Modeling the viscoplastic deformation of azopolymers under the influence of structured light

Nikolai Liubimtsev[1], *Marina Saphiannikova*[1]

[1]*Leibniz Institute of Polymer Research Dresden, Germany*

Email of communicating author: grenzer@ipfdd.de

A distinctive characteristic of side-chain azopolymers is their capacity to convert structured light irradiation into a well-defined stress field [1]. This stress field arises from the alignment and elongation of the polymer backbones along the polarization direction of the light, which serves as a nematic director. Irradiation with linearly or elliptically polarized light results in a uniaxial or biaxial orientation of the azopolymer chains. The stress tensor is directly proportional to the rate of change of the second-order orientation tensor, which can be predicted based on the spatial distribution of the light intensity and polarization [2,3].

Through the application of viscoplastic photoalignment modeling, we demonstrate that excellent correlation with the experimentally observed reshaping of azopolymer microstructures is achievable. Three-dimensional light fields, such as highly focused Gaussian beams or various q-plate patterns, are employed to induce directional photodeformations. The light field is implemented in the finite element software ANSYS either analytically or through the direct mapping of its intensity, polarization, and ellipticity at each material point. This direct mapping technique proves particularly useful for arbitrary light fields, which can be generated by spatial light modulators on the surface of the sample.

The financial support of the DFG grant GR 3725/10-1 is gratefully acknowledged.

References

[1] M. Saphiannikova, V. Toshchevikov, N. Tverdokhleb. “Optical deformations of azobenzene polymers: orientation approach vs. other concepts.” Soft Matter 2024, **20**, 2688-2710.

[2] I.K. Januariyasa, F. Reda, N. Liubimtsev, et al. “Stress-driven photo-reconfiguration of surface microstructures via vectorial field-guided lithography.” Light Sci Appl 2026, **15**, 194.

[3] N. Tverdokhleb, B. Audia, P. Pagliusi, M. Saphiannikova. “Viscoplastic photoalignment modeling of asymmetric surface restructuring in azopolymer films by elliptically polarized light.” J. Mater. Chem. C 2025, **13**, 1263-1271.