3D printing (fused deposition modelling) of metallic tubes with complex geometries

Master/Semester project

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

Fused deposition modelling (FDM) or fused filament fabrication is a 3D printing technique where a polymer melt is extruded through a nozzle onto a temperature-controlled build platform. A three-dimensional structure is successfully created by stacking the extruded polymer layer-by-layer. For most applications and structures, a flat build plate is usually sufficient. However, it can be limiting in some cases where fine features are required as overhangs and some post processing techniques like sintering are to be employed on the printed object.

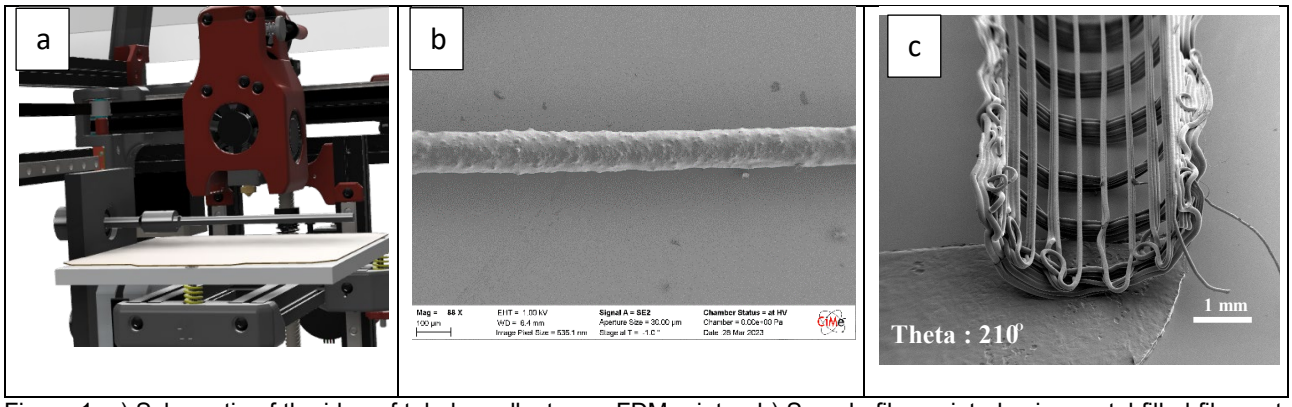

Figure 1. a) Schematic of the idea of tubular collector on FDM printer. b) Sample fibre printed using metal filled filament. c) Potential design ideas for printing.

A FDM printer usually uses a standard polymer filament with 1.75/2.85 mm diameter. A large variety of polymers have been processed using this technique with poly lactic acid (PLA) being the most utilized due to the ease in processability. Other materials such as Nylon, flexible thermoplastic urethane and fiber reinforced polymers have also been used and are available commercially. There is increasing interest in composite materials, specifically metal filled and ceramic filled polymers which can be used in FDM. The printed parts from these materials can be sintered (high temperature treatment) to obtain fully metallic and ceramic components.

This student project will involve improving and upgrading the tubular collector on a Voron FDM printer. The next part of the project will involve printing of metal/ceramic filled polymer filaments with minimum resolution feasible. The printed parts will be sintered and analyzed to further optimize the FDM approach to obtain fully metallic/ceramic tubular constructs. The project can be expanded to test the feasibility of printing composite filaments using melt electrowriting (MEW) technique which involves application of an additional high voltage to the FDM setup in order to reduce the minimum feature size which can be obtained.

Possible tasks:

- Incorporating heating on tubular collector on Voron 0
- Software control for printing complex geometries with minimum resolution on tubes
- Testing composite materials to print functional constructs (metal or ceramic filled FDM filaments)
- MEW of composite materials

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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)

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