Muscle-like adaptability from liquid crystal networks

Federico Lancia, Alexander Ryabchun, Nathalie Katsonis*

Bio-inspired and Smart Materials, MESA+ Institute for Nanotechnology, University of Twente, PO Box 207, 7500 AE Enschede (NL)

Recent advances in soft robotics have witnessed the transition from shape morphing, to encoding adaptive mechanical responses into materials. In many biological materials and tissues such as muscle fibers, collagen or fibrin, non-linear elasticity and strain-stiffening are key features that allow the establishment of high strains, and resistance to failure. I will discuss our efforts to develop strategies towards wholly artificial molecular materials that respond to illumination actively, with such a muscle-like mechanical response.

We have reported earlier on springs of liquid crystal polymer networks, in which azobenzene photo-switches are incorporated covalently, so that their photo-isomerization is amplified across increasing length scales, and eventually results into complex and versatile motion at the macroscale [1]. We have also shown that these objects also display non-linear responses to mechanical stress [2]. Here, we evidence that these springs stiffen under illumination with UV light, *i.e.* upon disruption of the liquid crystalline order. This stiffening stands in contrast to the photo-induced softening that was reported in fully polymerized networks so far. We propose that this adaptability to light is mediated by the low molecular mass liquid crystal that is incorporated into the network, because this liquid crystal interacts differently with the polymer fibers, depending on the polarity of the latter.

Besides unraveling an unprecedented photo-stiffening effect in liquid crystal networks, these results establish phase heterogeneity as a key control parameter in the photo-mechanical response of these materials.

References

[1] Iamsaard *et al*., *Nature Chemistry* **2014**, 6, 229-235.
[2] Iamsaard *et al*., *Nature Protocols* **2016**, *11*, 1788-1797.

**Corresponding author e-mail: n.h.katsonis@utwente.nl*