Project updated: 23.12.2018

Inkjet printing polymer and polymer composites for wearable VOC sensors

Semester Project, Master Project

(Section: microengineering, electrical engineering, material science)

In the era of the internet of things (IoT), the demand for low-power and cost-effective wearable sensors towards personalized medical and consumer devices has been growing. Among them, sensors capable of detecting volatile organic compounds (VOCs) are of particular interest owing to their applications in personalized health care and consumer devices. Among different sensing materials, polymer and polymer composites can be used for the room temperature and selective detection of VOCs. The polymer-based VOC sensors are low cost, relatively simple to process, operate at room temperature, and are compatible with flexible substrates. Such advantages make them suitable candidates for IoT-enabled wearable applications.

This project aims to develop a wearable VOC sensor composed of multiple sensing elements made of polymers and polymer composites. The sensors will be fabricated additively using Drop-on-Demand inkjet printers (DOD IJP). DoD IJP can is be used to deposit the conductive tracks and the sensing material, providing a high degree of flexibility in the sensor design.

The choices for the flexible substrate include polyimide, PEN, PET, or SEBS. The first step is to optimize the surface functionalization of the substrate. Subsequently, the conductive tracks will be designed and printed onto the substrate, followed by the deposition of the sensing materials. The fully printed sensors will be characterized by exposing them to different VOCs.

Work description:

- Surface functionalization and characterization of the flexible substrate
- Inkjet ink formulation
- Sensor fabrication using Drop-on-Demand inkjet printing
- Characterization of the sensor response upon exposure to different volatile organic compounds (e.g., alcohols, ketones, hydrocarbons)

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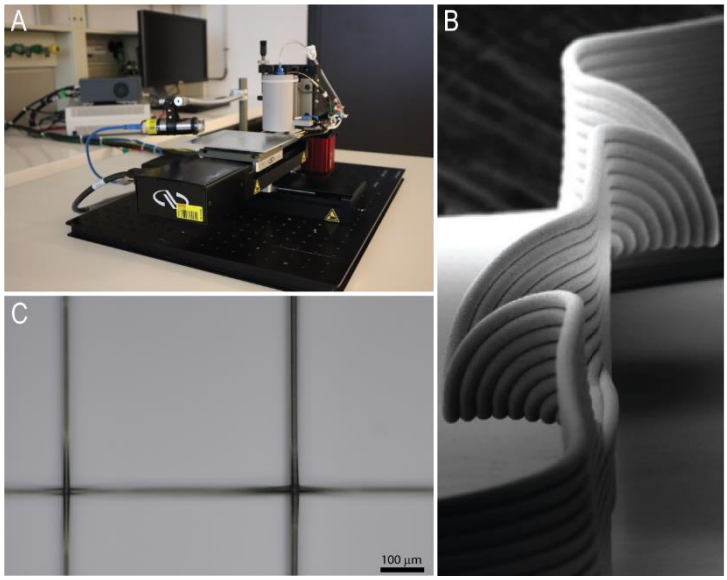
Advanced additive manufacturing instrument development

Internship / Master Thesis / Master Project

(Section: microengineering, electrical / mechanical / material / computer science)

Melt electro writing (MEW) is an emerging high-resolution additive manufacturing technique for fibers, membranes and 3D objects in the micrometer range. MEW is related to solution electrospinning and allows the fabrication of continuous fibers with diameters of 1 – 50 µm, this is up to 10x smaller than for most other additive manufacturing techniques. Current and future applications of MEW include biomedical sciences, sensors, the textile industry, filtration technologies and many more.



A) MEW instrument at LMIS1 B) 3D MEW printed structure (adapted from Liashenko et.al. 2020) C) 2.5D printed "checkerboard" structure, 10 fibres stacked at intersection points

In the MEW process a polymer melt is expelled from a charged nozzle, forming a continuous fiber. This fiber is stabilized by an electric field and accumulates on an electrically grounded collector. Moving the collector according to a preprogramed trajectorydesign allows "printing" of patterns and structures. We recently built a MEW printer that allows for micro-metre sized 2D and 2.5D structures.

The goal of this student project is to further develop this instrument, including hardware, software and processing.

There are multiple project openings for master project, master thesis and internships available. Students with interest and experience in computer science and/or mechatronics are especially encouraged to apply. If more students are interested, we will define the work for a team.

Possible projects are:

- Creation of custom software for data collection, collector trajectory control and real-time parameter analysis and regulation
- Upgrading the instrument hardware to allow for full 3D printing, advanced processing control and improved environment regulation
- Development of printing processes for 2D and 3D structures with established and new materials.

Work description:

- Improvement of MEW setup and software
- Development of printing process

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