Institut "Jožef Stefan" Ljubljana, Slovenija

TECHNOLOGY OFFER

PREPARATION OF LIQUID CRYSTAL POLYMERS (ELASTOMERS) FOR USE AS DEVICE COMPONENTS OR 3D PRINTING APPLICATIONS

Fields of use

Components in macro- and micromechanical devices as well as in 3D printing applications

Current state of development

The solution has been demonstrated and tested in the laboratory.

Type of cooperation

License agreements and/or technical cooperation agreements with industry or research partners

Intellectual property

Patent application has been filed for the technology

Developed by

Jožef Stefan Institute

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Summary

A method for preparation of thermo-responsive polymer composite materials (polymer dispersed liquid crystal elastomers) has been developed. Mixing of thermo-active elastomers into polymers allows for controlled and reversible reshaping of the material by changing its temperature. The material can be used for components in macro- and micromechanical devices as well as in 3D printing applications.

Description of the invention

Liquid crystal elastomers (LCEs) are smart polymer materials that combine the ordering of mesomorphic molecules (liquid crystals) with the elastic properties of polymer networks. Functionalization of standard LCE components is often made difficult due to polymerization inhibition issues. In addition, behavior of elastomer materials is often restricted by its structure, not allowing for flexibility in mechanical response. Consequently, currently available LCE materials still lack easy implementation into larger scale production environment. The major obstacle is the microscopic size of LCE domains: although individual LCE domains possess shape memory, the sample as a whole is inert. The Solution: The invention is a polymer dispersed LCE (PDLCE), a binary soft-soft composite that exhibits elastic behavior intermediate between the rubber elasticity of the matrix and soft/semi-soft elasticity of the LCE particles. The LCE composites can be prepared having custom-tailored properties; they can be shaped into arbitrary forms, and functionalized by using a prefunctionalized matrix, e.g. a matrix containing micro- or nano-sized fillers. LCE particles are mixed in a manner that allows for thermo-mechanical responsiveness of the composite, which allows for a more versatile response as compared to the standard one.

Application: Conventional LCE material can be replaced with PDLCEs in LCE-based actuator devices; these materials can be used in manufacturing components of electronic devices, including macro-, micro-, and nanoscopic devices (switches, valves, microfluidic systems, micro-pumps imitating peristaltic motion, artificial muscles in robotics, etc.). In addition, the PDLCEs may be used as materials in 3D printing applications.

Main Advantages

- efficient tailoring of the thermal response by using a simple manufacturing approach
- use of different fillers allows for preparation of materials for different applications
- mixing of components can be done in different ratios, multiple LCE materials may be included in the composite, and they may be locally ordered as desired

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- different kinds of particles can have different sizes, order parameters, phase transition temperatures, and anisotropic properties

- composite may be prepared sequentially in multiple layers and thereby made to respond differently at different points

- polymerization inhibition is avoided by filling functionalized matrix materials with conductive, ferroelectric or ferro-magnetic nanoparticles or photoactive molecules; nothing beyond thermomechanical responsiveness needs to be provided by LCE particles

- particles can be produced by milling the poly-domain LCE material, avoiding the tedious two-step crosslinking approach for production of mono-domain LCEs

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