3D printer upgrade to enable successful melt electrowriting of tubular structures with various sizes and geometries

Master/Semester project

(Section: Microengineering, Materials Science, Robotics, Bio Engineering)

Over the last two decades, additive manufacturing (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 fabricate structures from a wide range of biomaterials. For biomedical applications, high resolution 3D printing techniques, such as melt electrowriting (MEW) have been favoured for their exceptional ability to replicate the fine features and complex microarchitecture of native tissues to mimic both their structure and function. To date MEW research often utilises pressure-driven extrusion methods on custom devices built by individual research groups, processing the most common polymer in MEW polycaprolactone (PCL).

At the LMIS1, we are currently investigating a novel filament-based extrusion system for MEW, which has many advantages over the current standard due to the possibilities in processing a wider variety of polymers. The printer has two different collector configurations, flat and tubular (cylindrical) collector, which can be used for printing structures. A current limitation of the tubular system is the availability of a single diameter mandrel (3 mm). This student project will contribute to upgrading the printer and interchangeable upgrades to enable successful printing on mandrels with diameter in range of 1 – 5 mm (cylindrical and polygonal). There will be an additional software component in the project which will aim at designing the codes to enable successful MEW on these mandrels.

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.

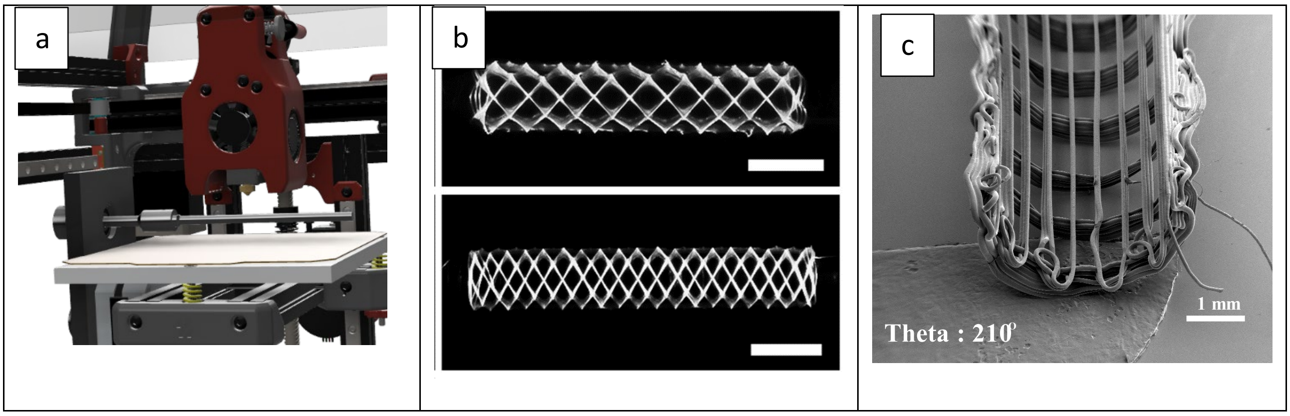

Figure 1. a) Schematic of the idea of tubular collector on MEW printer. b) Sample wrap around tubular designs printed using MEW (2mm scale). c) Theta tubular design for printing using collectors of various diameters.

Possible tasks:

- Modification of the printer for successful processing on various collector sizes/designs
- Software control for printing complex geometries.
- Assessment of mechanical properties of the printed tubes

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Useful reading: Hong et al, Open5x: Accessible 5-axis 3D printing and conformal slicing (https://dl.acm.org/doi/10.1145/3491101.3519782)