



Optimization of Liquid Crystal Materials for Photo- and Thermomechanically Responsive Elastomers

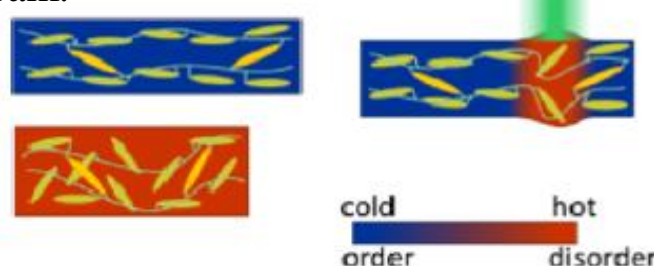
Milena Jeżak, Dorota Węglowska, Przemysław Kula, Wiktor Piecek, Jolanta Konieczkowska, Ewa Schab-Balcerzak and Rafał Węglowski

Introduction and the aim of the study

Light- and thermocontrolled liquid crystal polymer networks (LCNs) being tunable photonic switches can be used in several fields of application such as optical communications or sensors [1]. The photomechanical response of such functional materials can be used to convert either thermal or light energy into different forms of mechanical energy [2].

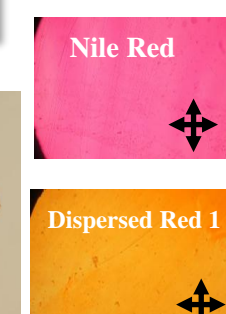
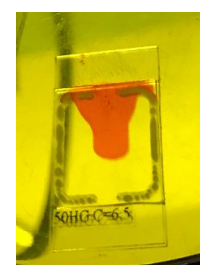
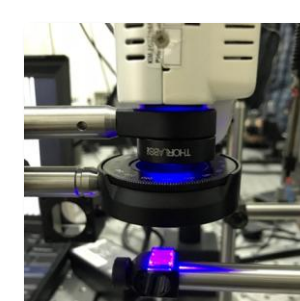
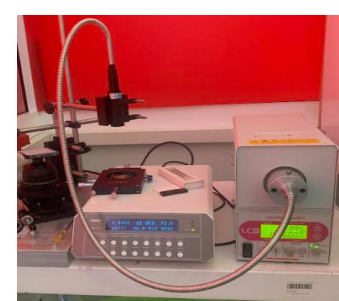
Cross-linked polymer chains (yellow) arranged in one direction in an LC polymer network stripe deform locally because of increased temperature. With efficient light-absorbing dye, the heating can be induced by light absorption from a laser beam.

In this work, we demonstrate the process of the preparation and the investigation of photo- and thermomechanically responded liquid crystalline elastomers.



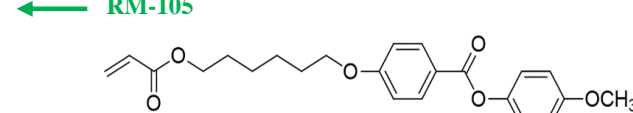
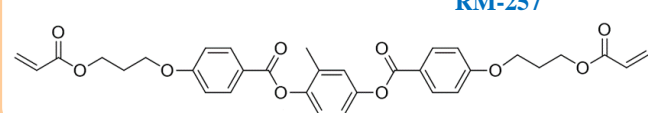
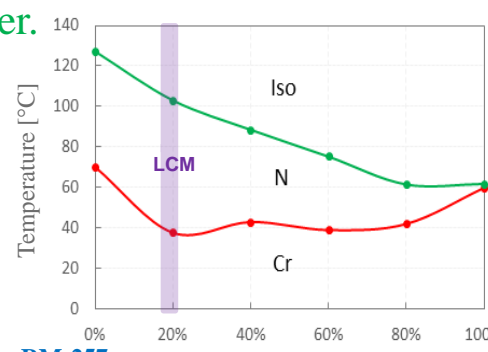
Liquid Crystal Polymer Network Film

To prepare LCN films, a photoalignment method was used. Glass slides were spin-coated with a photoalignment azopolyimide (JK158) solution (~1%) in N-methyl-2-pyrrolidone, dried, and heated at 130 °C for 2.5 h to evaporate the solvent. The polyimide orienting layers were exposed to linearly polarize UV light with wavelengths in the 345–380 nm band (Hamamatsu LC8 Xe-Hg UV lamp with a Glan-Taylor prism polarizer) with 3 mW/cm² intensity at the glass plane for 40 minutes.

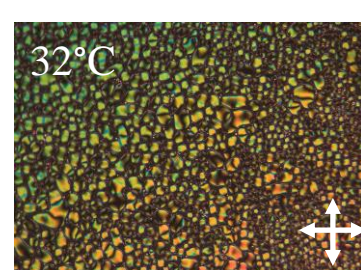
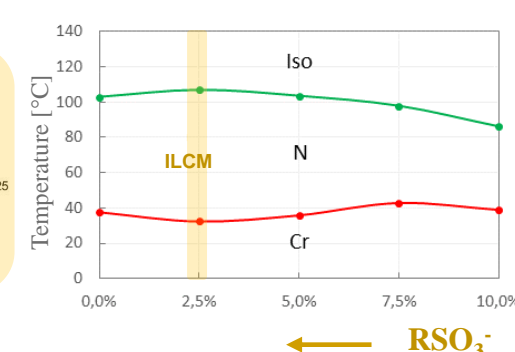
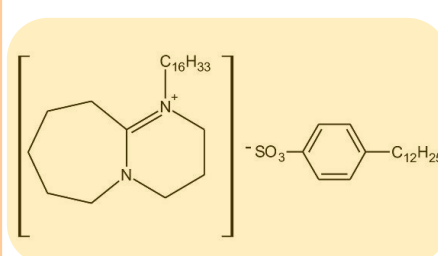


Liquid Crystal Mixture

The liquid crystal nematic mixture (LCM) is based on commercially available compounds and contains 80wt% of the **RM-257 LC cross-linker** and 20wt% of the **RM-105 LC monomer**.

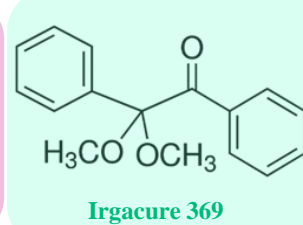
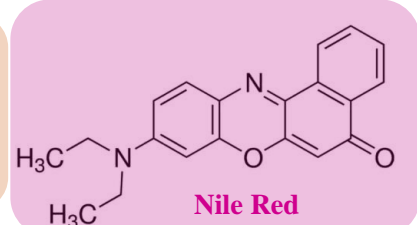
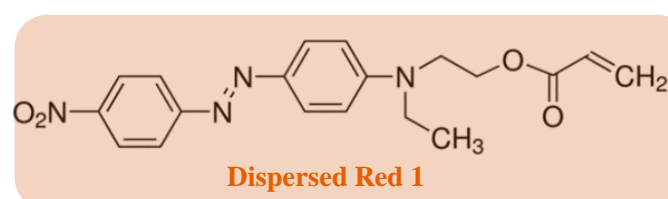


The ionic liquid crystal mixture (ILCM) was prepared by adding 2.5 wt% of the ionic compound **RSO₃⁻** to LCM.



nematic phase during cooling

The ILCM mixture was doped with the dye in amount of 1 wt % (**Disperse Red 1** or **Nile Red**), which provides efficient green laser light absorption and then 1 wt % of the photoinitiator (**Irgacure 369**).

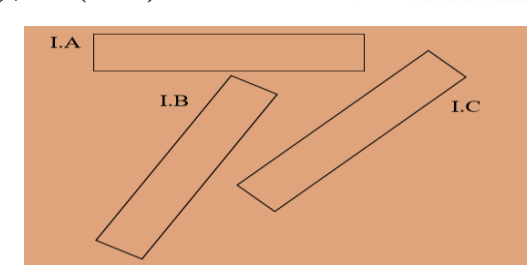
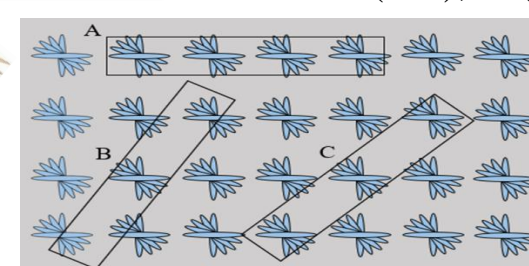
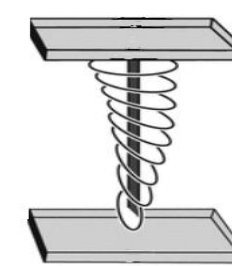
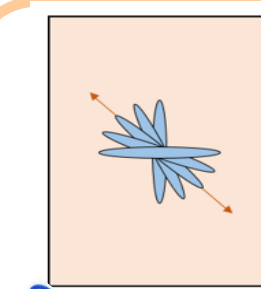


All the compounds were melted and stirred on a hot plate in a glass flask at 80 °C.

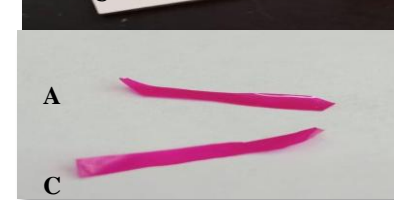
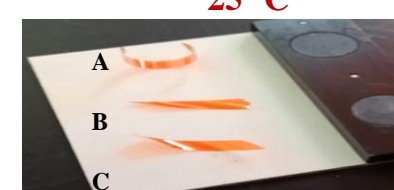
Thermo- & Photomechanical Response

Twisted Nematic

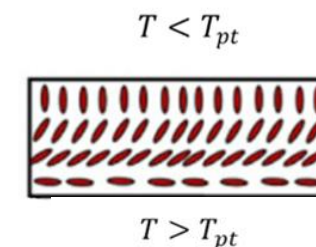
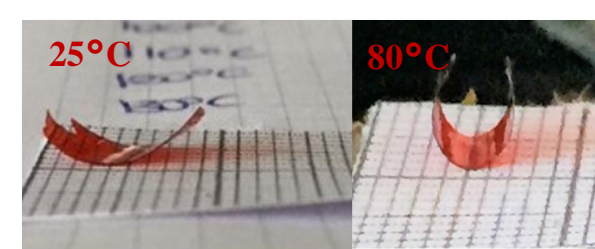
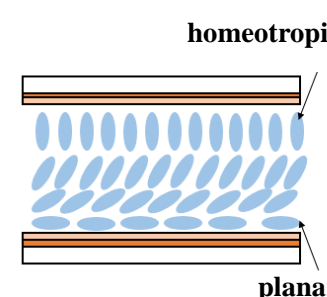
The ILCN the foil was cut into pieces according to the following directions: A (45°), B (115°), C (90°).



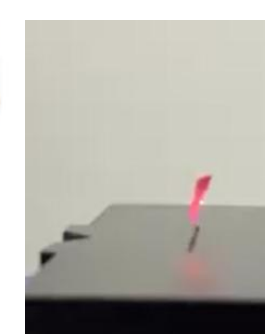
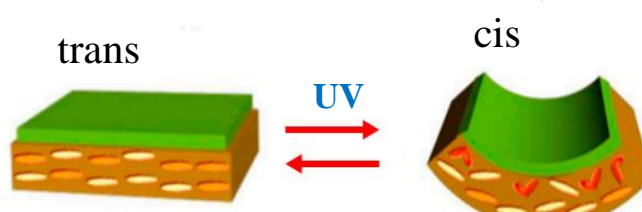
Alignment and cutting direction of the film (top view)



Homeotropic-Planar



On laser irradiation a straight strip bends:



REFERENCES

- [1] A. Minewicz, et al., Opt. Materials, 1, 605 (2003).
- [2] K. Dradrach, et al., ACS Appl. Mater. Interfaces, 12, 8681 (2020).

ACKNOWLEDGMENT

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