PENN CENTER FOR INNOVATION
Empowering Ideas

Highly Stable Nematic Liquid Crystal Polymers for Optical, Actuator, and Sensing Applications

Inventor
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STAGE OF DEVELOPMENT
Early stage research

INTELLECTUAL PROPERTY
Provisional Pending

REFERENCE MEDIA
Xia, Y.; Serra, F.; Kamien, R. D.; Stebe, K. J. and Yang, S.*, “Direct mapping of local director field of nematic liquid crystals at the nanoscale”, *Proc. Nat. Acad. Sci. USA*, 2015, 112 (50), 15291–15296. DOI

DESIRED PARTNERSHIPS
- License
- Co-development

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Problem
Functional Liquid Crystal Monomers (LCMs) have been used for decades in conjunction with Liquid Crystal Polymers (LCPs) as actuators and sensors, but the challenge of controlling and maintaining LC alignment on surfaces has remained an inherent obstacle. Existing materials typically have high phase transition temperatures, and the low viscosity at these temperatures limits the ability to control the director field during polymerization.

Solution
LC structures and compositions that incorporate strong dipole-dipole interactions lead to a highly stable nematic phase with strong anchoring strength. Upon photo-cross-linking, the orientation of the mesogens can be faithfully locked without reorientation. This has the advantage of allowing for direct visualization of the LC director field and defect structures with 100 nm resolution.

Advantages
- Large nematic window of 40K to > 100K
- Excellent surface anchoring characteristics.
- Optical signatures remain unchanged in the liquid crystal polymers allowing for direct visualization by SEM with 100 nm resolution.
- Lower cost compared to 5CB, a well-established liquid crystal small molecule, and processability is consistent with current LC manufacturing processes.

Applications
- Optical film, coating or encapsulant with high positive birefringence
- Actuators, sensors, or artificial muscle
- Optical wave guides or polarizers
- Photovoltaic substrates

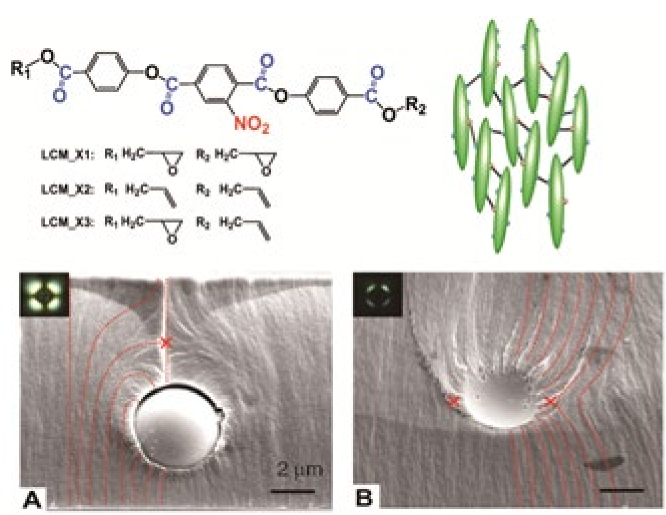

Figure1: Top panel shows schematic illustrations of the chemical structures of various liquid crystal monomers, and random intermolecular dipole-dipole interactions between nitro and carbonyl groups. Different colors represent different functional groups: red for nitro; blue for carbonyl. Bottom panel shows SEM images of silica colloids suspended in crosslinked liquid crystal polymers where either a point defect (A) or a line defect (B) is formed to screen the charge of the colloid. Insets: Polarized optical microscopy (POM) images of point (A) and line (B) defects circumscribing silica colloids. The director field of the LC is represented by the red dotted line and the red crosses show the position of defects. Scale bars: 2 μm