Ultrafast Optofluidic Imaging on a Chip for Massive Image-based Single-cell Profiling

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Abstract— Ultrafast optofluidic imaging is an emerging interdisciplinary technology that seamlessly integrates ultrafast optical imaging with microfluidics, which is capable of realizing high-resolution, high-throughput, high-content imaging and quantitative analysis of biological organisms in high-speed and complex fluid environments. Ultrafast optofluidic imaging has exhibited promising application potential in bioenergy, food science, drug screening, disease diagnosis and many other fields. In this talk, I will review our recent research progress on ultrafast optofluidic imaging on a chip for massive image-based single-cell profiling. Specifically, we developed several methods, including time-stretch brightfield imaging, time-stretch quantitative phase imaging, frequency division multiplexing imaging, to statistically identify and characterize various blood cells on a chip. By virtue of the high throughput above 10,000 cells per second and the high spatial resolution of 800 nm, we were able to apply our methods for practical biomedical applications [1–5]. First, we utilized our method for characterizing the landscape of circulating platelet aggregates and temporally monitoring blood cells in patients with COVID-19 [1]. The analysis of the big image data shows the anomalous presence of excessive platelet aggregates in nearly 90% of COVID-19 patients. Second, we used our method to study the long-term effects of mRNA COVID-19 vaccinations on platelets [2]. Our result shows no significant or persisting platelet aggregation trends following the vaccine doses. Third, we combined our method with an *in vitro* 3D stenosis microfluidic chip to study stenosis-induced platelet aggregation and efficacy of antiplatelet drugs on atherosclerosis [3, 4]. Our method shows practical utility for development of optimal pharmacologic strategies for patients with atherosclerosis. Our ultrafast optofluidic imaging on a chip is expected to provide a powerful tool for cell biology and medicine.

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