249e Continuous Lysis of Cells in a Locally Concentrated DC Field on a Microfluidic Chip

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Recently, on-chip electrical lysis of biological cells has been raising a lot of interests due to its widespread applications in recovering the contents of cells without introducing lysing agents which may interfere with subsequent biological assays. Applying a DC field for cell lysis typically requires the overall voltage as high as thousands of volts to generate an field strength of 1-10 kV/cm [1, 2]. Bubble generation and Joule heating can often be induced under such high field strengths and continuous operation becomes difficult. Decreasing the gap between the electrodes can decrease the overall voltage [3, 4]. However the fabrication of high density microscale electrodes increases the cost. Furthermore, AC or pulsed electrical fields are typically applied and they are not compatible with bioanalysis methods such as electrophoresis. In this study, we demonstrated that GFP-expressing E. coli cells were lysed continuously while flowing through a microfluidic device. The DC field was intensified in a defined section of the microfluidic channel by altering the channel geometry. The overall applied voltage was lowered to several hundred volts to general a local field of 1.5-7 kV/cm. This permitted 3-5V/cm of lysis field strength per volt applied. We found that local lysis field strength of 1500V/cm was required for the lysis of 95-100% of GFP-expressing E. coli. This field strength was substantially lower than the lysis field needed in the case of pulsed electrical fields (around 7kV/cm). The lysis was witnessed by the plate count and the fluorescence spectroscopy. Our design enabled spatially confined electrolysis with a moderate overall voltage. Operating continuously under DC field makes our approach a high throughput method, which can be easily coupled with on-chip electrophoresis. The same method can also be applied for the lysis of mammalian cells and for the electroporation and transfection.

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