MicroTAS 2021 Workshop 6 Information

WORKSHOP TITLE: Open Space Microfluidics

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WORKSHOP DESCRIPTION:
The vast majority of microfluidic devices currently uses networks of sealed microchannels (with four walls) and chambers that are linked to various inputs/outputs to provide a “chip-to-world” interface. However, in many emerging applications in chemistry and the life sciences, the traditional “closed-channel network” view of microfluidics fails to make a difference. This is the case whenever microfluidic systems must interface with the standards of the pharmaceutical industry: the pipette, the petri dish and the well plate. The emerging area of open-space microfluidics provides new opportunities for handling, analyzing and interacting with biological samples and also gives much freedom to end-users for new classes of experiments by removing the need for full containment of chemicals and liquids.

The goal of this workshop is to consolidate the views and latest developments on an emerging topic of open-space microfluidics that enables chemical processes on or near surfaces.

OVERVIEW OF MATERIAL TO BE COVERED AND WHAT ATTENDEES CAN EXPECT TO TAKE AWAY FROM THE WORKSHOP:

This workshop part contains 3 lectures:

(i) The first lecture will introduce the concept of the microfluidic probe, where the fluidic delivery is physically decoupled from the bottom sample. The microfluidic probe combines concepts of scanning probes and hydrodynamic flow confinement (HFC) that is achieved with the simultaneous injection and aspiration of fluids. Attendees will learn about the working concepts of the different flow regimes within the various probes' designs, including hierarchical and radial HFCs, and how these can be leveraged to improve bioassay kinetics. Then, different biological and clinical applications of the probe will be discussed, including protein patterning, micro-immunohistochemistry, in situ hybridization and microscale sampling for genetic and transcriptomic profiling. Further, attendees will be shown how open microfluidics can be applied in microtiter plates, bringing the benefits of microfluidics to standard bioassay supports.

(ii) Thomas Gervais: The second lecture will provide a framework and fabrication strategy to generalize open space systems with large number of flow apertures (Goyette et al, Nat. Commun., 2019). Attendees will learn the basic laws governing reagent transport in open-space systems and elegant mathematical tricks to characterize them. Using videos and examples, they will be walked through the CAD drawing, 3D printing, operation, and applications of microfluidic multipole devices. Applications will be showcased in immunoassays, roll-to-roll printing, and general surface processing.

(iii) Ashleigh Theberge: The third lecture will focus on using passive forces such as capillary flow to move fluids in open microfluidic and mesofluidic channels (see review article: Berthier et al., Anal. Chem., 2019, 91, 8739−8750). In this lecture, "open channels" refer to channels with at least one air-liquid interface, such as open grooves (lacking a ceiling) or rail-based systems (lacking side walls). We will discuss the conditions for spontaneous capillary flow to occur in open systems. Participants will learn how to use equations to design open channels with dimensions and wetting properties (contact angle) favorable for capillary flow. We will also cover practical considerations such as fabrication using computer numerical control (CNC) milling, 3D printing, and injection molding. Finally, we will discuss applications such as hydrogel patterning, cell culture, chemical reactions, and chemical analysis.

WHO SHOULD ATTEND (target audience, e.g. career stage, academia/industry, field):

The workshop is intended for a broad audience with interest in interfacing microfluidics with open surfaces for applications in the life sciences. It is particularly suited for graduate students and post-docs working in microfluidics and the broad areas of life-sciences. This could help them in their research work, and to think about experiments to be performed on biological materials and substrates in a completely new way. Academicians would also benefit from this course, and we would encourage them to include open space microfluidics

as a teaching topic in their respective courses. Representatives from industry will be exposed to a new microfluidic technology that has a very practical use.

PARTICIPANTS WILL NEED THE FOLLOWING:

All support is ok to attend the workshop. Matlab, Catia, COMSOL, are the software programs required to run the open-access codes afterwards.