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Editorial: The future of lab on a chip technologies: an early career scientists' perspective

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Editorial on the Research Topic
The future of lab on a chip technologies: an early career scientists' perspective

Microfluidics has been an emerging research field in the past 2 decades, early microfluidics began as an offshoot of the MEMS (Microelectromechanical System) field on handling liquid in small volumes for various purposes (mainly biological). And most of the microfluidics fabrication techniques are all inherited from the MEMS field. Gradually, researchers start to use some more low-cost and flexible fabrication methods for microfluidics, which significantly lower the barrier to using microfluidics in various fields. In the recent decade, microfluidics has been widely used in biological, medical, environmental, food science, material science, and even in the energy field. Various successful commercial products have also been developed, mainly in the biological and medical fields. The past pandemic also significantly promote the development of microfluidic-based nucleic acid testing equipment. Unlike the widely accepted Moore's Law in the semiconductor industry, the future trend of microfluidics is still unclear, in this Research Topic, 14 early career scientists contributed 5 papers on the discussion of the future trend for Lab-on-a-chip techniques.

Ali et al. from Chonnam National University, Korea discussed the droplet microfluidic technologies for next-generation high-throughput screening. Droplets as an independent reaction chamber can be generated and manipulated with microfluidic techniques in large numbers. Authors in this work reviewed the most recent studies from the aspect of droplet generation (building library) and droplet separation. Authors claimed that for future development of microfluidics, PDMS (polydimethylsiloxane) should be replaced by some easy-to-process material for massive production, and more reliable and high throughput droplet screening methods should be developed.

Core from the University of Glasgow discussed the sustainable aspect of Lab-on-a-chip devices. Conventional microfluidic devices were fabricated with glass, silicon, or polymer material, and most of the polymer-based microfluidic devices used PDMS, and the sustainability Research Topic was rarely concerned or discussed. Innovatively, the author in this work discussed achievements around LoC sustainability and potential LoC life cycle sustainable improvements and also proposed environmental impact analyses and sustainable materials should take center stage in new LoC research.

Sahin et al. from Technical University of Munich reported their study on Deep learning based recognition of shape-coded microparticles. Encoded particles can be used for

multiplexed diagnostics, drug testing, and anti-counterfeiting applications. With the fast-moving speed and large quantities in Lab-on-a-chip devices, the shape-coded microparticles were hard to recognize in conventional approaches. In this study, authors successfully used AI-powered multi-class segmentation of shape-coded particles by using the pre-trained models, they also envisioned the classified particles can be further analyzed to obtain specific information desired for bioassays.

Owen from the University of Edinburgh discussed the perspective of using numerical modeling and machine learning in inertial microfluidics to promote the development process of microfluidic devices. The author of this work suggested the opportunity to use numerical modeling to reduce the burden of physical experiments and also combine numerical modeling with machine learning algorithms for multiple coupled parameters to be explored simultaneously and uncover the underlying physical mechanisms.

Abouhagger et al. from Center For Physical Sciences And Technology (CPST), Lithuania reviewed the electrochemical biosensors as promising tools to study microbial biofilms in Lab-on-a-chip devices. Microbial biofilms are complex communities of microorganisms that adhere to surfaces with a complicated attachment process and dynamic behaviors. The authors in this study reviewed the most recent approaches to using the electrochemical biosensor in microfluidics chips for investigating biofilm dynamics, virulence, and properties. Authors claimed this approach can potentially advance the understanding of microbial biofilms in different settings.

From early career scientists' perspective and also with the fast developing AI technique, the future development of Lab-on-a-chip technologies will achieve a much closer integration. AI-powered image processing and recognition, AI-powered flow simulation, AI-powered chip design or even AI-powered drug screening is or will soon become a reality. In addition to the future trend of Lab-on-a-chip technologies, high throughput droplet microfluidics with precise droplet handle and detection ability, sustainable microfluidics, and microfluidics in biofilm study may all become promising directions.

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Conflict of interest

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