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Dislocations and Grain Boundaries in Optimally-Packed, Twisted Filament Bundles AMIR AZADI, Department of Physics, University of Massachusetts, Amherst, GREGORY GRASON, Department of Polymer Science and Engineering, University of Massachusetts, Amherst — From the collagen fiber to the parallel-actin bundle, twisted and rope-like assemblies of filamentous molecules are common and vital structural elements in cells and tissue of living organisms. We study the intrinsic frustration occurring in these materials between the two-dimensional organization of filaments in cross-section and out-of-plane interfilament twist in bundles based on the non-linear continuum elasticity theory of columnar materials. We find that interfilament twist generates in-plane stresses that couple favorably to the presence of topological defects, edge dislocations, in the cross-sectional packing, thereby restructuring the ground state filament packing of twisted bundles. The stability of dislocations increases with increases in both the degree of twist and lateral bundle size. We show that in ground states of large bundles, multiple dislocations pile up into linear arrays, radial grain boundaries, whose number and length grows with bundle twist. Remarkably, the "polycrystalline" texture of these optimal packings of twisted bundles show a striking similarity to models of the "almost crystalline" cross-section of collagen fibers.

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