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Ultra-large amplitude contraction in micron-sized LCE actuators

Patrick Keller, Hong Yang and Axel Buguin

Institut Curie, CNRS UMR 168, 26 rue d' Ulm 75248 Paris cedex 05, France

The search for " smart materials ", that respond to external stimuli (pH variations, ion concentration, temperature, electric field, etc) by changes in shape or size, has recently attracted considerable attention from the material research community.[1-3] In addition to the obvious attractiveness of such studies in basic science, "smart materials" have many potential applications of great interest including serving as the key building block for fabrication of sensors, micro-robots, micro-pumps and actuators.
Some years ago, de Gennes[4-5] first proposed to use nematic liquid crystal elastomers as "artificial muscles". The idea was to make use of a conformational change of the polymer backbone at the nematic to isotropic phase transition[6] as the motor for a macroscopic contraction. Based on de Gennes's idea, several thermo and photo-responsive nematic liquid crystal elastomers have been produced.[7,8] For our part, we have developed actuators using side-on nematic liquid crystal elastomers[9-11]. Making use of a soft lithography technique called replica molding,[12] we have succeeded in creating micron-sized responsive pillars made of nematic side-on liquid crystal elastomers.[13] However, the observed contraction did not exceed 40%.We have now developed a new system, which shows contraction of up to 400% in micronsized pillars. Applications in the domain of "responsive surfaces" with stimuli-dependent roughness will be presented.

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