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Polymorphism of stable collagen fibrils (G)

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We explore a variety of thermodynamically stable molecular configurations of collagen fibrils. Using a liquid crystal model of radial fibril structure with a double-twist director field, we show that two dimensionless parameters, the ratio of saddle-splay to twist elastic constants k_{24}/K_{22} and the ratio of surface tension to chiral strength $\tilde{\gamma} \equiv \gamma/(K_{22}q)$, largely specify both the scaled fibril radius and the associated surface twist of equilibrium fibrils. We find that collagen fibrils are the stable phase with respect to the cholesteric phase only when the reduced surface tension is small. Within this stable regime, collagen fibrils can access a wide range of radii and associated surface twists. Remarkably, we find a maximal equilibrium surface twist which is compatible with corneal collagen fibrils, and we show how the large surface twist is needed to explain the narrow distribution of corneal fibril radii. Conversely, we show how small surface twist is required for the thermodynamic stability of tendon fibrils in the face of considerable polydispersity of radius.

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