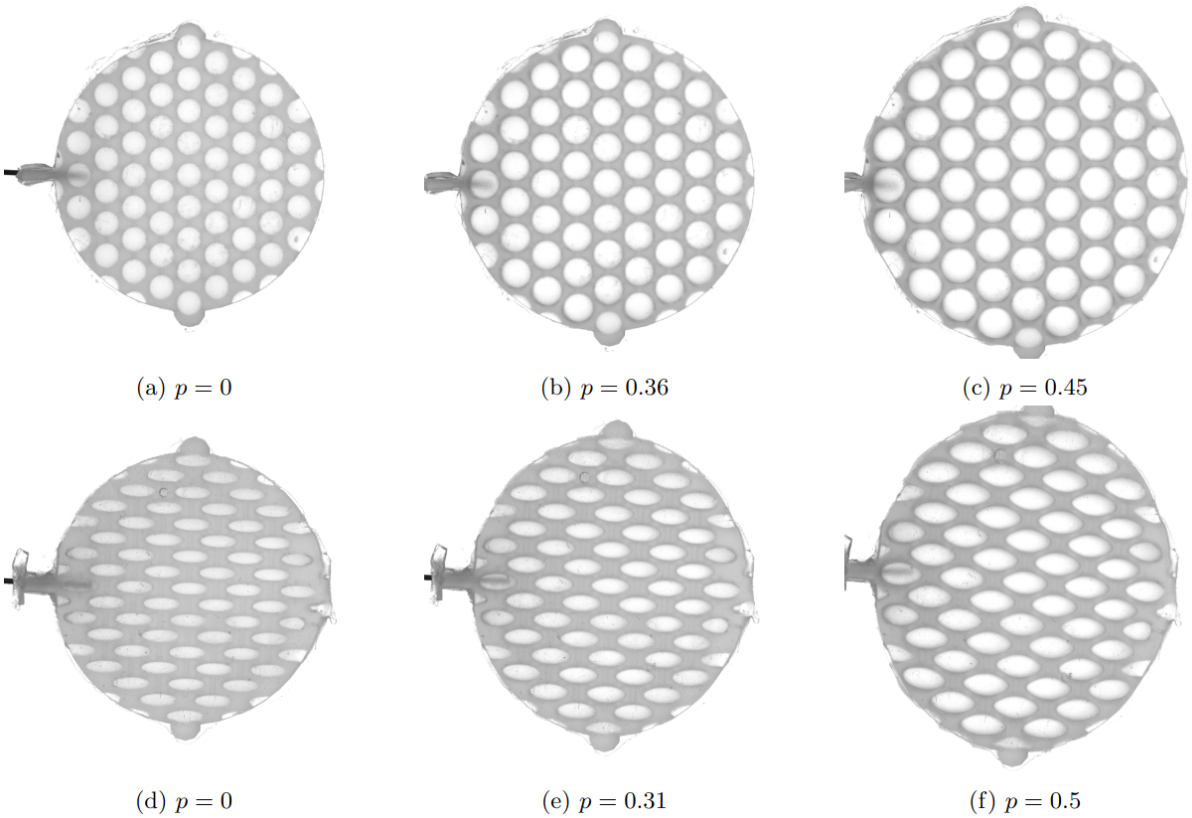
Fully programmable inflatable panels

Ofir Mirkin[1,2], Mélina Skouras[1] Emmanuel Siéfert[2]

[1] Univ. Grenoble Alpes, INRIA, CNRS, Grenoble INP, LJK
[2] LIPhy, Université Grenoble Alpes, CNRS, Saint-Martin-d'Hères
ofir.mirkin@etu.univ-grenoble-alpes.fr

Self-deployable materials are expected to have wide application potential, e.g., in robotics, medicine, and architecture. So far, all responsive materials have limited deformation possibilities, and researchers lack control over the six local degrees of freedom (three for the metric and three for the curvature). Here, we introduce a strategy to address this limitation. We investigate how variations in mesoscale properties and applied pressure influence the deformation of inflatable elastic architected materials. Our structures feature a triangular network of interconnected cylindrical cavities, and we study how their density, eccentricity, and orientation control the in-plane deformation. To program the curvature, we superimpose two layers with different cavity geometries, achieving a 2D generalization of the bilayer effect. Our goal is to use these building blocks to fully program target shapes and, in the long run, gain control over their intermediate configurations or mechanical properties by leveraging the numerous degrees of freedom. Figure 1 illustrates examples of isotropic and anisotropic in-plane deformations.



(a) $p = 0$ (b) $p = 0.36$ (c) $p = 0.45$

(d) $p = 0$ (e) $p = 0.31$ (f) $p = 0.5$

FIGURE 1: Isotropic (top) and anisotropic (bottom) structures at different pressure levels p (bars)