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Assembling and Disassembling Solids using Collective Action of Shape-Morphing Polymer Ribbons

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Abstract

Aligned liquid crystal elastomers (LCEs) respond to temperature changes by changing form in programmed manners. We will describe using many shape-morphing ribbons comprised of LCEs to create solids that self-assemble, modulate volume, and disassemble on demand. This is achieved by inducing dispersions of LCE ribbons to mechanically interlock. This approach mimics the aggregations of fire ants, worms, and caterpillars where many 'responsive' units can transiently aggregate to generate new collective functions. Ribbon shape, which is readily controlled in LCEs, and concentration dictate if aggregation occurs and govern the global mechanical properties of the solid that forms. The aggregated liquid crystal elastomer ribbons have a 12-fold increase in the yield stress compared with cooled dispersion. If ribbons are forced to translate in space, this motion enables the assembly of solids from dilute dispersions. Motion of each ribbon within the aggregate can also induce isothermal dispersion or probe the strength of entanglements. We envision using these processes to enable macroporous materials that flow, assemble, and disassemble on demand.

Keywords:

liquid crystal elastomers entanglement porous materials