Highlights

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Molecular Model for Light-Driven Spiral Mass Transport in Azopolymer Films

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We described a detailed microscopic mechanism, that provides a first complete picture of the wavefront-sensitive light-induced mass transport phenomenon in azobenzene-contatining polymers.
In fact, we have found the unexpected experimental observation of spiral-shaped relief patterns on the surface of an azopolymer that has been illuminated with a vortex laser beam, that is a beam having a helical wavefront. The spiral handedness of the polymer pattern is determined by the vortex one.
This result is quite surprising because the common understanding hitherto was that these surface patterns respond to the light intensity distribution and its gradients. The intensity pattern of a vortex beam is shaped as a "doughnut" and carries no information whatsoever about the vortex handedness.
We then introduced a model of the mass migration process based on anisotropic light-driven molecular diffusion. A key ingredient of our model is an enhanced molecular diffusion in proximity of the free polymer surface, which is essential for explaining, in particular, the recently observed spiral-shaped reliefs resulting from vortex-beam illumination.
Our model provides a realistic, although simplified, description of the light-induced mass-transport process at the molecular scale, illustrating the microscopic nature of the surface-enhanced diffusion term needed to explain the spiral relief patterns observed under vortex light illumination.

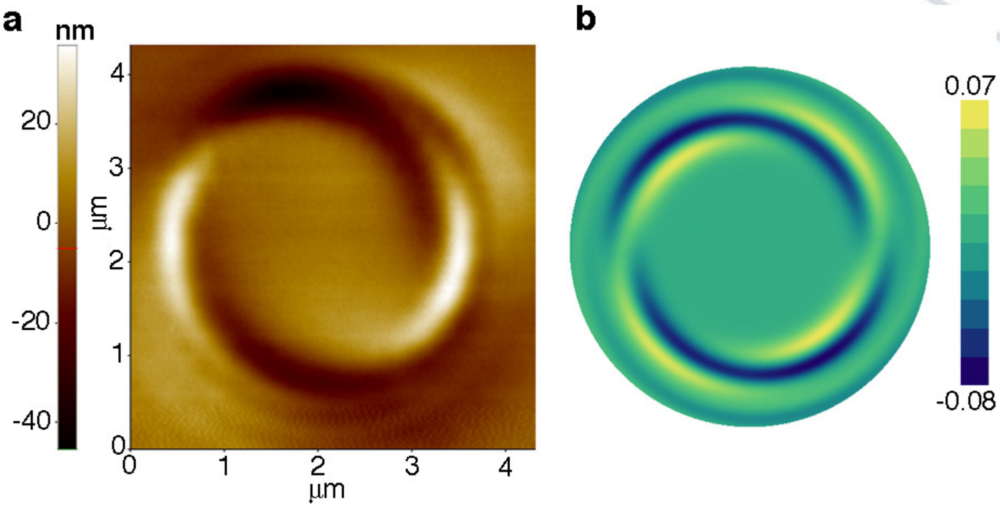

Figure – (a) Relief spiral patterns induced on the polymer by an impinging vortex light beam. (b) Pattern predicted by our model.