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Helical Twisting Power and Interparticle Correlations in Aqueous Cholesteric Suspensions of Size-Fractionated Chitin Nanocrystals

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Similar to the well-known cellulose nanocrystals (CNCs), rod-shaped nanocrystals of chitin also form cholesteric liquid-crystalline suspensions in water. In our previous work [1], we showed that the biological source of chitin nanocrystals (ChNCs) affects the phase behavior and the helical pitch of these cholesteric suspensions, mainly via variations in the mean length (or the mean aspect ratio) of the rod-shaped particles.

To further investigate how particle size affects the liquid crystalline properties of ChNC suspensions, we adapted a size fractionation experiment by Honorato-Rios and Lagerwall [2] to ChNCs from a single biological source (the oyster mushroom) and successfully separated the ChNCs according to their length (Figs. a.1 and a.2) in several fractionation steps. Our results clearly show that as the length of the ChNCs decreases, the helix pitch of their cholesteric suspension decreases. This means an increase in the helix twisting power (HTP) (Fig. 1b) at decreasing length of the ChNC. While this trend is consistent with our previous findings in [1], it is in contrast to the observations reported for the case of CNCs by Honorato-Rios and Lagerwall [2]. In addition, we studied by small-angle X-ray scattering the mean values of the distance and the twist angle between neighboring ChNC particles along the twist axis. For the shorter nanocrystals this mean interparticle twist angle is by more than one order of magnitude larger than for the longest ChNCs investigated, providing valuable insights into the nature of the chiral interactions in particle-based liquid-crystalline systems.

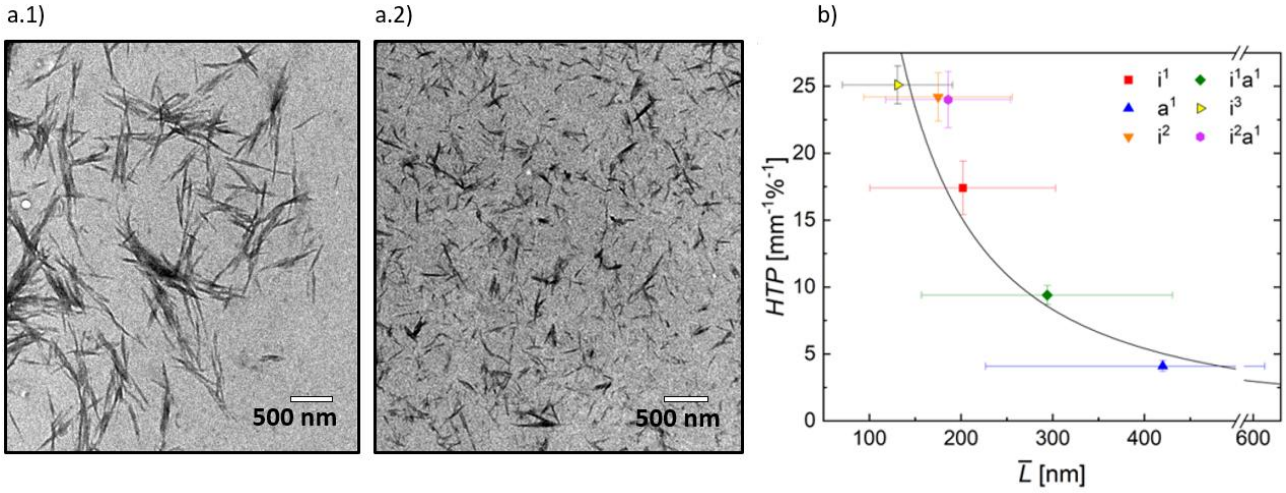

Figure 1. a) Transmission electron micrographs of the fractions with the longest and the shortest ChNCs, showed in a.1) and a.2), respectively. b) HTP of the ChNCs from the different fractions versus the mean ChNC length $\bar{L}$.

References

[1] F. J. Kolb, D. M. Takeva, N. Von Seggern et al., *Biomacromolecules* **26**, 417-427 (2025).
[2] C. Honorato-Rios and J. P. F. Lagerwall, *Communications Materials* **1**, 69 (2020).

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