Soft microrobotics: bistable mechanism in glass

Co-promotor: Thomas LESSINNES

Advisor: Loïc AMEZ-DROZ

Lab: TIPs

Description:

Context: Soft microrobotics use elastic deformation of materials to generate a specific displacement (bending, elongation, twist…) upon the application of an input stimulus such as air pressure in pneumatic fluidic actuator, light or heat in polymeric transduction. When the stimulus is removed, the displacement comes back to zero. It is therefore of the utmost importance to make use of bistable systems, which only switch from one stable state to another one upon application of the input stimulus, while conserving their position in absence of any stimulus. This also paves the way to multi-stability [1] (more than two stable states), and to defining motion sequences in the structural design of the soft actuator. Bistable structures can also be used as threshold-based force sensor, or recently in endoscopic biopsy capsules [2].

Objective: Model different bistable scenario and implement them first with upscaled PLA-3D printed models, second with true scale glass prototypes. Characterize them to validate the models. Provide a state of the art on the use of bi- and multi-stable mechanism in microrobotics.

Methods: Literature review. Matlab and FEM implementation of reference models [3-5]. Produce upscaled models and true scale prototypes. Characterize them (force-displacement.

Prerequisites: Mechanics and mathematics. Interested in a combined theoretical and experimental work.

Contact: loic.amez-droz@ulb.be

References:

[1] Inflatable Origami: Multimodal Deformation via Multistability (2022), https://doi.org/10.1002/adfm.202201891

[2] Design of a Microbiota Sampling Capsule using 3D-Printed Bistable Mechanism (2018) 10.1109/EMBC.2018.8513141

[3] An analytical analysis of a compressed bistable buckled beam (1998) https://doi.org/10.1016/S0924-4247(98)00097-1

[4] Analytical modeling for rapid design of bistable buckled beams (2019) https://doi.org/10.1016/j.taml.2019.04.006

[5] A centrally-clamped parallel-beam bistable MEMS mechanism (2001) https://doi.org/10.1109/MEMSYS.2001.906551