Development of Blister Packs for Microfluidic Point-of-Care Systems

Esther Low, Biomedical Engineering BSE, Global Health BS
Mentors: Dr. Jennifer Blain Christen, Vi Nguyen
School of Biological and Health Systems Engineering; School of Electrical, Computer and Energy Engineering

Research question: Do blister packs enhance usability of point of care (POC) devices, allowing them to be used without any training while maintaining repeatability and reliability of filling the device's reservoirs?

Introduction: A blister pack is a type of packaging that holds a material or chemical within a cavity and protects against environmental factors such as humidity and contamination. In the BioElectronics Systems and Technology (BEST) Lab, a point-of-care (POC) device was developed to detect multiple pathogens and deliver healthcare to underserved communities. The current device requires reagent injection, but integrating an on-chip blister pack can improve ease of use and safety by removing the need for syringes and minimizing exposure to hazardous reagents.

Methods:

1. Design and Modeling: A CAD model of the blister pack and test chip was created using SolidWorks.
2. Fabrication: The blister pack was fabricated using thermoforming plastic sheets and aluminum foil with a vacuum former.
3. Integration: The blister pack was integrated onto the modified POC cartridge using a press.
4. Testing Usability: Manual actuation tests were performed to determine the percent of volume exported out of blister packs of varying volumes (200, 250, 300, 350 µL)
5. Performance Evaluation: The functionality of the blister packs were assessed by analyzing the completeness and consistency of reagent delivery into the device's reservoirs, focusing on repeatability, reliability, and ease of use.

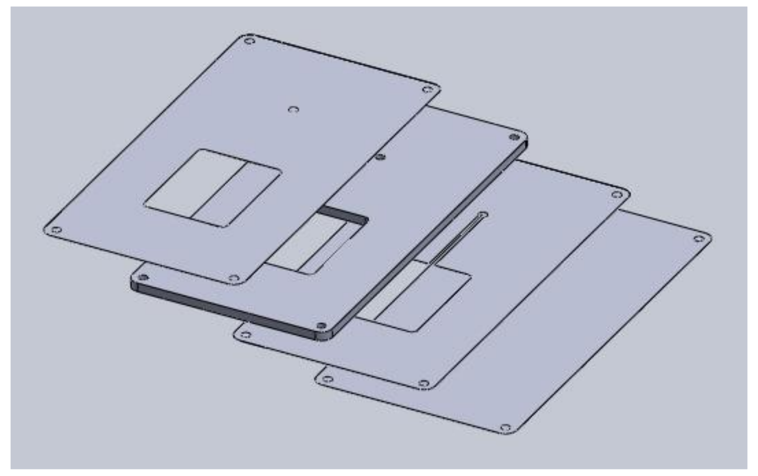

Figure 1. CAD Model of Test Chip
The test chip includes a total of 4 layers in the order of a layer of PET, PSA, acrylic, and PSA on top.

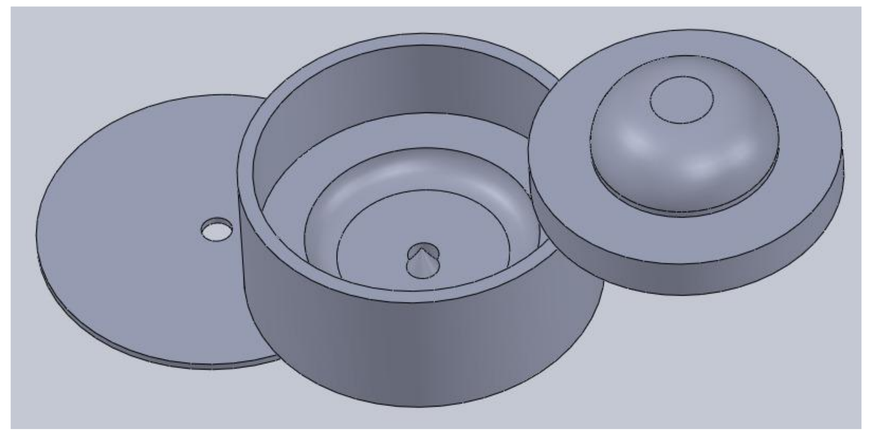

Figure 2. CAD Model of Blister Mold, Holder, and Adhesive
The blister mold was used to thermoform the set of blisters of varying sizes with PETG. The mold was created using a SLA printer.

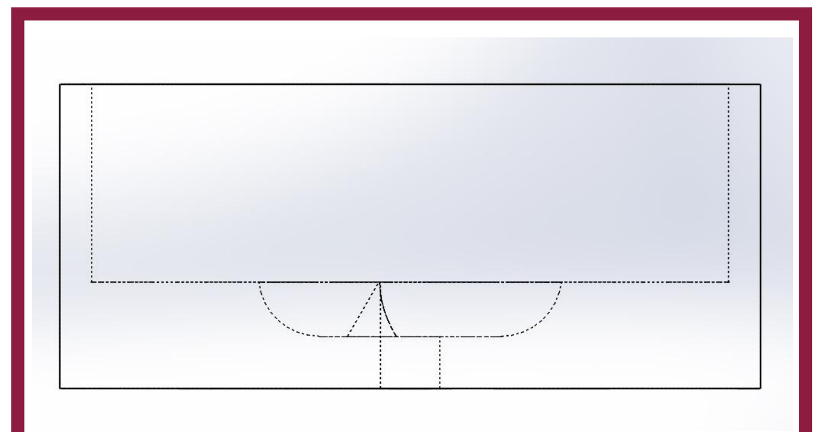

Figure 3. CAD Model of Blister Holder
The blister holder features a piercer meant to puncture the blister foil and release the liquid into the channel and well.

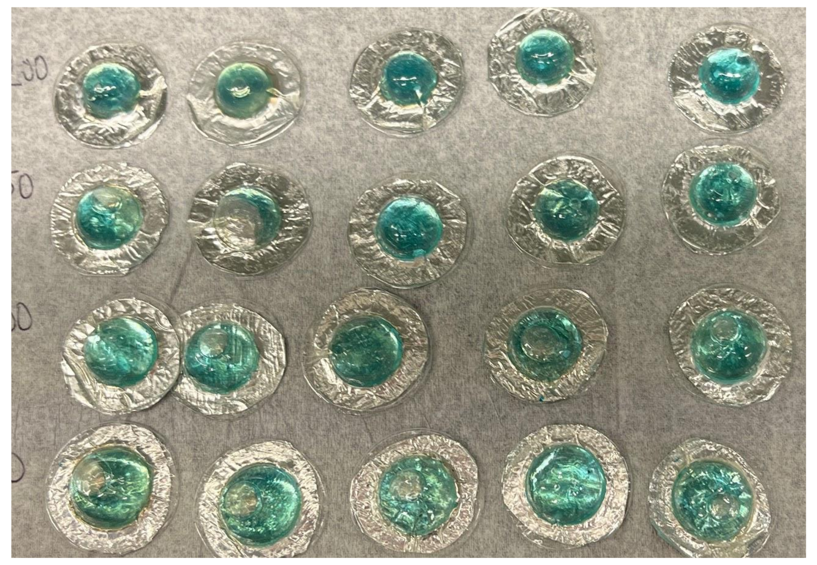

Figure 4. Set of 20 Blister Packs
A set of 20 blister packs is used in each experiment. Included in the set are 5 blisters for each of the following volumes: 200, 250, 300, 350 µL.

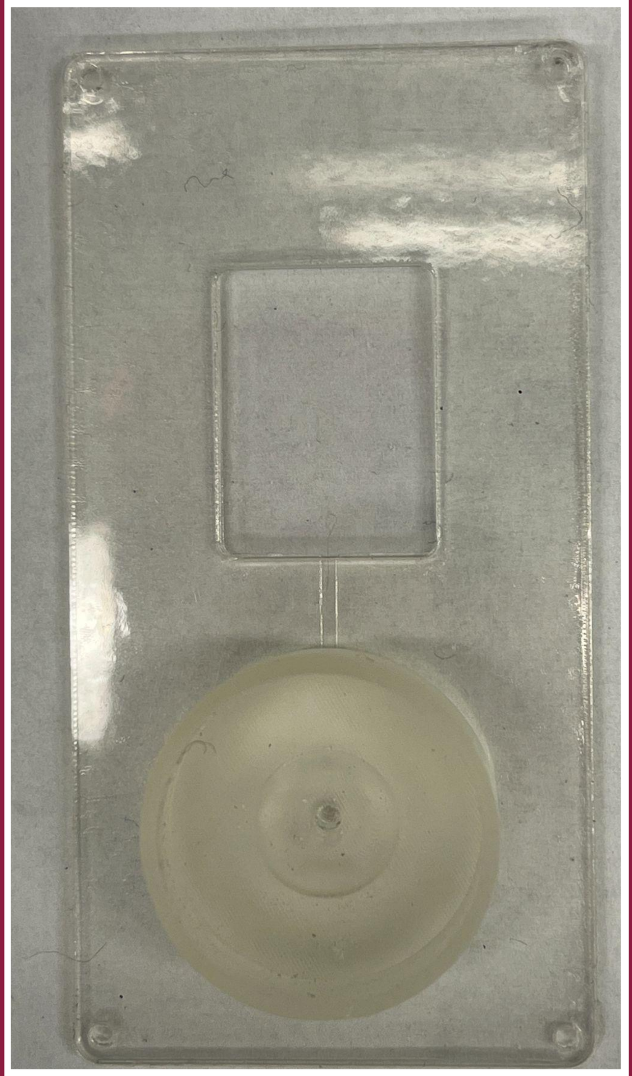

Figure 5. Test chip with blister holder attached

Figure 6. 250 µL blister before and after puncture on test chip
The blue liquid in the reservoir is the released volume from the blister.

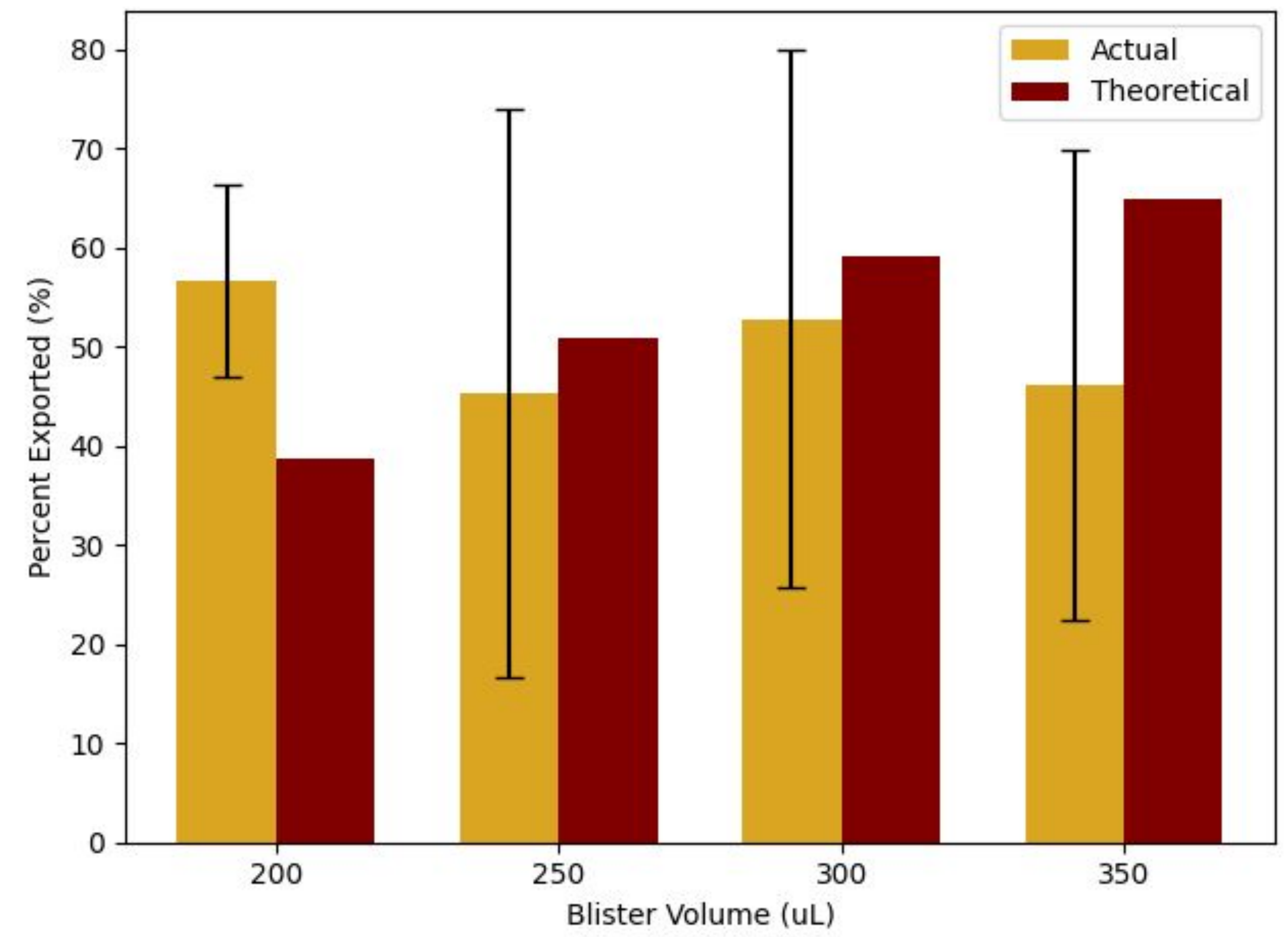

Figure 7. Graph comparing the percentage of volume exported out of the blister per blister volume.
The comparison between the actual and theoretical volume exported is shown above.

Conclusions and Future Work: Blister packs integrated into the test chip retained an average of 50.2% of reagent across 20 trials, with retention ranging from 45.3% to 56.6% depending on volume. While effective for on-chip storage, delivery efficiency varied with blister size, indicating a need for optimization. Future efforts will focus on improving consistency by refining blister design, testing new materials, and enhancing actuation methods.

Acknowledgements: I would like to thank Vi Nguyen for her overall contribution to this work and continued assistance.

FURI

Ira A. Fulton Schools of Engineering
Arizona State University