# In-air droplet generation and solidification via microfluidics

## Semester Project

(Section: Material Science – Microengineering)

Droplet microfluidics is a technology used to encapsulate fluids, cells, and other materials into microscale droplets.[1] In this project, droplet microfluidics is employed to generate microdroplets of diverse materials, which can then be solidified into microbeads and assembled to construct three-dimensional (3D) objects. This approach enables the conceptualization of a novel 3D printing process based on the voxel-by-voxel assembly of materials with contrasting properties. In conventional water-oil droplet microfluidics, a large fraction of the flow is from the liquid carrier which is unfavourable to be deposited on 3D printing substrate. One of the strategies is to replace the liquid carrier with air flow to form droplets.[2] However, there is a research gap on studying the in-air droplet generation and polymerization.

Using a step emulsification microfluidic device, water droplets can be controllably generated in air flow. Now, the next step is to form droplets in air flow using low-viscosity acrylate or acrylate containing nanoparticles as the dispersed phase. The droplet size and generation frequency need to be characterized while adjusting the flow rates of two phases. The effect of microfluidic junction geometries on the droplet generation is also expected. Besides, the advancing speed of droplets carried by the air flow is crucial to measure when considering the sequential polymerization step. To gain more time for polymerization in air flow, a new channel design will be explored to slow down the droplet movement in the microfluidic channel. This in-air droplet generation and polymerization study will advance the project to bead ejection and 3D assembly in the future.

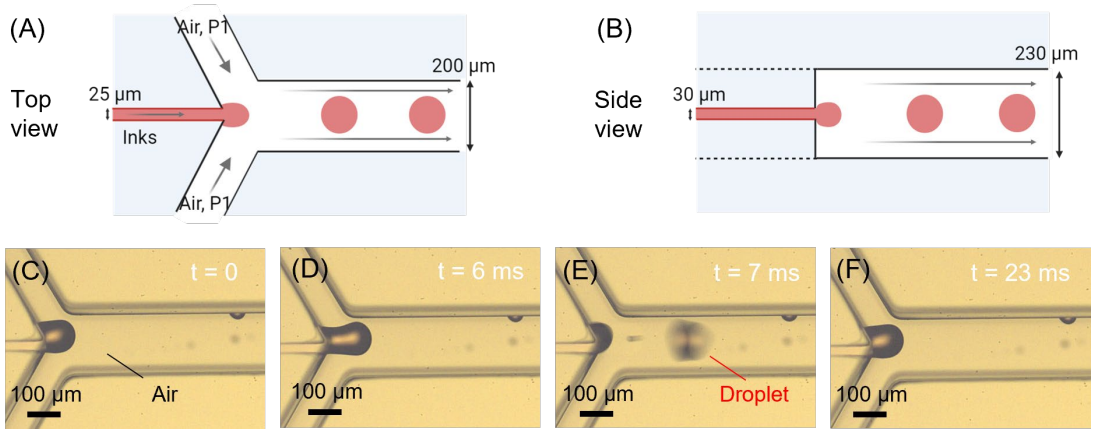


Figure: (A, B) Schematics of step emulsification microfluidic junction. (C-F) Timelapses of generation of a water droplet in air flow using the step emulsification microfluidic junction made of PDMS.

Possible tasks:

a) Acrylate droplet generation in air flow using a step emulsification microfluidic junction.
b) Characterization of the dependence of droplet size, generation frequency, and dispersity on flow rates and channel geometries.
c) Droplet polymerization characterization with or without an air evacuation channel design.

**Contact:** Tao Zhang *(tao.zhang@epfl.ch)*
Dr. Arnaud Bertsch (*arnaud.bertsch@epfl.ch*)

[1] Zhang, *et al. Trends in Biotechnology* (2023).
[2] Takagi, *et al. Microfluidics and Nanofluidics* 25.9 (2021): 74.

École polytechnique fédérale de Lausanne

Microsystems Laboratory 1
(Prof. J. Brugger)

EPFL STI IMT LMIS1
(Batiment BM)
Station 17
CH - 1015 Lausanne

Phone : +41 21 693 68 38
E-mail : tao.zhang@epfl.ch
Office : BM 3.117