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Microfluidic Manipulation for Biomedical and Biohealth Applications

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Abstract : Automation and control of biological samples and solutions at the microscale is a major advantage for biochemistry analysis and biological diagnostics. Despite the known potential of miniaturization in biochemistry and biomedical applications, comparatively little is known about fluid automation and control at the microscale. Here, we study the electric field effect inside a fluidic channel and proper electrode structures with different patterns proposed to form forward, reversal, and rotational flows inside the channel. The simulation results confirmed that the ac electro-thermal flow is efficient for the control and automation of high-conductive solutions. In this research, the fluid pumping and mixing effects were numerically studied by solving physic-coupled electric, temperature, hydrodynamic, and concentration fields inside a microchannel. From an experimental point of view, the electrode structures are deposited on a silicon substrate and bonded to a PDMS microchannel to form a microfluidic chip. The motions of fluorescent particles in pumping and mixing modes were captured by using a CCD camera. By measuring the frequency response of the fluid and exciting the electrodes with the proper voltage, the fluid motions (including pumping and mixing effects) are observed inside the channel through the CCD camera. Based on the results, there is good agreement between the experimental and simulation studies.

Keywords : microfluidic, nano/micro actuator, AC electrothermal, Reynolds number, micropump, micromixer, microfabrication, mass transfer, biomedical applications
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