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Effect of electrode geometry on field strength in plastic microfluidic devices and application to cell membrane permeabilization MARC CHOOLJIAN, UC Berkeley-UCSF Graduate Program in Bioengineering, JACOBO PAREDES, DORIAN LIEPMANN, UC Berkeley — We have developed a method that allows embedding of electrodes in up to 3 walls of a plastic microfluidic channel. Electric field strength and homogeneity of various electrode geometries is analyzed theoretically and experimentally by evaluating the efficiency of on-chip lysis of cells. Electric field-mediated disruption of membranes is an important tool in diagnostics, basic biology, and synthetic biology due to the ability to permeabilize the cell membrane without changing the chemical composition of the buffer. Typically, fields of the required magnitude are applied to the cell by discharging a capacitor through a mixture of cells in a cuvette, resulting in a transient high-voltage pulse. We demonstrate that is possible to substitute a spatially varied DC electric field along a microchannel and to control the timing of the pulses by changing the electrode spacing and the flow rate. Homogeneity of the field with respect to the cross section of the channel is key to achieving critical field strength regardless of the cell's lateral position in the channel. A comparison of 2D versus 3D electrode geometries on the efficiency of electroporation and on side-effects arising due to the electric field (recirculating flows and hydrolysis) is presented.

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