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Gigahertz acoustic streaming induced cell membrane poration towards intracellular delivery

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Efficient intracellular delivery of exogenous materials remains a critical issue in fundamental biological researches and clinical applications. Here, we developed a novel chemical-free method for intracellular delivery enhancement using a designed gigahertz ultrasonic electromechanical resonator. When excited by a sinusoidal electric signal, the propagation and attenuation of acoustic wave in liquid will generate high-speed acoustic streaming. The liquid above the device working area will be accelerated and strike the substrate surface, thus generates pressure on cells, induces deformation and membrane poration, and finally realizes delivery of exogenous materials. To verify the intracellular delivery ability, DOX was selected as an example, and an enhanced fluorescence of DOX in cells exposed to resonator stimulation can be seen. We also realized the delivery of fluorescent-labeled DNA strains and plasmids. Besides, different power applied to the resonator can induce different fluid velocity, thus generate different force intensity and control the deliver efficiency. Pores on membranes induced by acoustic streaming treatment were observed by SEM. Disrupted cell membranes and porous structures can be seen after treatment, and resealed after 10 min recovery, indicating a strong fluid force exerted on cells and the influence is temporary and reversible.

Biography

Xuexin Duan has completed his PhD from University of Twente and Postdoctoral studies from Yale University. He is currently working at Department of Precision Instrument Engineering, Tianjin University as a Full Professor. His research is about micro/nano fabricated devices and systems for biochemical sensing and biomedical applications. He has published more than 60 SCI indexed articles, including *'Nature Nanotechnology', 'Advanced Materials', 'ACS Central Science', 'Physical Review Applied'*, etc. He holds 1 US patent and 10 Chinese patents. He has been awarded as National 1000 Plan Professorship for Young Talents (2014), Outstanding Youth Funds of Tianjin (2017), Young Scientist of World Economic Forum (2018).

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