ABSTRACT

Zhan, Yihong. M.S.E., Purdue University, May, 2009. Gene Delivery based on Microfluidic Electroporation. Major Professor: Chang Lu.

In this thesis, I present two microfluidic electroporation techniques for delivering genes into cells: flow-through microfluidic electroporation and droplet-based microfluidic electroporation.

The flow-through electroporation for gene transfection has been realized by our group's former work. Wang and Lu (2006) proposed a novel multi-segment device to produce multi-pulse like behavior for reaching the transfection frequency as high as 25%. The research I conducted here focused on varying the geometry of the device and the electric parameters of the electroporation to improve the transfection frequency. The highest transfection frequency I got is as high as 45%, which is comparable to the traditional electroporation method. This optimization could be used to scale up the device to realize the high-throughput gene delivery.

The droplet-based microfluidic electroporation technique is also demonstrated for delivering genes into Chinese hamster ovary cells based on the use of integrated microelectrode technique and a common dc power supply. Currents of different size droplets generated by different flow rates of immiscible fluid are investigated.

The relation between the current and the droplet parameters are qualitatively discussed. The cells are successfully transfected and expressed. The droplets serve as microreactors, which minimize the distance between the cell and DNA, and can attain high DNA concentration when the same amount of total DNA is used. These advantages facilitate the gene delivery and have the potential of studying the individual cell transfection behavior and the single gene transfection mechanism.