

26th nanobiofluids seminar

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Conference Room (Room 134), 1st Floor, Bldg. No.1

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[Zoom link](#)

Designing single-layer PDMS devices for micron to millimeter-scale deformations



Leon Gebhard

PhD Student

Physical Microfluidics and Bioengineering
École Polytechnique and Institut Pasteur

Abstract

The elasticity of PDMS has been instrumental in advancing important microfluidic technologies, ranging from early valves to sophisticated organ-on-a-chip systems. Still, most designs that allow the deformation of microfluidic channels require complex multi-layer PDMS architectures or external actuators. To address this limitation Jain and Belkadi (Biofabrication, 2024), recently introduced a device in which a linear microfluidic channel can be deformed through the pressurisation of two adjacent air chambers. While they demonstrated how the channel ceiling deformation can be leveraged to compress biological materials, it remains unknown how the device geometry influences this deformation.

Here, we performed a systematic numerical and experimental study on variants of this device, through which the height of the PDMS layer is identified as the main feature that determines the ceiling deformation. Three modes of channel deformation are identified as the geometry is varied: a U shape with a central minimum, a W shape with two minima and a central maximum, or an inverse U shape with an upward-bulging single maximum. The numerical results are validated in experiments that reproduce the three modes for the predicted geometries and demonstrate vertical ceiling deformations ranging from a few microns to the millimeter scale. The generality of this approach is demonstrated for two example applications: A fully closing single-layer microfluidic valve and an optical lens of controllable anisotropic magnification. This work leverages the rapid prototyping enabled by 3D printing or micro-milling to open new perspectives in microfluidic actuation.

Biography

Leon Gebhard started his PhD in Charles Baroud's laboratory for Physical Microfluidics and Bioengineering in 2025, to find ways of programming large deformations in soft geometries. During his undergraduate studies of Chemical Engineering at the Technical University of Munich, he founded the student association neuroTUM (neurotum.com), in which he explored how different experimental paradigms affect the accuracy of brain-computer interfaces. Afterwards, during his Master's studies at the École Polytechnique de Paris, his research focus shifted to the interplay between mechanics and biology, both in plants and mammalian cellular aggregates.

Host: Hirofumi Shintaku, shintaku@infront.kyoto-u.ac.jp