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Editorial

Special Issue on "Advances in Microfluidics Technology for Diagnostics and Detection"

David J. Kinahan [1,*], Dario Mager [2], Elizaveta Vereshchagina [3] and Celina M. Miyazaki [4]

[1] School of Mechanical and Manufacturing Engineering, Dublin City University, Dublin D9, Ireland
[2] Institute of Microstructure Technology, Karlsruhe Institute of Technology, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany; dario.mager@kit.edu
[3] Microsystems and Nanotechnology Department (MiNaLab), SINTEF Digital, SINTEF AS, Gaustadalléen 23C, 0373 Oslo, Norway; Elizaveta.Vereshchagina@sintef.no
[4] Centre of Science and Technology for Sustainability, Federal University of São Carlos, Sorocaba, São Carlos, SP 13565-905, Brazil; celinammiyazaki@gmail.com
* Correspondence: david.kinahan@dcu.ie

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In recent years microfluidics and lab-on-a-chip havecome to the forefront in diagnostics and detection. At the point-of-care, in the emergency room, and at the hospital bed or GP clinic, lab-on-a-chip offers the potential to rapidly detect time-critical and life-threatening diseases such as sepsis and bacterial meningitis. Furthermore, portable, cost-efficient, and user-friendly diagnostic platforms have a great deal of potential for global health applications. They can enable disease diagnostics and detection to occur in resource-poor settings where centralized laboratory facilities may not be available. At the point-of-use, microfluidics and lab-on-a-chip concepts can be applied in the field to rapidly identify plant pathogens, thus reducing the need for damaging broad-spectrum pesticides while also reducing food losses. Microfluidics can also be applied to the continuous monitoring of water quality and can support policymakers and protection agencies in protecting the environment. Perhaps most excitingly, microfluidics also offers the potential to enable the development of entirely new diagnostic tests that cannot be implemented using conventional laboratory tools. Examples of microfluidics at the frontier of new medical diagnostic tests include early detection of cancers through circulating tumor cells (CTCs) and highly sensitive genetic tests using droplet-based digital PCR.

The Special Issue on "Advances in Microfluidics Technology for Diagnostics and Detection" in *Processes* collects recent work from researchers active in this field. The Special Issue is available online at https://www.mdpi.com/journal/processes/special_issues/microfluidics_technology_diagnostics_detection. The interdisciplinary nature of research in the field of lab-on-a-chip has resulted in a collection of papers addressing a wide range of topical areas. For instance, Loy et al. [1] describe a low-cost and modular mixing platform for creating three-component siRNA polyplexes. They describe the use of low-cost microcontrollers (Raspberry Pi) to provide a flexible and programmable platform. The integration of low-cost microcontrollers with microfluidics is an emerging trend to enable distributed (and often wireless) sensing. The wireless nature of these concepts simplifies sealing and contamination issues, which justifies the extra effort. Many properties can today be measured wirelessly, as shown in Toto et al. [2] where they describe the development and miniaturization of a wireless vacuum sensor, which is enabled by combining the Pirani principle and surface acoustic waves (SAWs).

The COVID-19 pandemic has had a major impact on the economy and the overall health of the world. It has also had a great impact on the inter-connectivity of the globe. The rapid development of effective vaccines has demonstrated the capability of the scientific community to respond quickly and effectively to such challenges. Similarly, in the field of microfluidic diagnostic and detection, much work has been undertaken to improve the efficacy of COVID-19 diagnostic testing. While vaccine production is ramped up, diagnostic 'test and trace' will remain the primary tool healthcare officials have to attenuate the spread of the disease. Centralized laboratory testing and the development of low-cost portable tests for use in the field have been identified as the two major pillars for enabling 'test and trace'. With reliable field-based testing still some distance away, the characterization of laboratory-based assays is perhaps even more critical in the short-term. Towards this, Xie et al. [3] demonstrate detection of the SARS-CoV-2 virus, at low viral load estimates, using a commercially available microfluidic qPCR laboratory instrument.

In the field of point-of-care testing, the centrifugal lab-on-a-disc (LoaD) platform is identified as having great potential due to its portability, flexibility, and relatively low cost. This technology has been applied to a wide range of applications. Hin et al. [4] present a portable laboratory instrument that can be deployed in resource-poor settings to support epidemiological control of diseases (i.e., malaria, zika, etc.) associated with the mosquito vector. Importantly, the platform can also test for markers associated with an insect's species and its resistance to insecticides.

Centrifugal microfluidics also has potential in enabling and automating new diagnostic tests in the laboratory. In recent years, digital PCR has emerged as a highly sensitive diagnostic test for diseases of genetic origin. However, it can be difficult to implement in the laboratory and requires specialized and often expensive laboratory instrumentation. Schlenker et al. [5] use a centrifugal approach to demonstrate four-plex digital droplet PCR (ddPCR) capable of detecting 3.5–35 mutant DNA copies from 15,000 wild-type DNA copies for application in the detection of point-mutations associated with cancers. Finally, as a reflection of the emerging importance of the lab-on-a-disc platform, Miyazaki et al. [6] present an extensive review of biosensing technologies for use in centrifugal microfluidics.

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