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Magneto-orientational coupling and helical unwinding in ferrocholesteric nanocomposites doped with α-FeOOH nanorods

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The ability to control the self-assembly of functional superstructures in liquid crystals is an important aspect of modern soft matter physics. While cholesteric liquid crystals are responsive to external stimuli, their sensitivity to magnetic fields is often limited by the small diamagnetic anisotropy of the host molecules [1]. To address this, we investigated a ferro-cholesteric system consisting of a nematic E7 matrix doped with the chiral agent CB15 and functionalized with goethite (α-FeOOH) nanorods at a volume fraction of 10^{-3}.

Our results highlight the dual-magnetic nature of goethite nanorods, which possess a permanent magnetic moment along their longitudinal axis and a field-induced moment directed orthogonally [2]. A critical finding is that a purely diamagnetic model is insufficient to describe the system´s behaviour, as the model consistently overestimated the magnetic induction required for both the cholesteric to nematic and nematic to cholesteric transitions. The discrepancy between the standard theory and experimental data is significant and points to the dipole factor. It is assumed that the permanent magnetic dipoles of the nanorods provide an additional torque that assists the external magnetic field in reorienting the liquid crystal matrix.

We provide a detailed analysis of the helical unwinding under varying magnetic field strengths, observing a distinct shift in the critical fields required for structural distortion compared to matrices without goethite nanorods. These findings suggest that the magneto- orientational coupling between the nanorods and the chiral matrix allows for precise fine- tuning of the critical fields.

References

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Type:

Poster