Microfluidics Microscope

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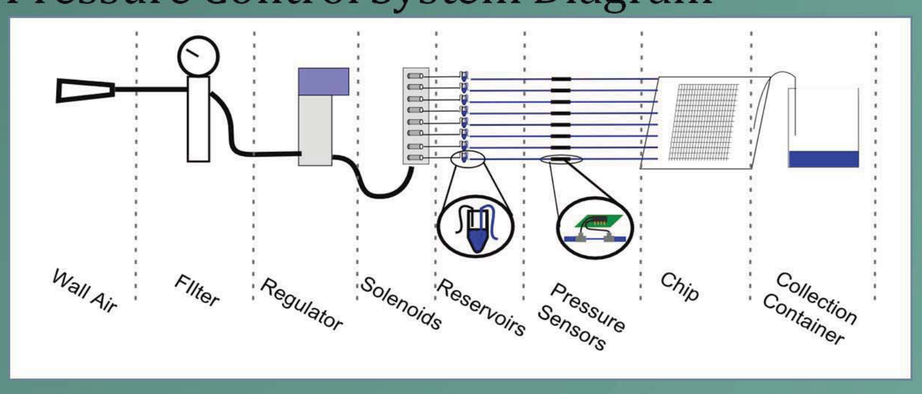
Microfluidics research and development can provide solutions to many applications. The Complex Fluids Group at Brandeis is studying protein crystallization using microfluidics devices. Under a National Science Foundation (NSF) Materials Research Science Engineering Center (MRSEC) grant, Brandeis is expanding their user facilities for conducting this research and sharing these capabilities with other laboratories. Last year's SCOPE team developed a prototype of an imaging platform for the Brandeis Microfluidics Lab; this year we have refined this prototype and added new systems to provide more functionality. A pressure control system has been implemented, which allows the user to observe and control pressure driven-flow of liquid through the microfluidics chip. The pressure-based flow is driven by a digital pressure transducer and is regulated using a differential pressure sensor along the fluid path. A temperature stage provides on chip temperature conditions between -13°C and 60°C (with a maximum temperature gradient across the stage of 37°C). The temperature is controlled using a combination of PID and feed-forward controls and is capable of reaching steady state in under 3 minutes. We redesigned the circuitry as well as the electronics box to support the existing and additional systems. Finally, the team continued to develop a user interface in LabVIEW which images the chip, controls the various experimental systems, and addresses the needs of the Brandeis Lab.

Pressure System

Pressure Control System Diagram

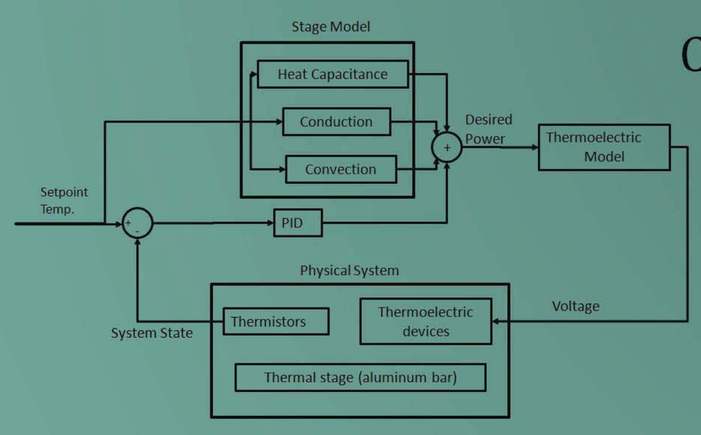


Fluid is driven by pressure from the reservoir through the chip and into the collection container.

Pressure System Description

- LabVIEW drives a digital pressure regulator which drives a flow into the microfluidic chip
- Utilizes differential pressure sensors to measure flow rate
- $2100 for 8 lines, vs syringe pumps $1800 for 1 line
- Drives flow between 75-700 uL/min

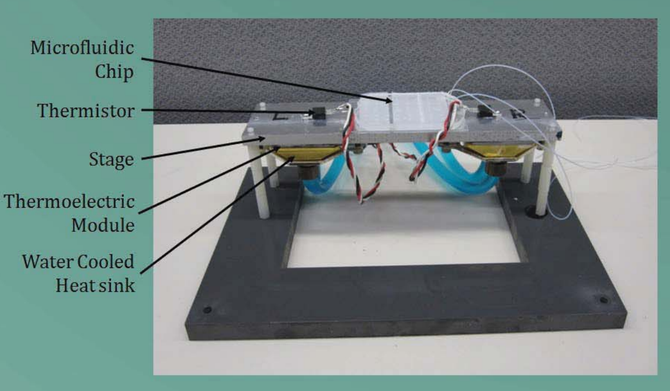
Temperature Stage



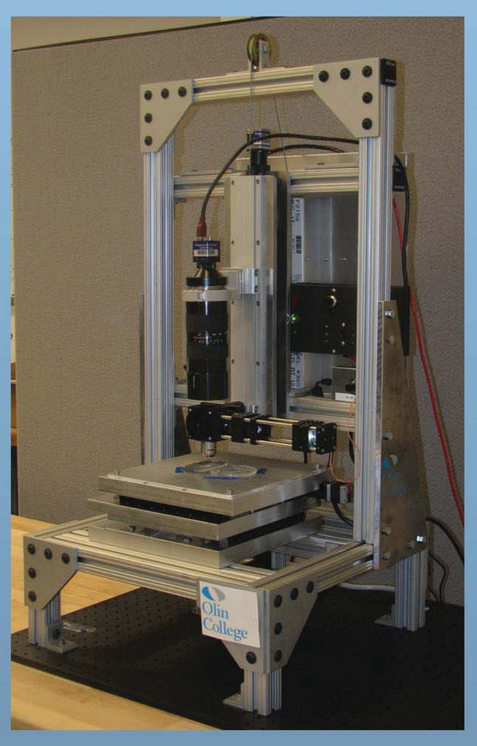
Control Algorithm

The control algorithm employs a combination of PID and feed forward to determine the appropriate power output to achieve the desired temperature.

Temperature Stage

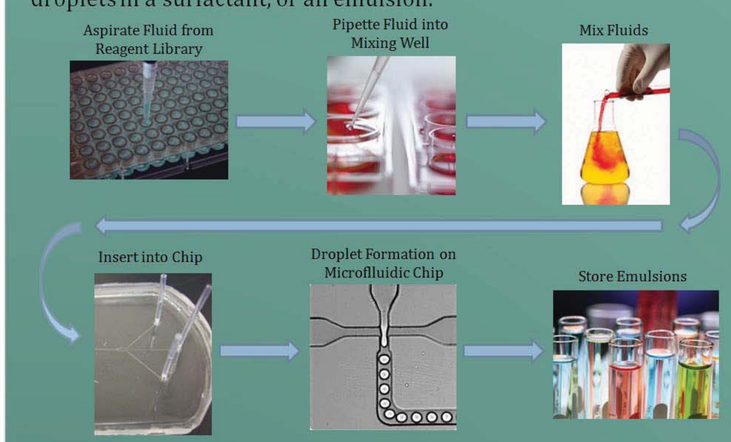


Modular Microfluidics Microscope System



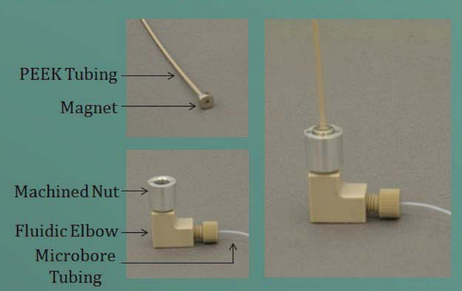
Emulsion Generation Process

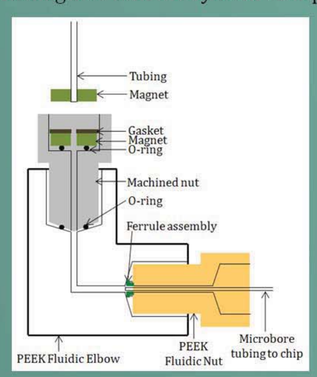
The purpose of the emulsion machine is to automate the process of mixing the fluids and pushing them through a microfluidic chip to form droplets in a surfactant, or an emulsion.



Chip Dock Concept and Prototype

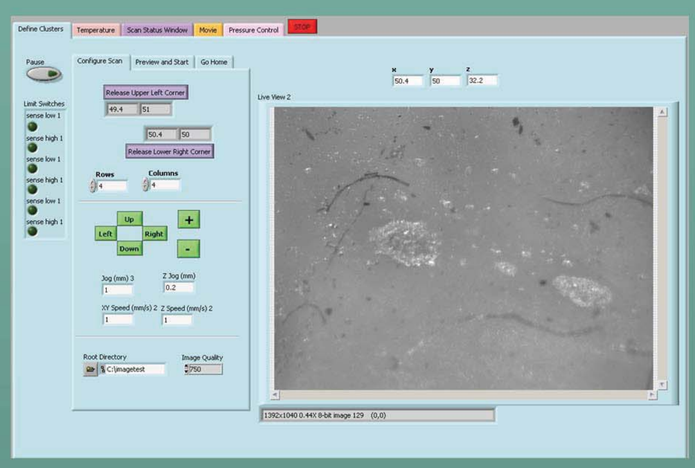
The chip dock connects the tubing from the syringe pump to the chip, and magnets seal the system so liquid can be pumped through the microfluidic chip and output an emulsion.

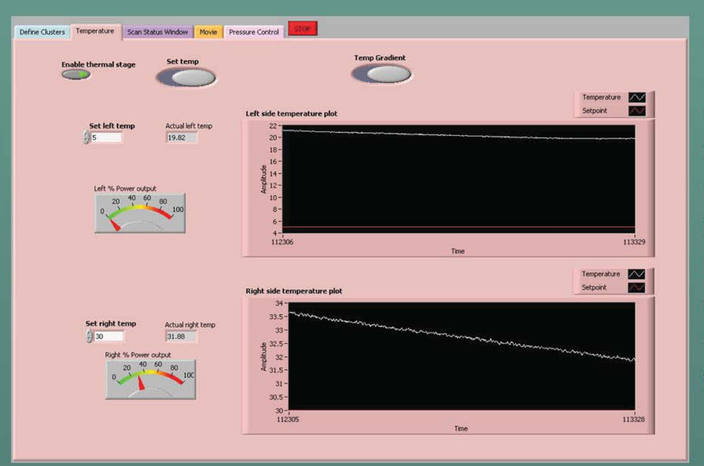




Emulsion Machine

User Interface





LabVIEW Interface

- Controls XYZ motion of the microscope
- Programmed scanning and imaging
- Thermal stage control
- Syringe pump control
- Pressure driven flow regulation