Multi-nozzle melt electrowriting (MEW) using microfluidic approaches

Master's thesis

(Section: Computer Science – Materials Science – Microengineering – 3D Printing)

Over the last two decades, additive manufacturing (AM or 3D printing) has been gaining significant attention in tissue engineering and biofabrication research as a versatile class of manufacturing technologies. This primarily stems from its ability to fabricate unique patient-specific designs as well as structures from a wide range of biomaterials.[1] For biomedical applications, high resolution 3D printing techniques, such as melt electrowriting (MEW) have been of interest for their exceptional ability to replicate the fine features and complex microarchitecture of native tissues to mimic both their structure and function.[2] Recently, a dual nozzle setup was demonstrated with a syringe based system and the effects of the electrical field on it studied.[3]

At the LMIS1, we are currently investigating a novel filament-based extrusion system, which has many advantages over the syringe system due to the possibilities in processing a wider variety of polymers.[4] As we have more freedom in nozzle design when using microfabrication, this should prove beneficial for the investigation of dual and multi-nozzle setups. This student project will contribute to the understanding of how the different parameters nozzle spacing, nozzle amount, and nozzle diameter interact and result in a printed fibre. This can allow for more control over the jet and the resulting structures for future applications.
The topic is highly multidisciplinary, involving aspects of engineering, computer and materials science: the focus can be adjusted depending on the student's preferential interests, best knowledge, previous experience and motivation.

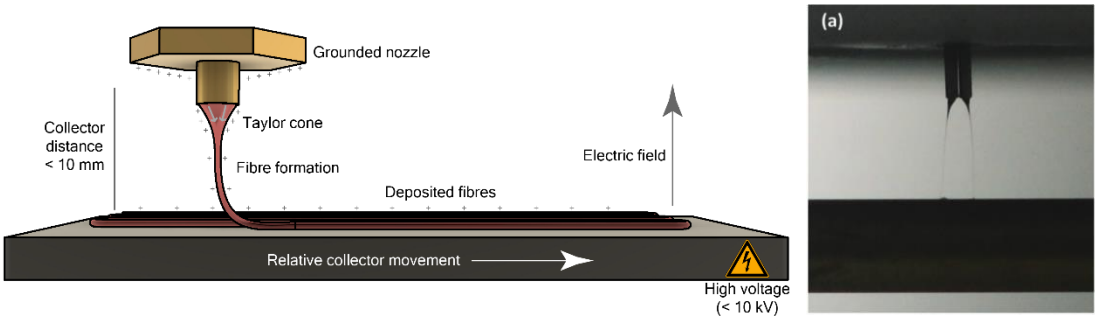

Figure 1 : *(left) schematic showing the principles behind melt electrowriting (MEW), (right) dual nozzle setup in operation, image taken from [3].*

Possible tasks:

- Design and manufacturing of dual and multi nozzle chips in CMi for our printers.
- Design of experiments to print different scaffolds and investigate different nozzle designs.
- Simulation of nozzles and their electrical properties (see [3]).
- SEM characterisation of scaffolds on modern instruments.

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[3] R. Sanchez Diaz, *et al.*, *Macromol. Mater. Eng.*, **2023**, *308*, 220526.
[4] A. Reizabal, *et al.*, *Addit Manuf*, **2023**, *71*, 103604.

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