Fabrication and characterization of gradient soft solids

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Scientific context

Many foreseen the usage of soft solids in innovative applications such as anti-fouling, tissue engineering, or soft robotics materials. To fulfill these aspirations, tailoring how such materials respond to contact is crucial, making them stiff, soft, sticky, or slippery, depending on the targeted utilization. In that regards, mechanical gradients hold great promises: The near-surface variation of a materials rigidity empowers it with effective interfacial contact properties. A soft upper-layer makes a silicone sticky, and an oxygen-inhibited skin a hydrogel slippery [1, 2]. The exploitation and rational design of gradient soft materials, however, is limited because gradient characterizations for now rely on indirect methods. We thus do not know what gradient results from a given fabrication process, and thus cannot engineer their design.

The aim of this project is to establish the link between fabrication protocols and mechanical gradients, in model soft solids. The fabrication method will rely on layering, a technique at the basis of 3D printing, and the characterization on micromechanics experiments, which allow for the visualization of materials displacements in the three spatial directions [3] (Fig. 1). Beyond opening new ways to design and control soft solids, this project will have far-reaching fundamental implications in the fields of multiphasic materials, 3D printing, and polymer physics.

Outlooks You will be using state of the art imaging and numerical analysis tools, and the expected results are likely to be published in a peer-reviewed international journal. The opportunity to continue as a Ph.D. student can be considered.

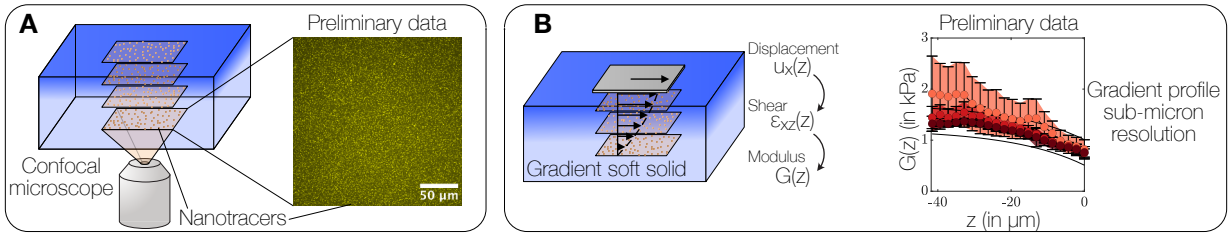

Figure 1: Project overview (A) Micromechanics allow for 3D displacements inside transparent materials. (B) We will use them to accurately measure gradient profiles.

Bibliography

[1] J. Mandal, K. Zhang, N. D. Spencer et al. *Soft Matter* (2021).

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