PLATFORM DEVICE FOR THE ELECTRICAL CHARACTERIZATION OF SOAP FILMS

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PROGENY

Motivation

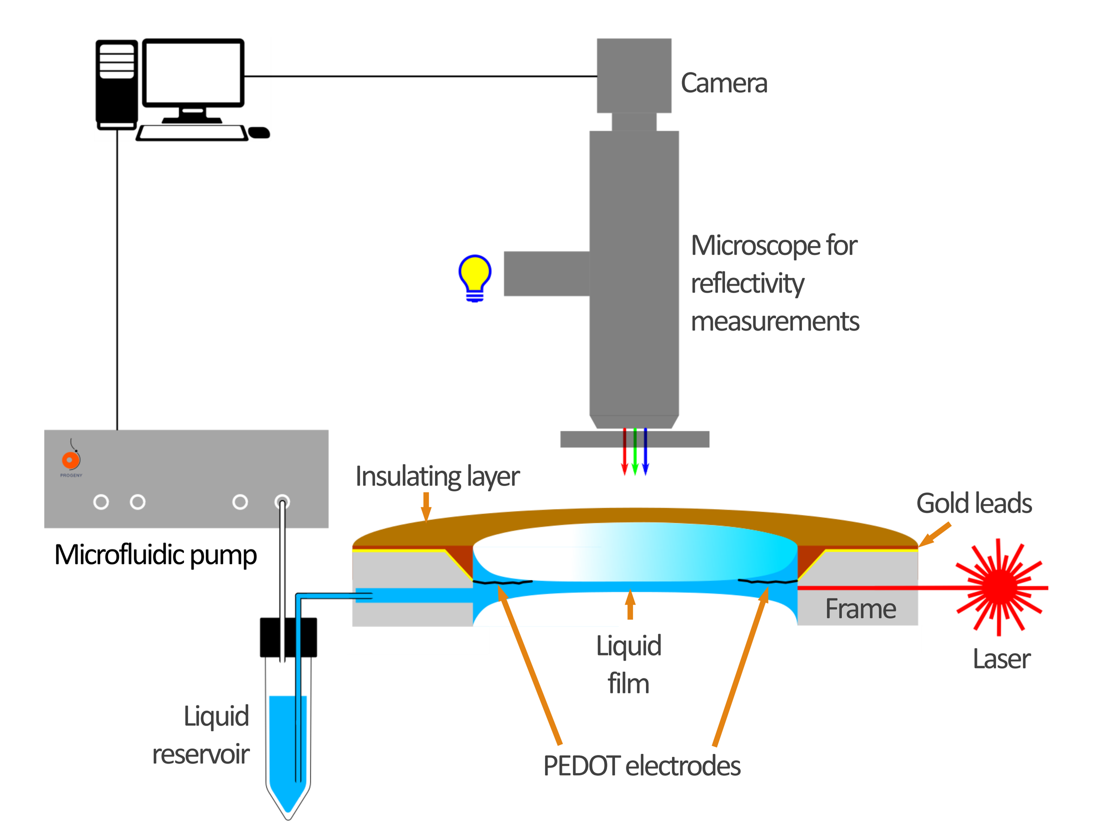
Designer soap films may be utilized as functional, soft materials in new types of biomimetic devices and sensors (proto-opto-electro-mechanical systems - POEMS) that offer added functionalities and good environmental compatibility. To facilitate research into the properties of soap films, we are developing a modular R&D platform that permits maintaining, manipulating and studying such films over prolonged periods.

R&D Platform

The central element of the platform is a frame, made from anodized aluminum or ceramic, that supports the liquid film mechanically. This frame has internal channels to carry liquid to and from the film driven by a microfluidic pump system. It is intended to design an interference-based film thickness measurement setup that provides information to the microfluidic pump in a feedback loop, which permits controlling the film thickness. The frame is surrounded by chamber equipped with quartz glass windows. Frame and chamber will accommodate various tools to investigate the film properties:

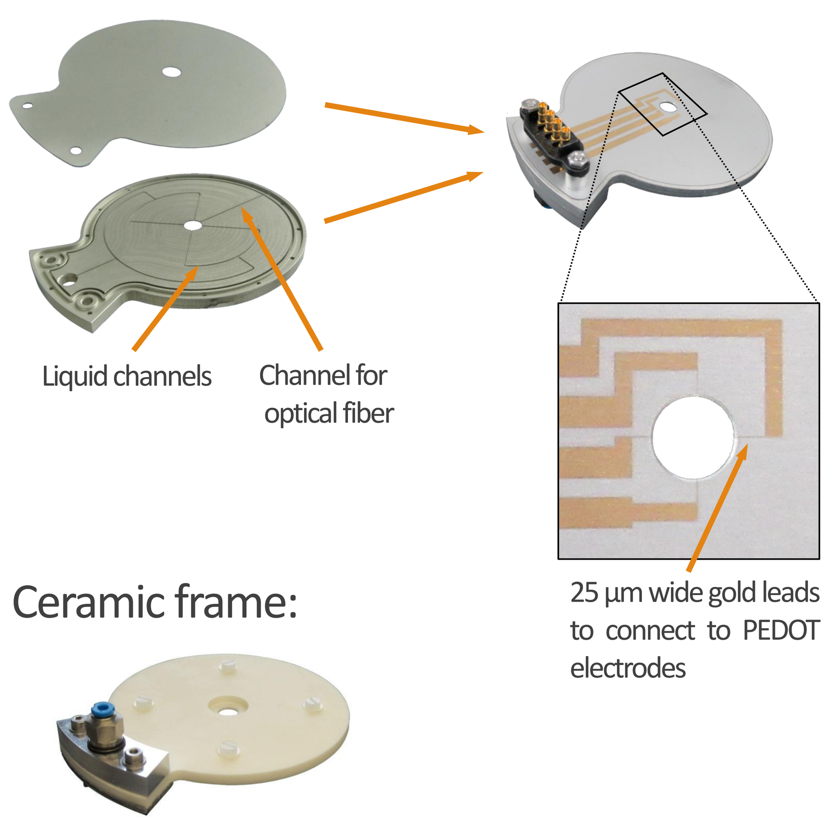
- **Transport measurements:** Field-effect transistor measurements and impedance spectroscopy will be conducted to investigate the electronic and ionic/protonic transport in the surfactant layers on the films. To contact the surfactant layer, conducting polymer fibers (PEDOT) will be grown from gold electrodes within the films to the film surface.
- **Optical measurements:** The frame includes an additional internal channel to hold an optical fiber that couples into the side of the film. Moreover, a chamber window may be exchanged with a CCD to study the optical properties of the films.
- **Gas diffusion experiments:** The chamber contains gas access ports that allow creating defined, separate atmospheres and pressures on either side of the film, while gas sensors permit monitoring the gas composition.
- **Mechanical experiments:** SAW, acoustic and ultrasonic devices may be integrated into one of the chamber sides to investigate the mechanical and electrical response of the films to mechanical excitations.

Schematic Cross-Section of Frame and Thickness Control Setup

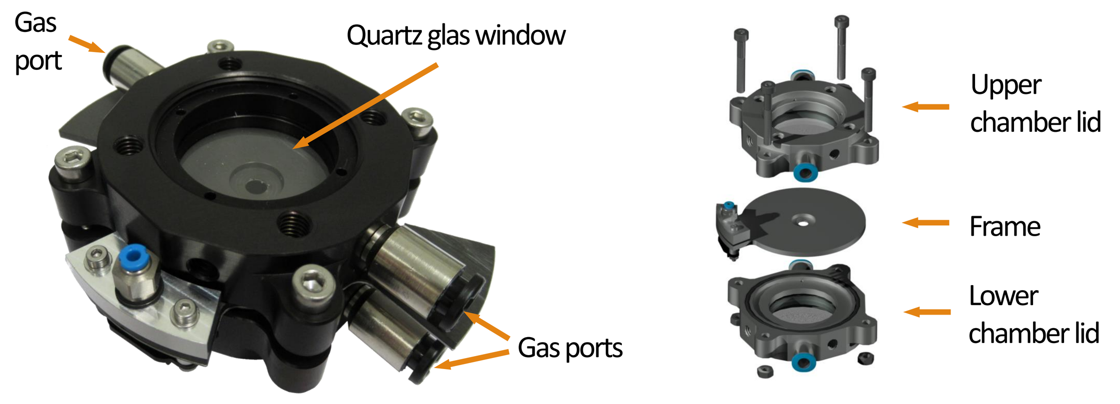


Frame

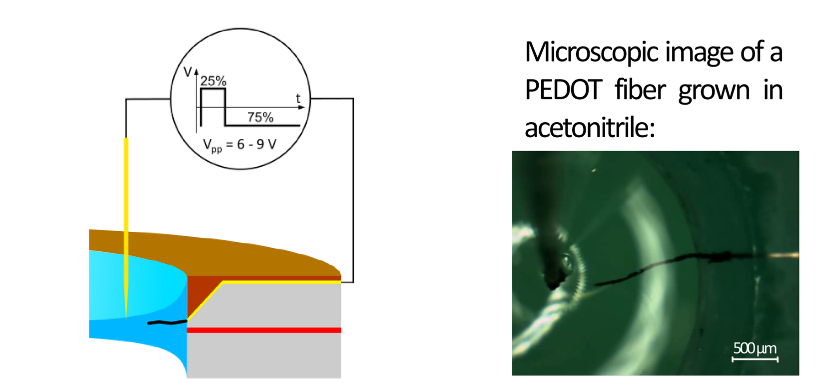
Anodized aluminum frame:



Chamber



PEDOT Electrode Growth



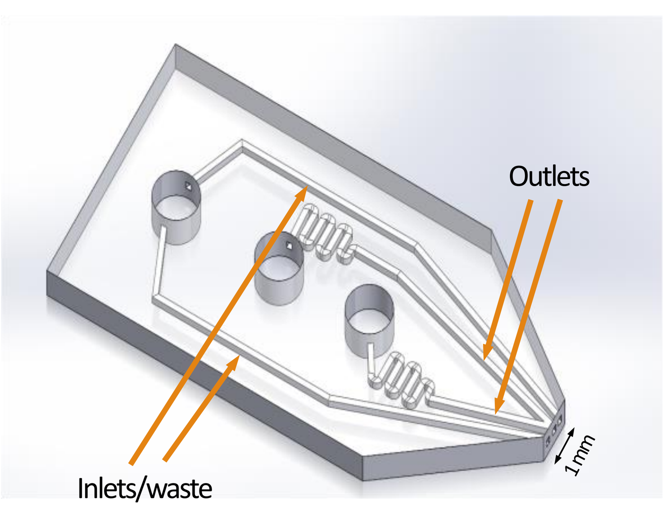
Wafer-Scale Fabrication of Free-Standing Microfluidic Devices Using Dry-Resist Laminates

In order to access the soap films to introduce reactants/materials and perform experiments, a microfluidic device has been design, fabricated and tested. This device makes use of the open-volume microfluidics paradigm.

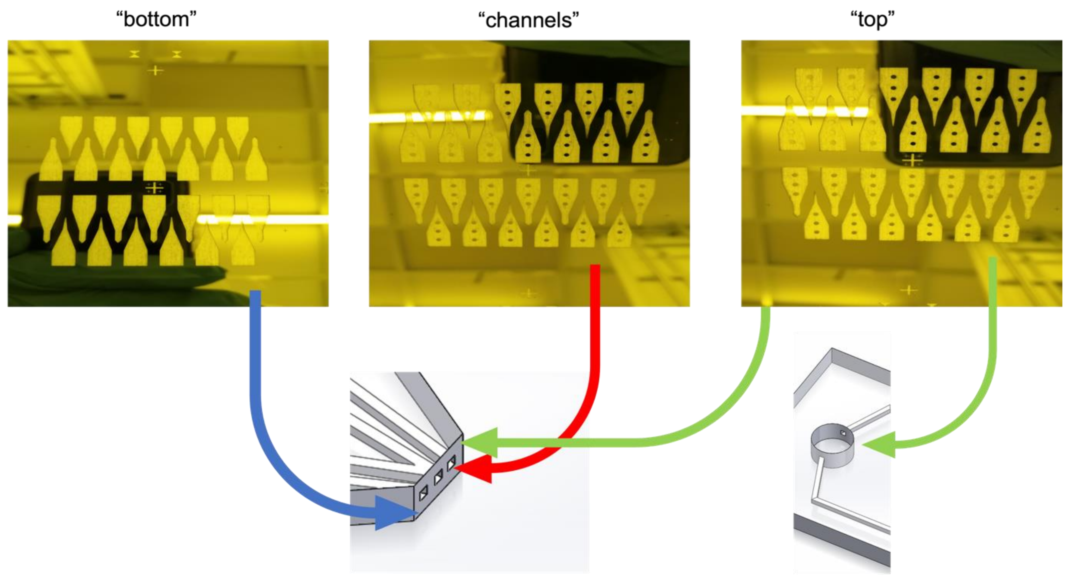
Design Principle

Using a dry resist process, we fabricate well-defined open volume devices with channel dimensions in the range of 40 x 40 µm on the wafer scale.

Schematic of the design for the microfluidic pipette

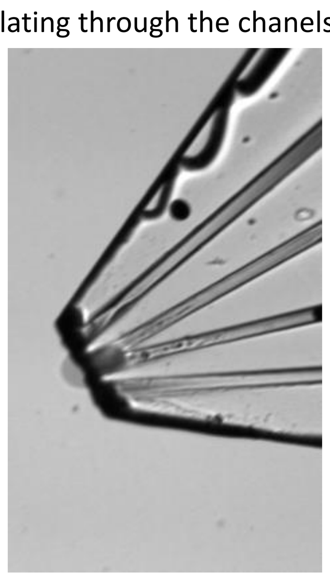


UV-photolithography masks used for exposure of the dry-resist laminates

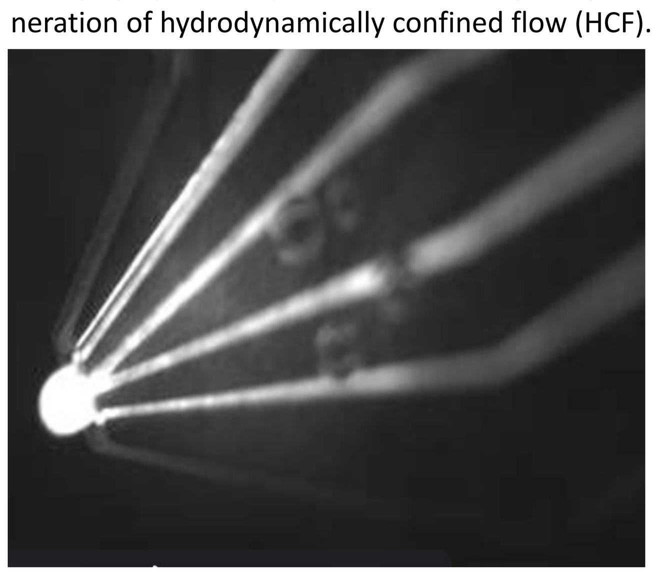


Microfluidic pipette attached to a 3D-printed liquid reservoirs

Microscope contrast image of a fluorescent dye circulating through the chanels



Fluorescent image: A virtual cell flow is formed at the tip (gray/white spot), demonstrating the generation of hydrodynamically confined flow (HCF).



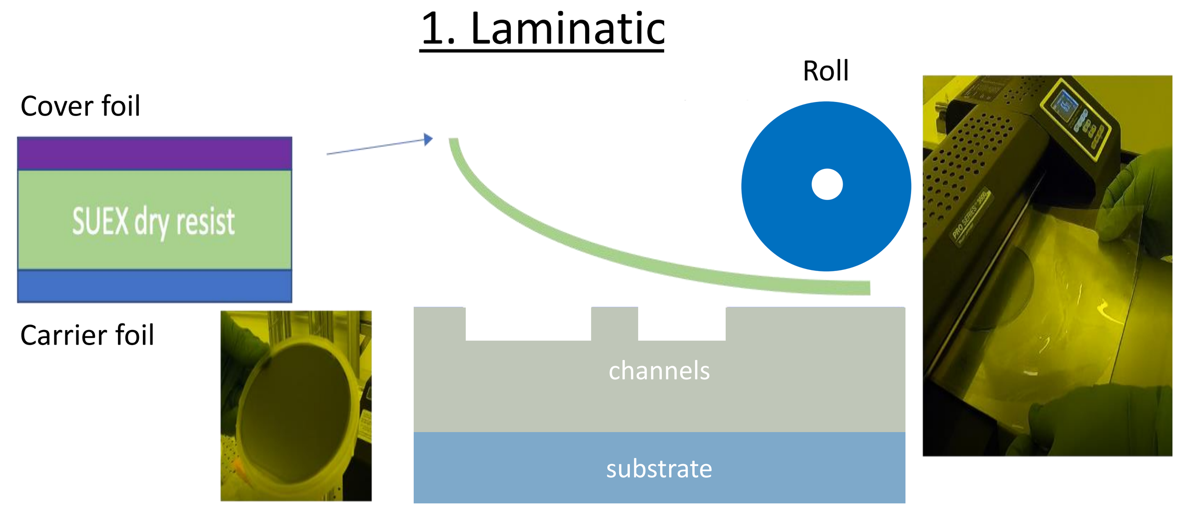
<u>Advantages of lamination</u>

- Fast process
- No liquid resist (uniformity)
- Multiple layers
- Fully enclosed cavities
- Optically transparent devices
- Reduction in fabrication time
- Resin waste elimination

Innovative Lamination-Based Fabrication Process

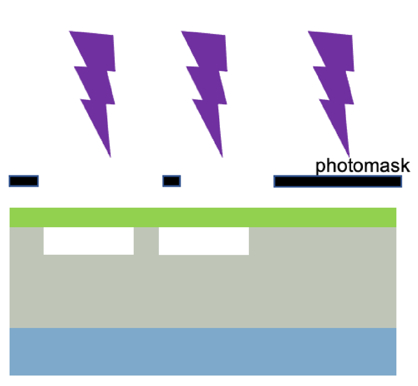
Consecutive lamination, exposure and development of dry-resist laminates (SUEX)

<u>1. Laminatic</u>



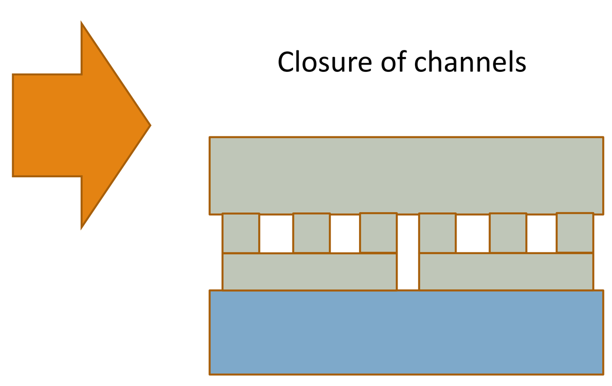
<u>2. Exposure</u>

UV light



<u>3. Development</u>

Closure of channels



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