Amyloid Fibril Polymorphism: Almost Identical on the Atomic Level, Mesoscopically Very Different

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Amyloid polymorphism of twisted and straight β-endorphin fibrils was studied by negative-stain transmission electron microscopy, scanning transmission electron microscopy, and solid-state nuclear magnetic resonance spectroscopy. Whereas fibrils assembled in the presence of salt formed flat, striated ribbons, in the absence of salt they formed mainly twisted filaments. To get insights into their structural differences at the atomic level, 3D solid-state NMR spectra of both fibril types were acquired, allowing the detection of the differences in chemical shifts of (13)C and (15)N atoms in both preparations. The spectral fingerprints and therefore the chemical shifts are very similar for both fibril types. This indicates that the monomer structure and the molecular interfaces are almost the same but that these small differences do propagate to produce flat and twisted morphologies at the mesoscopic scale. This finding is in agreement with both experimental and theoretical considerations on the assembly of polymers (including amyloids) under different salt conditions, which attribute the mesoscopic difference of flat versus twisted fibrils to electrostatic intermolecular repulsions.
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