Efficient transformation of microalgal cells to capture CO₂ via digital microfluidic electroporation

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Although algal biofuels have been considered as productive biological systems for generating biomass and capturing carbon, the economic challenge still exist. Delivery of genetic material into cells across the permeabilized cell membrane via electrophoresis (EP) is an established research method for genetic engineering research. Using high-voltage electric pulses, electrophoresis can cause transient pores on cell membrane. However, the lab scale bulk tech needs to be improved since the use of high voltages may decrease cell viability meanwhile the transformation efficiency is low. In this work, we present a successful device with good performance of a digital droplet EP system for gene transformation of Chlamydomonas reinhardtii species. Two different droplet EP modes are investigated under different EP conditions (applied voltage and application time) on viability and transformation efficiency. Our device showed greater performance on gene transformation using microliter scale droplets, compared with the other reported microfluidic systems as well as bulk electroporation. The transformation efficiency is analyzed using flow cytometry (a fluorescence activated cell sorter, FACS). The droplet electroporation system has a great potential for the fully automated digital microfluidic cell engineering and culture platform.

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