From Grid Geometry to Adaptive Function : Multi-Axial Contraction in Liquid Crystal Elastomer Lattices

Mathis Lagier, Güzin Özkan, Desiree Chen, Danqing Liu

Eindhoven University of Technology
Email of communicating author: m.n.lagier@tue.nl

Liquid crystal elastomers (LCEs) are soft anisotropic materials that convert molecular alignment into reversible macroscopic deformation. While individual LCE strips mainly contract along one programmed direction, adaptive porous systems require coordinated deformation across multiple axes. Here, we investigate LCE lattices assembled from mechanically programmed strips as active porous architectures that transform uniaxial contraction into multi-axial pore closure. The grids were fabricated using a two-step crosslinking approach, followed by mechanical stretching, UV fixation, and lattice assembly. By varying programming strain, pore size, and assembly architecture, we show that planar LCE grids achieve near-complete and reversible pore closure upon heating above the nematic-isotropic transition temperature. The closure is tunable through programming strain and remains stable over repeated heating-cooling cycles. Woven and non-woven square grids further reveal how lattice architecture influences contraction efficiency and mechanical output. Beyond square planar grids, the same design principle is extended to triangular and diamond pore geometries, as well as three-dimensional cylindrical and cubic lattices. These structures show that pore shape and global geometry influence how local strip contraction is translated into collective deformation. Finally, these adaptive LCE lattices are explored as responsive platforms for flow control, soft valves, gripping, and liquid release through porous media compression.

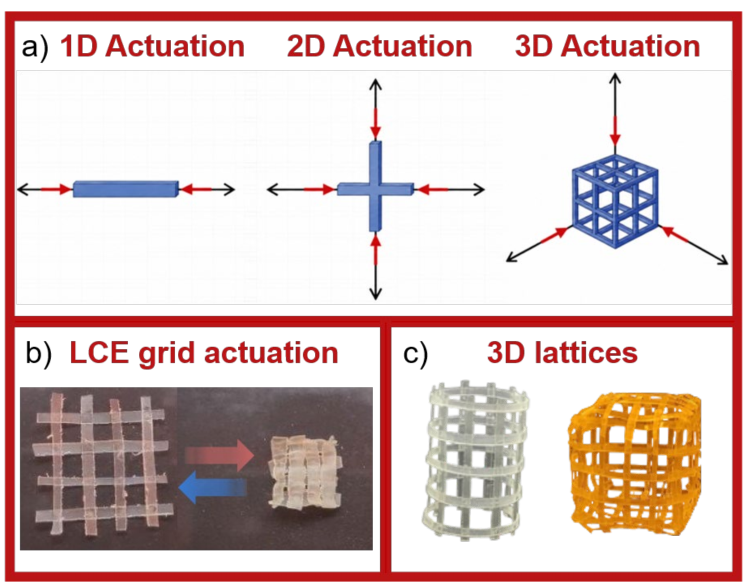

Figure 1. From 1D Strip Contraction to 3D LCE Lattice Actuation. (Arrows indicate the axes of dominant actuation in each architecture)