Soft microrobotics: towards a new set up to characterize active soft materials for voxel actuators

Co-promotor: -

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Description:

Context: Soft microrobotics use active soft materials to generate motion and forces exploited as soft actuators. "Soft" means here a deformable polymer and "active" means responsive to an external stimulus (light, heat) to generate a mechanical output (force and displacement). Such a material can be 3D printed with at the 10-100µm scale thanks to a two photon polymerization machine available in ULB. We recently demonstrated [1] the production of "active voxels", ie 50µm x 50µm x 50µm cubes designed to exhibit bending, contraction, twist or shear deformation. The next step is now to characterize the mechanical performance of such actuators (force-displacement characteristics and response time).

Objective: Design, build, calibrate and exploit an original experimental set up to measure the force-displacement characteristics of the "voxel-actuators", inspired from atomic force microscopy and MEMS force sensors in silicon, but to be produced in the lab with glass microstructures, which will be strained when contacting the active voxel. The strain of these "springs-like" glass structures can be measured optically on different ways: with a camera, making use of a reflected beam (AFM inspired solution), or by patterning a waveguide and a Bragg grating in the glass structure to measure its strain with the so-called Bragg wavelength shift.

Methods: Design a suitable compliant glass structure [2], to be embedded in a comprehensive set up enabling the voxel heating, imaging its motion, contacting it with the glass sensor thanks to positioning stages along the required degrees of freedom. Produce this glass structure with our FemtoPrint machine. Apply the develop set up to characterize polymer active voxels, and extract the parameters for a relevant materials model.

Prerequisites: Mechanics, materials, physics. Interested in mechanical design and experimental work.

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References:

[1] A Voxel-Based Approach for the Generation of Advanced Kinematics at the Microscale, https://doi.org/10.1002/aisy.202200394
[2] Compliant Mechanisms, https://www.wiley.com/en-us/Compliant+Mechanisms-p-9780471384786