MEMS analogous micro-patterning of liquid crystalline elastomers using a fluorinated photoresist

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Liquid crystalline elastomers (LCEs) combine the properties of polymeric elastomers with the self-organization of liquid crystals. Their actuation capacities through the anisotropy-to-isotropy change of macromolecular chains make them an unique class of shape memory materials.[1] In this work, we present a method to pattern LCEs in the micrometer range without using any mechanical processing steps to prepare micron sized LCE actuators compatible with MEMS technology.

For this purpose we developed a multi-layer spin-coating process. A water soluble sacrificial layer to remove LCE actuators in the end, a photoalignment layer to align LC monomers and a LCE precursor that is polymerized and crosslinked through UV-irradiation are spin-coated successively on substrates to synthesize 300-3500 nm thick LCE films. Films up to 700 nm thick are structured with oxygen plasma using a fluorinated photoresist that is orthogonal to all other layers. For patterning of thicker films a hard mask process using hydrogen silsesquioxane as a hard mask is used. Polarized optical microscope (POM) and profilometry images of a structured LCE film are shown in Figure 1. A resolution of 1.5-2.0 microns could be achieved with the described patterning methods.[2]

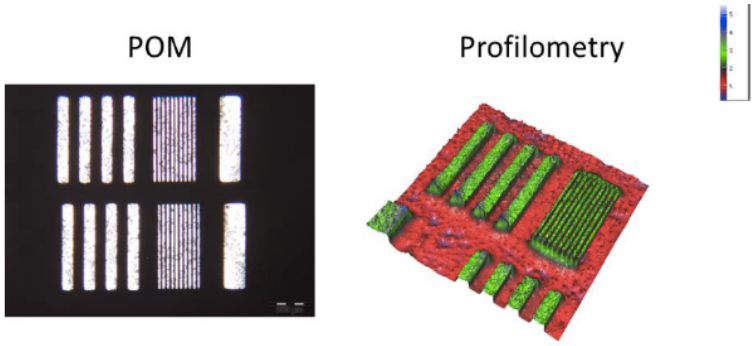

Figure 1: POM (left image, scale bar: 200 µm) and profilometry (right image, scale bar: 5 µm) images of a patterned LCE film using a hard mask process.

Structured LCEs show director dependent and reversible two-dimensional shrinkage and elongation and three-dimensional bending and twisting actuation motions. The described procedure makes it possible to pattern LCEs in every shape and with variable director fields and thus LCEs can be processed like classical MEMS. This shows the potential of LCEs in MEMS devices and encourage us to develop new kinds of micro devices in the future.[2]

References

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