Development of a Mesofluidic Channel with Magnetic Panels for Precise Particle Size-Based Sorting

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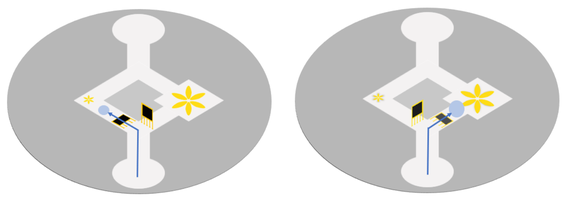
Introduction

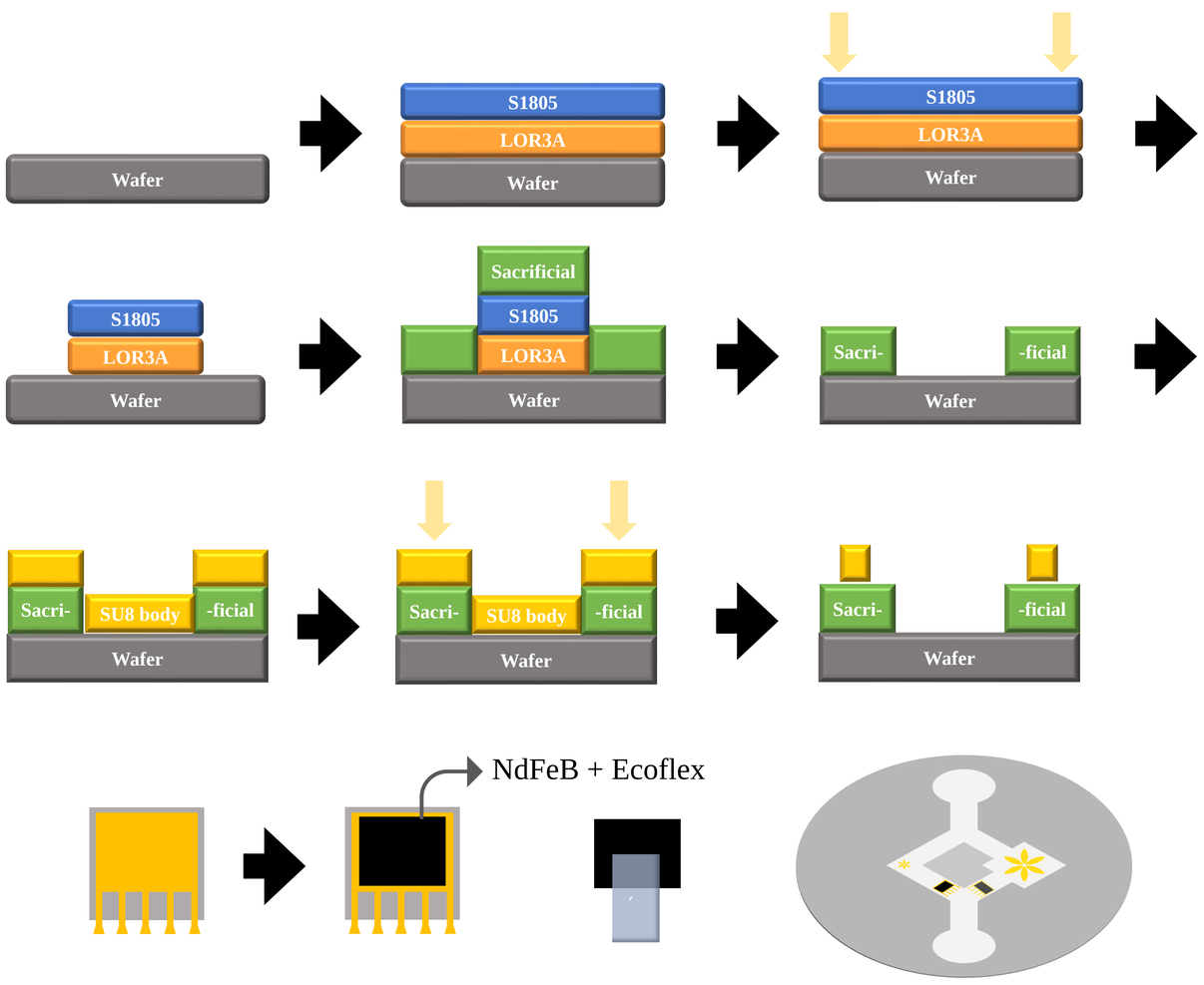
Recent advancements in organoid-based in vitro experiments have highlighted their importance in replicating complex biological environments. Particularly, research involving 3D organoids, fluidic channels, and mechanical components like grippers has shown significant progress in mimicking intricate physiological conditions. Despite these advancements, challenges remain in the precise sorting of particles or cells based on size and properties, indicating a need for innovative approaches.

This study addresses these challenges by developing a novel size-based particle sorting system using magnetic properties. By integrating magnetic panels within fluidic channels, fabricated through 3D printing and photolithography, this platform leverages external magnetic fields to control the opening and closing of specific channels. Unlike existing systems, this approach features magnetic grippers of different sizes within each channel, capable of capturing two different size of particles. This research stands out for its potential to create a customizable platform, offering enhanced precision and applicability in various experimental bioenvironments.

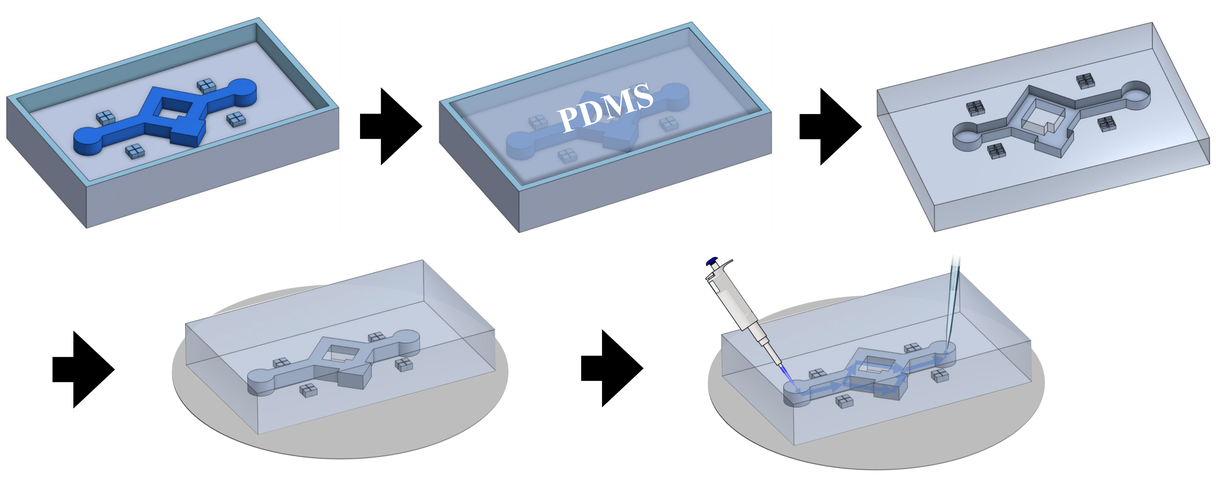


Experimental Methods

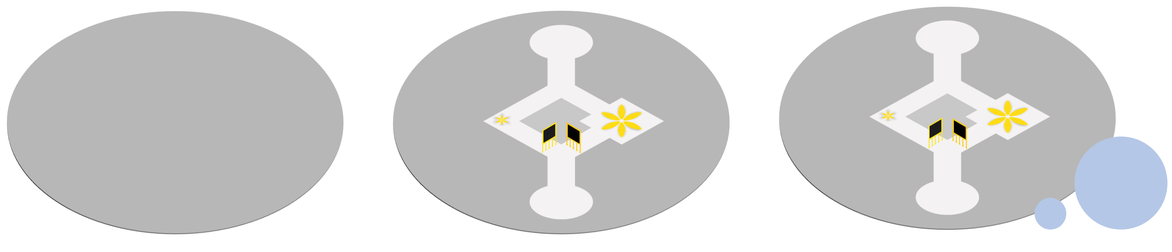
Panel & Gripper Fabrication



Channel Fabrication

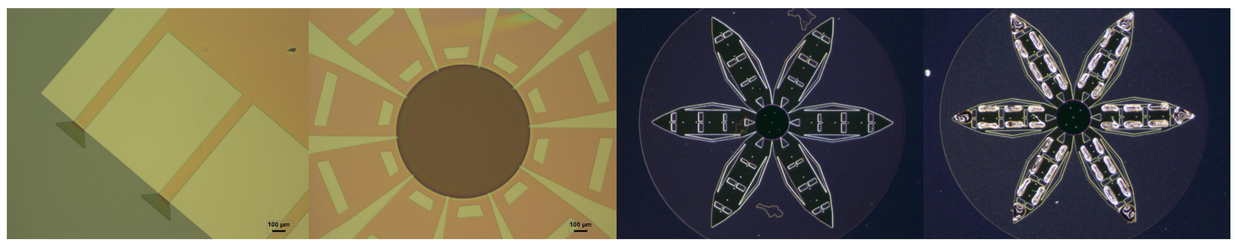


Experimental Process

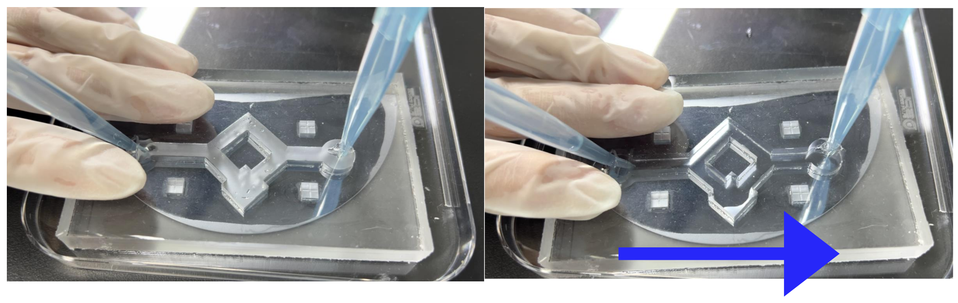


Results

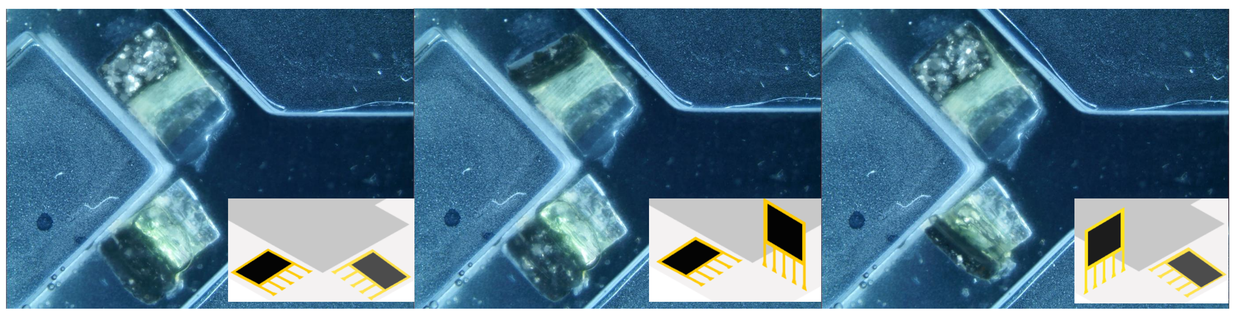
Fabricated Panel & Gripper



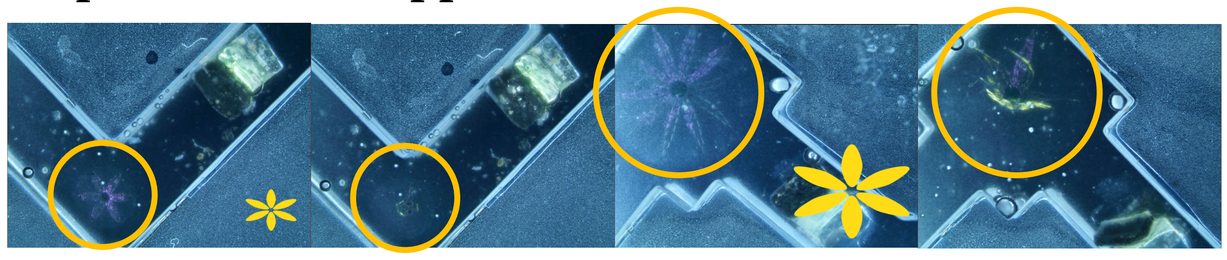
Operation of Fluidic Channel



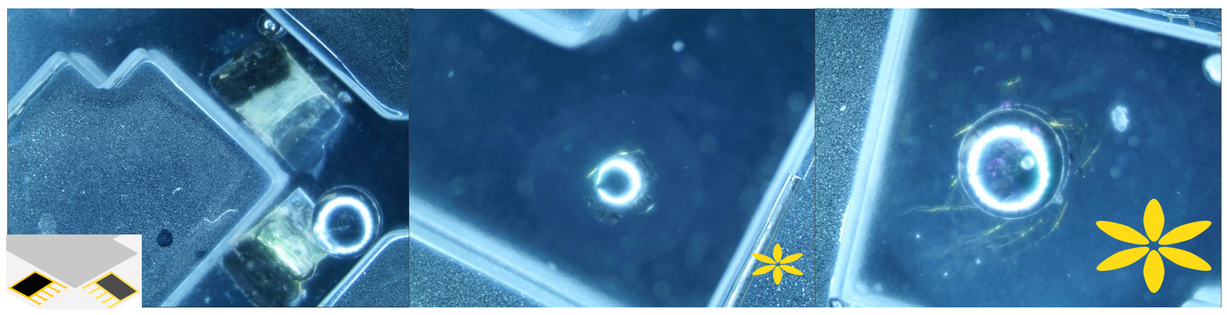
Operation of Panel



Operation of Gripper



Operation of Gripper with Balls (1mm & 3mm)



Conclusion & Further Study

This study successfully demonstrated the fluidic performance of the mesofluidic channel, confirming stable liquid flow and effective control of the magnetic panel's opening and closing via external magnetic fields. The magnetic gripper's functionality was also validated, showing its ability to grip. Initial issues with the fragility of the mesh-structured panel were resolved by modifying the attachment method.

However, challenges remain. The magnetic panel was too thick, impeding particle flow, and the large magnetic grippers experienced operational difficulties due to entanglement. Additionally, dead zones in the channel made it hard to control particle movement. Future work will focus on optimizing the panel thickness, redesigning the grippers to prevent tangling, and refining channel geometry to eliminate dead zones and improve overall performance.

Reference

[1] Cheong, Jiyong, et al. "Engineered nanoparticles for clinical assays." Nature Reviews Bioengineering (2024): 1-19.
[2] Park, Yoonseok, et al. "Three-dimensional, multifunctional neural interfaces for cortical spheroids and engineered assembloids." Science advances 7.12 (2021): eabf9153.