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Spiral photolithography of azopolymers

When a thin polymer film containing azobenzene moieties is illuminated with a patterned light field stable reliefs and valleys appear on its surface, while keeping its total volume approximately constant, thus revealing a process of molecular migration induced in the material by the optical field. These polymer reliefs form patterns that are related in a non-trivial way to the illuminating field structure. The mass transport appears to occur preferentially in the direction of the electric field and to result from a sort of photo-induced fluidization of the material. These optical writing phenomena make azopolymers very attractive for optical data storage applications or for the nanoscale imaging of electromagnetic field distribution. Recently, the potential advantage of using azopolymers in the place of sacrificial photoresists in the fabrication of silicon micro- and nano-structures has also been demonstrated.Despite the significant research effort of the last twenty years, the microscopic mechanism underlying this phenomenon remains unclear. In this framework, we have recently reported the appearance of spiral-shaped relief patterns on the polymer under the illumination of focused vortex light beams. The induced spiral reliefs are sensitive to the vortex topological charge and to the wavefront handedness. These findings are unexpected because the doughnut-shaped intensity profile of the writing vortex beams contains no information about the wavefront handedness.To explain our observations, we have developed a model that links the main features of this phenomenon to the surface-mediated interference of the longitudinal and transverse components of the optical field. The interference pattern drives the molecular migration, via a photo-activated anisotropic random walk. Our results could be useful for optimizing the emerging applications of the azopolymer light-induced mass migration phenomenon in the areas of photolithography and optical field nano-imaging.