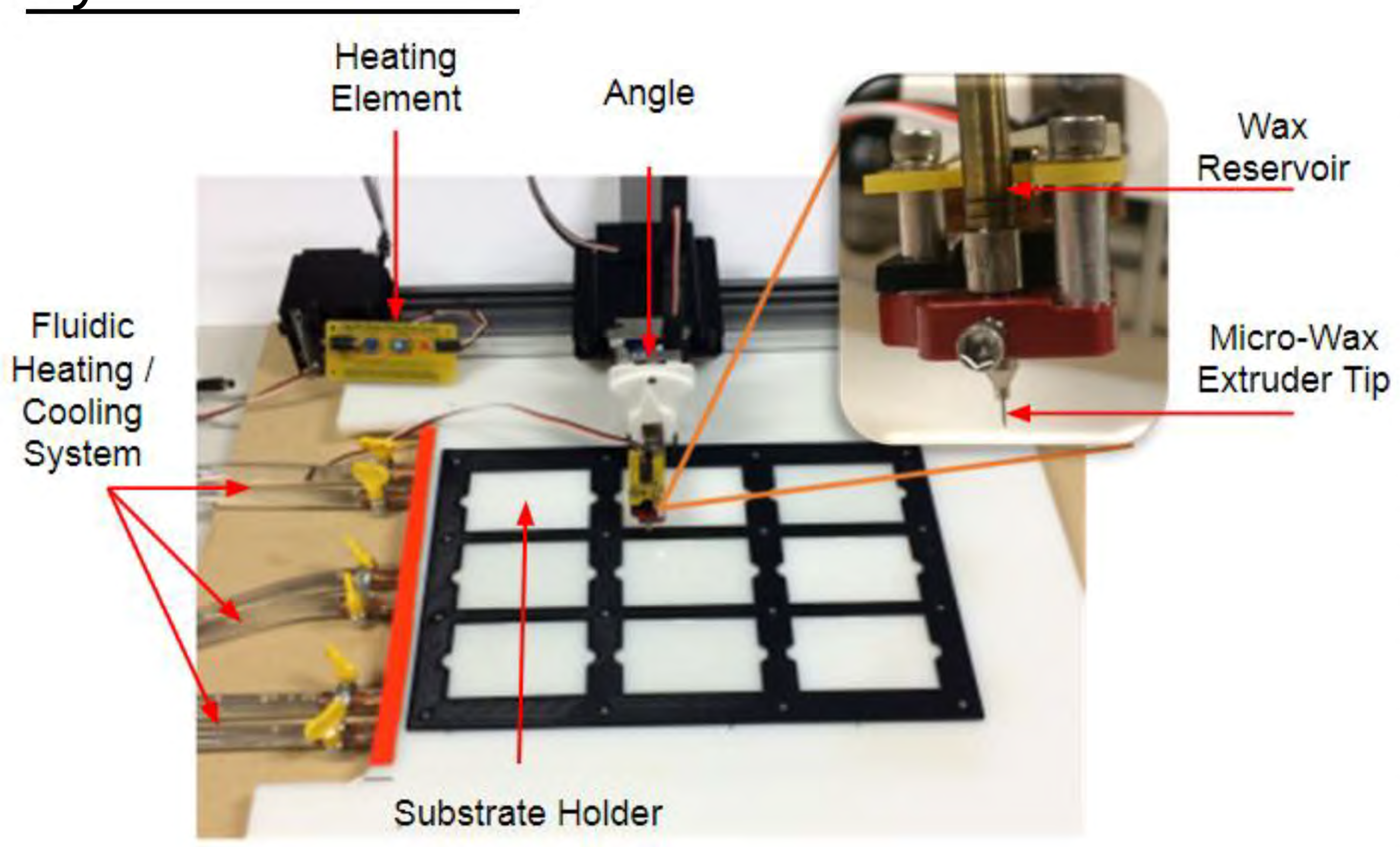

Fig. 2. The microfluidic system overview outlining the major components of the wax micromachining equipment.

Methods

- A new process for the creation of microfluidics was formulated (Fig 3.)
- Allows for the elimination of all clean room processes and chemicals

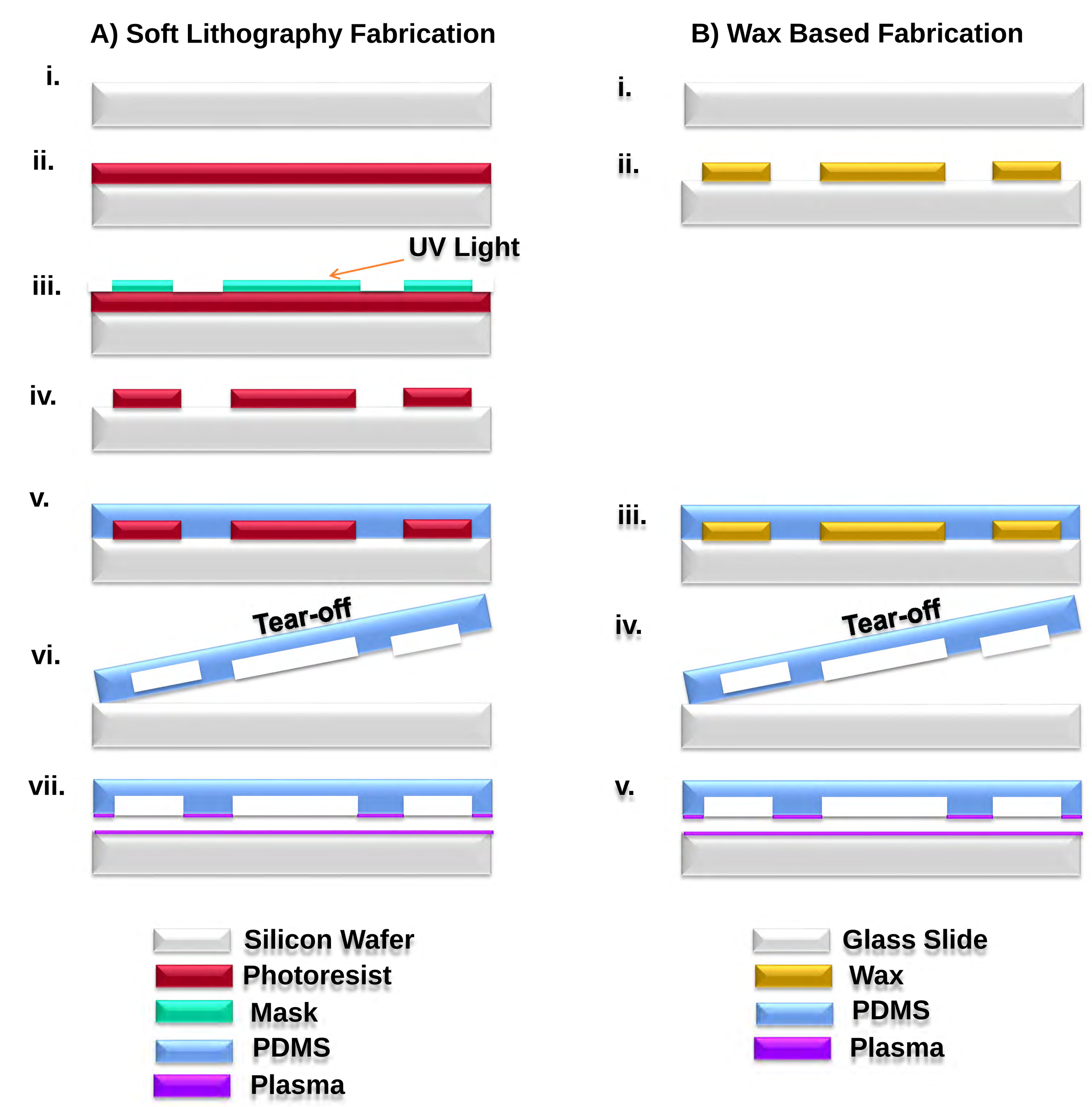

Fig. 3. Depicts both fabrication methods of Photolithography and Wax Microfluidics

Optimization

System was optimized through both Taguchi and Software methods allowing for:

- Increased channel uniformity
- Faster write speed
- Increased Resolution
- Predictability

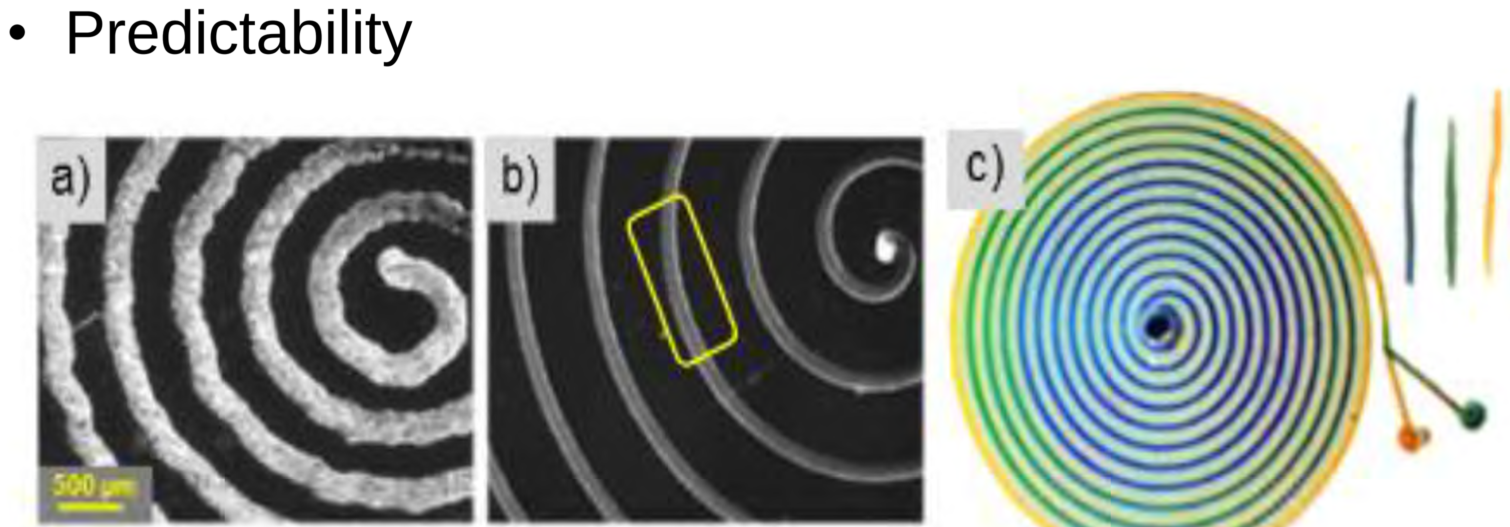

Fig. 4. A) and b) show the before and after system optimization using software optimization. C) shows a completed micromixer mixing yellow and blue dye to create a green mixed dye. Optimization components including writing speed, wax temperature, substrate temperature, and wax tip diameter were manipulated in the optimization of the system.[2]

Results

- 3 different applications were created and tested (Fig. 4, 5, 6)
- Color gradient testing was used on all three devices with different colored dye mixtures
- Serial dilutors were tested using fluorescent dye mixing to produce a microscope image and graph (Fig. 6)
- Tradeoffs in resolution and uniformity was compared to traditional microfluidics

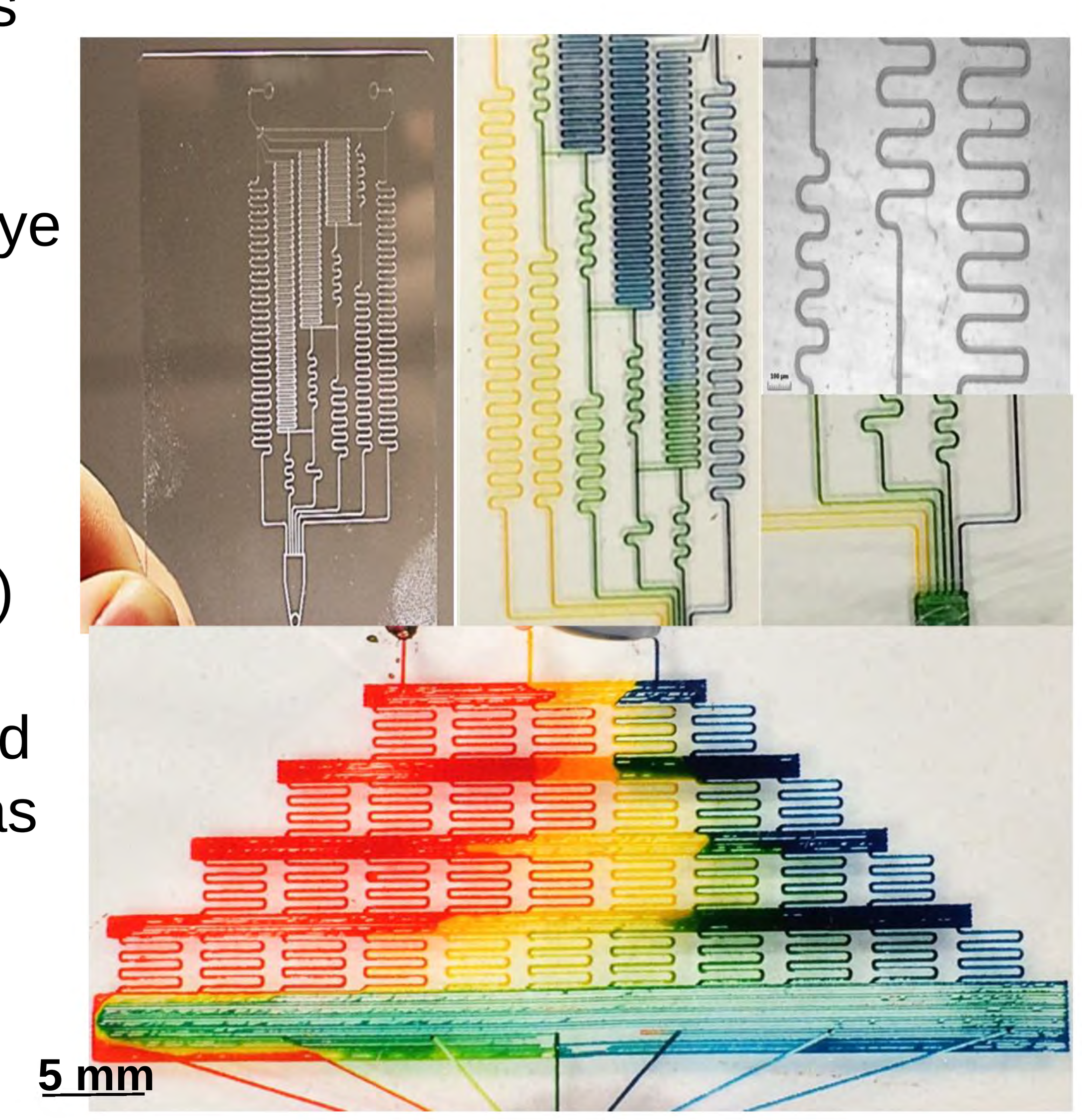

Fig. 5. Serial dilutor from wax to final microfluidic system. Also a picture depicting a rainbow mixer.[1]

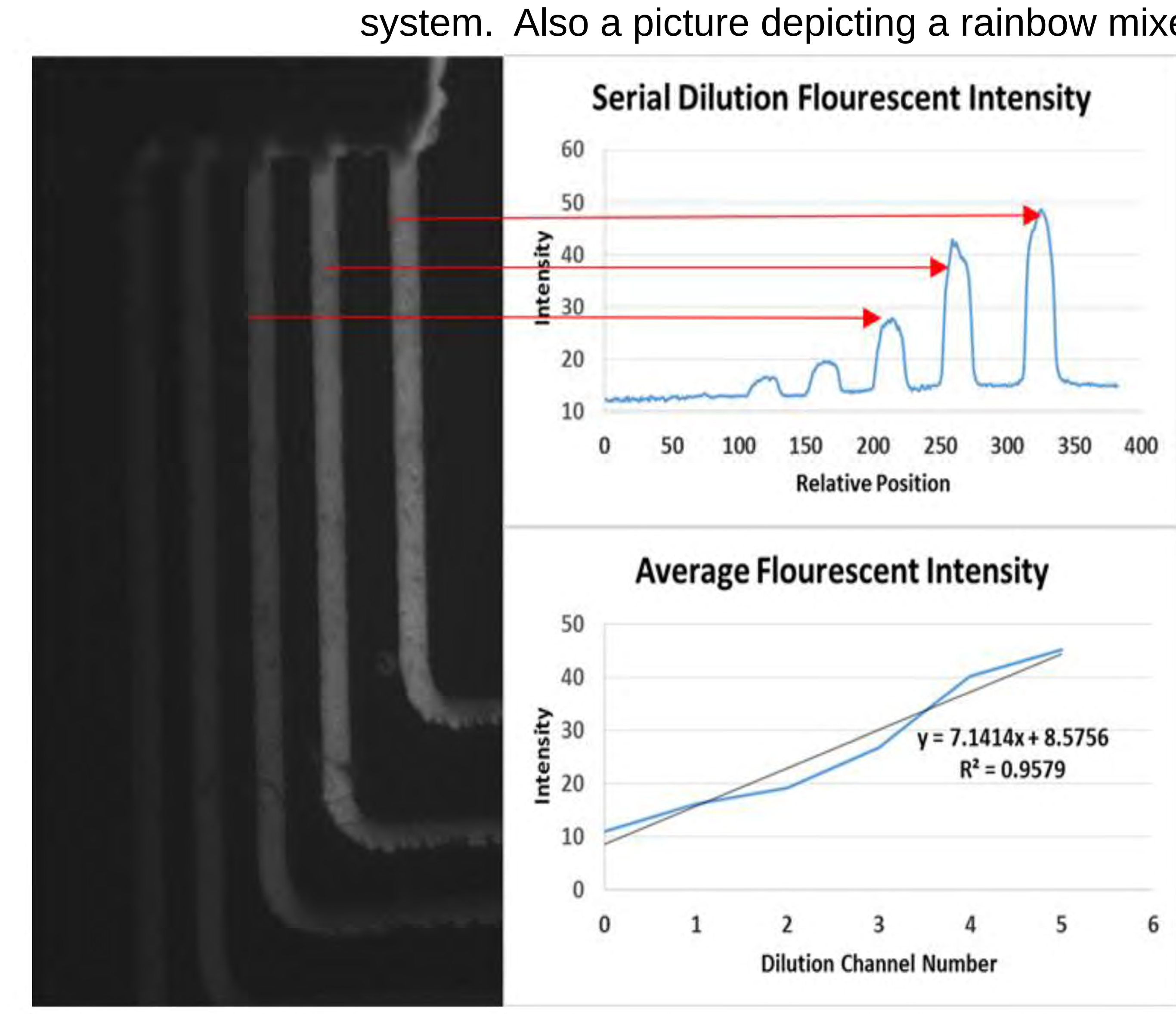

Fig. 6. Linear serial dilution was conducted on a wax device. This device was tested for the intensity of fluorescent dye yielding the graph on the top right. The bottom right graph was compared to the results of a cleanroom manufactured serial dilutor yielding similar results

References

1. Grimes, A., et al., Shrinky-Dink microfluidics: rapid generation of deep and rounded patterns. Lab on a Chip, 2008. 8(1): p. 170-172.
2. Li, Z.a., et al., Fabrication of PDMS microfluidic devices with 3D wax jetting. RSC Advances, 2017. 7(6): p. 3313-3320.