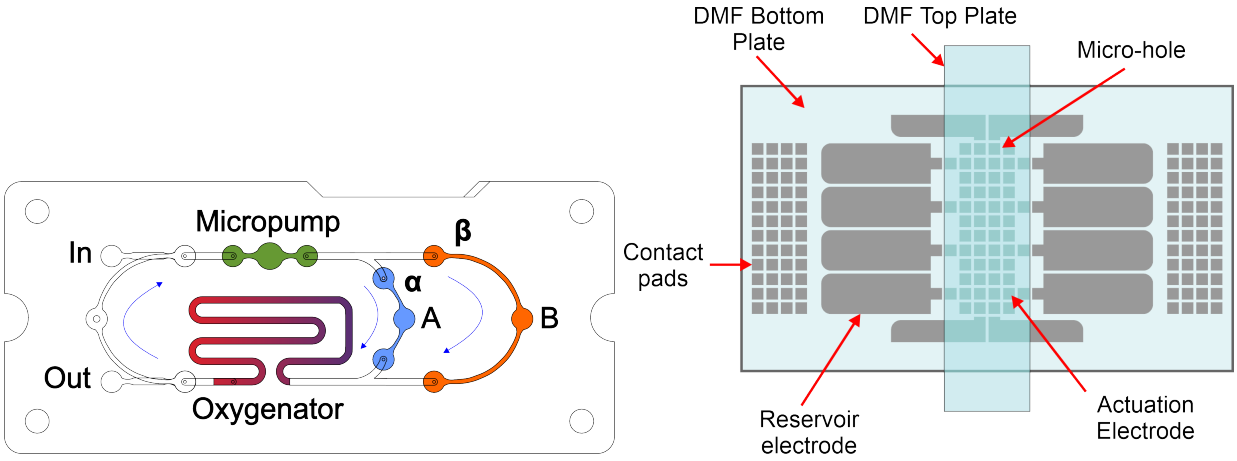
CONTENTS

BACKGROUND

Electrowetting-on-dielectric (EWOD)–based digital microfluidics (DMF) enables programmable manipulation of discrete droplets—such as dispensing, transport, merging, and splitting—using electric fields on a flat substrate as illustrated in Figure 1.1b(b), unlike traditional continuous-flow microfluidics. This eliminates the need for mechanical components like micro-pumps or valves as shown in Figure 1.1b (a). The underlying principle is governed by the Young–Lippmann equation, which relates voltage to contact angle modulation [1].



(a) (b)

Figure 1.1: Comparison between (a) conventional microfluidics (adapted from [2]) and (b) EWOD-DMF device (adapted from [3]).

Conventional EWOD-DMF systems are typically fabricated on glass or silicon using cleanroom processes [4], which, while precise, are expensive and integration-limited. PCBs present a cost-effective, scalable alternative with mature fabrication methods, multilayer routing, and easy integration with control electronics [5–7].

METHODS

BIBLIOGRAPHY

[1] H. Kim, S. K. Chung, and J. Lee, "PCB-based digital microfluidic platform for droplet mixing on an open surface," *Micro and Nano Systems Letters*, vol. 12, no. 1, Jan. 2024.

[2] M. Busek, S. Gruenzner, T. Steege, F. Schmieder, U. Klotzbach, and F. Sonntag, "Design, characterization, and modeling of microcirculation systems with integrated oxygenators," *Journal of Sensors and Sensor Systems*, vol. 5, no. 1, pp. 221–228, Jun. 2016.

[3] J. Peng, C. Chan, S. Zhang, A. A. Sklavounos, M. E. Olson, E. Y. Scott, Y. Hu, V. Rajesh, B. B. Li, M. D. Chamberlain, S. Zhang, H. Peng, and A. R. Wheeler, "All-in-one digital microfluidics pipeline for proteomic sample preparation and analysis," *Chemical Science*, vol. 14, no. 11, pp. 2887–2900, 2023.

[4] R. H. Vafaie, H. Dehganpour, and A. Moradpour, "Numerical simulation of EWOD on a printed circuit board for cleanroom-less digital fluidic manufacturing applications," *COMPEL - The international journal for computation and mathematics in electrical and electronic engineering*, vol. 38, no. 1, pp. 119–137, Jan. 2019.

[5] Jian Gong and Chang-Jin Kim, "Direct-referencing two-dimensional-array digital microfluidics using multilayer printed circuit board," *Journal of Microelectromechanical Systems*, vol. 17, no. 2, pp. 257–264, Apr. 2008.

[6] K. Sukthang, E. Pengwang, A. Tuantranont, and W. Wechsatol, "Rapid fabrication of close-typed electrowetting on dielectric devices," *IOP Conference Series: Materials Science and Engineering*, vol. 886, no. 1, p. 012046, Jul. 2020.

[7] Z. Yi, H. Feng, X. Zhou, and L. Shui, "Design of an open electrowetting on dielectric device based on printed circuit board by using a parafilm M," *Frontiers in Physics*, vol. 8, Jun. 2020.