Harnessing chiral self-assembly for helical mesogenic actuators


*Department of Chemical Engineering, Stanford University, **Department of Chemical Engineering and Chemistry, Eindhoven University of Technology

Background
- Nature-mimetic materials and actuators
  - Nature is full of agile twisting mechanics
  - Most soft robotics have only achieved uniaxial planar bending

- Liquid crystal (LC) alignment for molecular-level control
  - Nature-mimetic materials and actuators
  - Rotating molecular motion to multiaxial macroscopic motion

Experimental
- Self-assembling semiconductor (PFAB)
  - PFAB / liquid crystal (LC) films
    - PFAB / LC organization is preserved in polymerized films
    - Macromolecular helices are observed in SEM cross-sections

- PFAB induces cholesteric nematic LC mixtures
  - Pitch: 40 μm

Control parameters
- a) Intentionally separated layers
- b) Depolarized polymerization
- c) Circularly polarized illumination

Macromolecular helical actuation
- Reversible helical actuation is successfully achieved
  - UV illumination
  - Heat
  - Helical pitch can be controlled with temperature
  - Curling behavior is discovered as a balance between cholesteric assembly and alignment layer orientation

- PFAB demonstrates chiral control of helix handedness
  - SS 25% 40% 50% 60% 75%
  - RR 75% 60% 50% 40% 25%

- Side chain selection gives control of chiroptical properties and polymer organization

- Majority rules experiment shows RR preference in helix curling

- Notably, helices are still achieved absent of an alignment layer