Introduction: Microfluidic large-scale integration (mLSI) is an emerging field that has the potential to offer many benefits in biological experimentation and technology development. mLSI offers reduced costs and sample size, while maintaining high-throughput in biochemical tests and experiments. Since the field is new, relatively few engineers and scientists are trained in the area and therefore there is a need to outsource microfluidic chip design and microfabrication. Moreover, pneumatic control systems, and the use of solenoid valves make mLSI technology bulky and limits its use to specialized labs. Eliminating the peripheral equipment from standard testing protocol will allow for more widespread usage of this powerful technology. Our device is a portable, powerless controlled alternative to mLSI that operates without the use of this costly complex equipment.

Materials and Methods: For the fabrication of our devices, standard photolithography and softlithography processes were employed. We made use of both SPR positive photoresist and SU-8 negative photoresist to fabricate the channels in our microarray. Along with these photoresists, we used photoresist masks to selectively polymerize the photoresist on our silicon wafers. The softlithography section of the fabrication includes a two-part polymer referred to as PDMS (poly-dimethyl-siloxane). The two-part PDMS mixture is then mixed and thermally cured. The final product is then removed from the silicon wafers, that have now translated the features onto the PDMS, and oxygen-plasma bonded to glass slides. Once bonded, a final thermal curing step is used to complete the device fabrication. Testing methods made use of pressurized air to actuate our valves.

Results and Discussion: Following the analysis of our data, we were successfully able to replicate pressure patterns that represent the required actuation pressures to successfully open and close valves on-chip. The pressures were recorded using an Arduino code, accompanied with pressure sensors that delivered a voltage read-out, which we standardized to represent an output pressure.

Conclusions: This novel system allows for portability and miniaturization since it requires minimal external equipment to successfully control and operate mLSI experimentation. We were successful in generating pressure values that represent the requirements for this type of microfluidic operation. Moving forward, we will begin to test a complete on-chip ELISA that will represent the biological testing benefits our design offers to the industry.

References
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