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Liquid Crystal Phases End-modified Bacterial and Sisal Cellulose Nanocrystals

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Abstract:

Colloidal self-assembly is an effective strategy for constructing complex nanostructures from cellulose nanocrystals (CNCs). Owing to their chirality and surface interaction forces, CNCs can self-assemble into chiral nematic liquid crystalline (LC) phases in aqueous suspensions.[1] This enables the formation of LC phases with long-range chiral order, arising from a balance between van der Waals attraction and electrostatic repulsion. Variations in cellulose source and length strongly influence the self-assembly behaviour of CNCs.[2] In particular, the critical concentration for chiral nematic phase formation is not only governed by surface chemistry, but also by the morphology and dimensions of the CNC rods. Reducing end group (REG) modification of CNCs is emerging as a technique to alter the characteristics of their LC phases and broaden their applications as chiral templates. In this study, CNC-I allomorphs derived from bacterial cellulose (BCNC-I) and sisal fibres (SCNC-I) were chemically modified at their REGs with linear amine-terminated poly (ethylene glycols) via reductive amination. The effect of grafting CNC-I allomorphs with methoxypoly(ethylene glycol) amine (mPEG-NH_2, M_w = 10,000 Da) was investigated. The resulting materials were characterized using polarized optical microscopy (POM) and X-ray diffraction (XRD) to respectively assess liquid crystalline phase formation and crystallinity. Atomic force microscopy (AFM) was employed to examine particle morphology and dimensions. Furthermore, Fourier transform infrared spectroscopy (FTIR) and zeta potential measurements were conducted to confirm the presence of functional groups and evaluate surface charge. In summary, these findings provide deeper insight into how targeted reducing end-group modification influences CNC self-assembly, offering a more precise strategy for controlling chiral nematic organization and optimizing their performance in advanced nanostructured applications.

References

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