Molecular-self-assembly of peptides, peptide nucleic acids and metabolites into optically active assemblies

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The formation of ordered nanostructures by molecular self-assembly of proteins and peptides represents a central direction in nanotechnology. Indeed, polyamides provide superior features as materials with diverse physical properties. A reductionist approach allowed the identification of extremely short peptide sequences, as short as dipeptides, which could form well-ordered amyloid-like β-sheet-rich assemblies comparable to supramolecular structures made of much larger proteins. Some of the peptide assemblies show remarkable mechanical, optical and electrical characteristics. Among the electrical properties semiconductivity, piezoelectricity and pyroelectricity are most remarkable. Among the unique properties that were identified are the high mechanical rigidity with metallic-like point stiffness and Young's moduli, the quantum confinement of excitons that results in blue luminescence and non-linear optical phenomena, and piezoelectric properties with high effective piezoelectric coefficient values comparable to lithium niobate Two additional directions of the reductionist approach include the use of peptide nucleic acids and co-assembly techniques. A recent addition to the repertoire of building blocks includes small metabolites such as amino acids and nucleobases. The diversified accomplishments of the reductionist approach, as well as the exciting future advances it bears, will be discussed, with emphasis of optical properties.

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