Holographic recording in light-sensitive liquid crystal elastomers

M. Devetak[a], B. Zupančič[a], A. Lebar[a], P. Umek[a], B. Zalar[a], V. Domenici[b], G. Ambrožič[c], M. Žigon[c], M. Čopič[d], I. Drevenšek-Olenik[d]

[a]*J. Stefan Institute, Jamova 39, SI 1001 Ljubljana, SLOVENIA*
[b]*Dipartimento di Chimica e Chimica Industriale, Università degli studi di Pisa, via Risorgimento 35, 56126 Pisa, ITALY*
[c]*National Institute of Chemistry, Hajdrihova 19, SI-1000 Ljubljana, SLOVENIA*
[d]*Faculty of Mathematics and Physics, University of Ljubljana, Jadranska 19, and J. Stefan Institute, Jamova 39, SI 1001 Ljubljana, SLOVENIA*

In light sensitive liquid crystal elastomers (LCEs) liquid crystalline orientational order of the mesogenic molecular units is coupled with the conformation of the photosensitive molecular units, for instance photoisomerizable azobenzene derivatives [1,2]. Due to this coupling, even relatively minor light-induced perturbations in the concentration of trans and cis-isomers cause strong modifications of the orientational order and consequently of the refractive index of the medium. This provides a challenging prospect to use this media for recording efficient volume holograms of the phase grating type. Despite this, practically all experiments with light-sensitive LCEs reported till now used homogeneous illumination to stimulate the opto-mechanical response and only very recently it was shown that patterned illumination opens up a broad range of novel structures and possible applications [3].

We performed a systematic investigation of optical diffraction gratings fabricated in a light-sensitive LCE material by means of holographic patterning. 1D and 2D transmission gratings were recorded in the azobenzene-based LCE film by using an interference field of two and four UV (351 nm) laser beams. The effective thickness of the gratings was found to be 20 micrometers. We revealed the kinetics of the gratings recording and erasing processes at various temperatures and determined optimal recording conditions. We proved that the presence of nematic phase is vital for the efficient holographic recording. We also demonstrated reversible modification of the grating period by subsequent stretching and retraction of the film and explained huge temperature-induced modifications of the grating properties in the vicinity of the nematic-paranematic phase transition. Our results demonstrate that holographic recording in light sensitive LCEs on one hand provides a very convenient tool to study structural properties of these intriguing media, while on the other hand it is also very promising for applications in tunable diffractive optical elements.

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