Molecular engineering of model soft-matter systems using DNA

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DNA is widely recognized as a promising engineering material in the field of nanotechnology and material science. Here, I will show that using DNA as building block for constructing molecules with complex architecture in the field of soft matter can offer a great opportunity to obtain well-defined monodisperse systems with a wide variety of particle shape, stiffness, charge, etc. A small library of well-defined DNA-based macromolecular assemblies will be presented, focused on an all-DNA chain-stick construct which consists of a gapped DNA duplex - with contour length near DNA's persistence length - where two stiff double-stranded DNA segments of equal length are connected by a single-stranded flexible spacer. Trough a combined experimental and numerical study, we provide unambiguous evidence for the stabilization of an unconventional smectic-A liquid crystal phase, where most of the constituent molecules attain a folded configuration. Our results demonstrate that DNA as a building block offers an exquisitely tunable means to engineer a potentially rich assortment of lyotropic liquid crystals that can be precisely designed on subnanometer level.