Silicon-based Microfluidic Channel Structures for Future Human Cell Manipulation by Dielectrophoresis and Electroporation

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ABSTRACT

The controlled manipulation of human cells in microfluidic systems is a promising approach for cell biology, biomedical research, diagnostics and therapeutic development. Microfluidic channel structures provide defined geometries, small sample volumes, controlled flow conditions and optical accessibility, enabling reproducible cell guidance and observation [1]. Active cell manipulation can be achieved by acoustic, magnetic or electric fields [2]. This work focuses on electric-field based methods, as they can be integrated into microsystems and enable both dielectrophoresis cell control and electroporation-based membrane permeabilization.

The aim of this work is to establish a technological basis for such a platform by developing silicon-based microfluidic channels. At the current stage, the focus is on channel fabrication rather than biological cell experiments or active electrical manipulation. The realized structures provide defined fluidic pathways, inlet and outlet regions, observation areas and potential functional zones for later electrode integration (Fig.1, A and B).

Silicon-based fabrication offers high precision, reproducibility, mechanical stability and compatibility with microsystem technologies. Compared with polymer-based systems such as PDMS, silicon provides a dense, non-porous material platform with reduced absorption or loss of biologically relevant molecules into the channel walls [3].

Future work will include electrode integration, electric-field simulations, flow characterization and experiments with human cells using dielctrophoresis and electroporation.

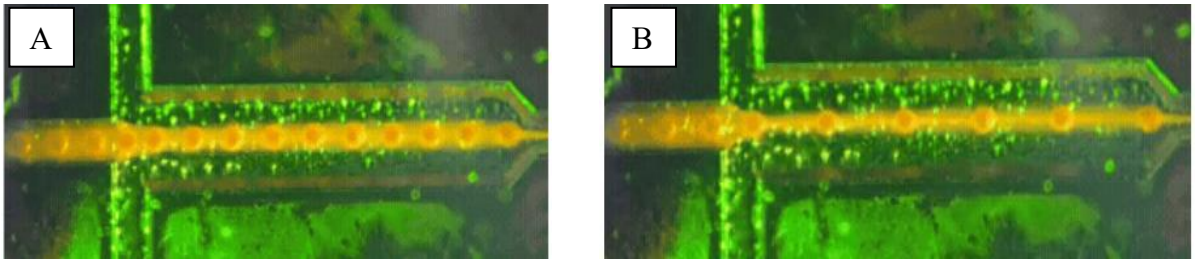

Fig.1: Identical microfluidic channel layout operated under different flow conditions, producing water-in-oil droplets with varying size and spacing in (A) and (B).

References

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