Liquid Crystals of DNA-based Nanoparticles

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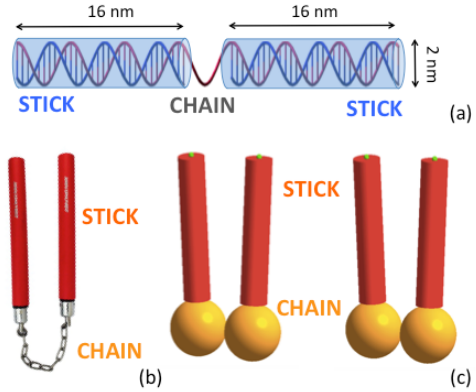

Figure – Example of a DNA-based system which undergoes a self-assembly-driven transition to a smectic phase [4]. (a) Building on DNA versatility in creating novel constructs one can design three DNA sequences which self-assemble at room temperature into a nanoparticle about 50 nm long comprising two double-stranded DNA duplexes linked together by a DNA filament 13 nm long. (b) This nanoparticle resembles a nunchaku, which is the traditional weapon of several martial arts, such as kung-fu and ju-jitsu, their size being 30 millions times smaller though. (c) Simple coarse-grained model of this DNA-based nanonunchaku used to carry out computer simulations.

Abstract:

Self-assembly of nanoparticles is the spontaneous formation through free energy minimization of reversible aggregates of basic building blocks, whose size ranges from few nanometers to microns. A relevant self-assembly process of nanoparticles is the formation of filamentous aggregates induced by the anisotropy of attractive interactions. Building on the venerable Onsager theory, we developed few years ago a novel theoretical approach for these self-assembly-driven colloidal liquid crystals (LCs). More recently, we also combined the molecular theory for cholesteric organization in systems where steric interactions dominate with that for self-assembly driven nematic ordering. Theoretical predictions for isotropic-cholesteric transition and for helical ordering in a real colloidal system – i.e. a water suspensions of short DNA duplexes, where the chirality of the constituent building blocks induces the formation of a chiral nematic phase – allow us to identify in the temperature and concentration dependence of the pitch an hallmark of DNA nanoparticles self-assembly, thus gainining an unprecedented level of understanding of the physical properties in these systems [3]. Finally, among all LC phases observed in self-assembly-driven colloidal LCs based on DNA, the smectic one was elusive so far. In a recent work, we have provided for the first time an unambiguous and clear evidence through experiments and numerical simulations that a water suspension of synthetic DNA-based nanonunchakus (see figure) can form smectic phases [4].

References:

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