Nematic Liquid Crystals under Conical Capillary Confinement: Theoretical Study of Geometry Effects on Disclination Lines

Alireza Shams,[1] Xuxia Yao,[2] Jung Ok Park,[2,3] Mohan Srinivasarao,[2,3,4] and Alejandro D. Rey[1,*]

1 Department of Chemical Engineering, McGill University, Montreal, Canada
2 School of Materials Science and Engineering, Georgia Institute of Technology, Atlanta, USA
3 Center for Advanced Research on Optical Microscopy, Georgia Institute of Technology, Atlanta, USA
4 School of Chemistry and Biochemistry, Georgia Institute of Technology, Atlanta, USA

Liquid crystals (LCs) are self-organizing anisotropic viscoelastic soft matter materials that flow like viscous liquids and display anisotropies like crystals. When a nematic liquid crystal is confined in a capillary tube with strong anchoring conditions, disclinations defects of higher and lower topological charge can be formed, including defect branching . The shape of the disclination lines is a function of confinement and bulk elasticity. Our previous work[1] shows that nematic liquid crystals under cylindrical confinement display a radial-to-planar polar defect texture transition through the nucleation and uniform motion of a disclination branch point that separates a high charge disclination from two lower charge ones. Here, we present modeling of a nematic LC confined to different conical geometries with homeotropic anchoring that also displays the branch point. Determination of the defect geometry in conjunction with a model provides a means of characterizing the elasticity of the liquid crystal[2]. Our results show gradients in confinement ($dR/dx=\tan\alpha$) increases the bending stiffness while larger conical angle (2α) decreases the alignment and decreases total curvature, creating a competition that results in lower total curvatures but greater total elasticity. These new findings are useful to assess the Frank elasticity of the nematic liquid crystal and predict the best condition for the novel structures.

References:
[1] A. Shams, X. Yao, J. O. Park, M. Srinivasarao and A. D. Rey, *Theory and modeling of nematic disclination branching under capillary confinement*, Soft Matter, 8, 11135–11143, (2012).
[2] A. Shams, X. Yao, J. O. Park, M. Srinivasarao and A. D. Rey, *Mechanisms and Shape Predictions of Nematic Disclination Branching under Conical Confinement*, Soft Matter, under review (2014).

* presenting author; E-mail: alejandro.rey@mcgill.ca