Capillary Microfluidic Systems for Precise Microparticle Separation

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Abstract— This study introduces an innovative capillary-based microfluidic system for precise microparticle separation. Fabricated with a Co2 laser, the multi-layered microfluidic allows efficient particle manipulation within microchannels. Experimental validation demonstrates high-throughput processing within two minutes, showcasing its potential for rapid diagnostics in diverse applications.

Keywords— Microfluidics, Separation, Capillary.

INTRODUCTION

The precision and accuracy of separation techniques are paramount for ensuring reliable disease assessment and effective patient care. The ability to selectively manipulate and isolate microparticles holds significant implications for disease detection, monitoring, and understanding of underlying biological processes. As such, microfluidic systems have gained prominence as pivotal tools, offering an approach to harnessing intrinsic capillary forces for microparticle separation [1]. Microfluidics, by virtue of their miniature scale and precise control over fluid dynamics, present a remarkable opportunity to capitalize on natural phenomena, such as capillary action, as driving forces for microparticle manipulation. These systems eliminate the need for external manipulation and intricate mechanical setups, streamlining the separation process. The inherent simplicity of capillary-based microfluidics positions them as compelling alternatives to conventional techniques [2].

METHODOLOGY

The separation process was conducted by passing a prepared solution of microparticles through a specialized membrane. The multi-layered microfluidic was meticulously designed and fabricated using a CO2 laser. The laser-cut layers were then carefully assembled manually to form the desired microfluidic elements. The assembly process ensured optimal functionality. The proposed system harnessed capillary forces, guiding microparticles with precision within designated microchannels. Filtered samples were efficiently collected within the microchannels and reservoir. This fabrication process facilitated the production of reproducible microfluidics on a larger scale, meeting the demands of high-throughput applications. These attributes were of paramount importance as they directly contributed to the reliability, consistency, and credibility of diagnostic outcomes.

Results

Experimental validation of the capillary-based microfluidic system showcases its remarkable capability to efficiently isolate microparticles. The high-throughput processing of particles within less than two minutes underscores the system's potential for rapid diagnostic applications. Moreover, the successful separation of microparticles holds significant promise across diverse diagnostic applications, including cell-free DNA analysis, pathogen detection, and protein biomarker identification. This versatility highlights the system's potential to address a wide spectrum of diagnostic needs.

# C**onclusion**

In conclusion, this study presents an innovative approach to microparticle separation through capillary-based microfluidic systems. By harnessing intrinsic capillary forces, these systems offer a streamlined solution to particle manipulation. The meticulous fabrication process ensures precision and high throughput, making the system a reliable tool for diagnostics. With applications ranging from clinical diagnostics to environmental monitoring, microfluidics are poised to redefine microparticle manipulation strategies, contributing to the advancement of diagnostics and prognostics.

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