Self-assembly of flexible and rigid structures: from colloidal molecules to lattices

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Propositions

accompanying the thesis

Self-Assembly of Flexible and Rigid Structures: From Colloidal Molecules to Lattices

i. Using a cubic shape as a template improves the yield of colloidal molecules of AB_2 type from 54% to 80% and AB_6 type from 39% to 80% when compared to the yield from spherical particles as templates in the electrostatic assembly of colloidal molecules.
Chapter 2 of this thesis

ii. In flexible colloidal molecules, whether a sphere is moving confined or not over the surface a cube isn't solely determined by the shape of the templating particles. Factors like the size ratio of the sphere to the cube, temperature and DNA concentration can also determine the motion type.
Chapter 3 of this thesis

iii. Spheres attached to cubes by surface-mobile DNA linkers experience greater energetic costs when approaching highly curved edges, leading to confine motion of spheres on a cube's facet, and these energy costs increase with increasing sphere size.
Chapter 3 of this thesis

iv. Using just geometric constraints the number of pathways taken to assemble into flexible square lattices could be reduced. But geometric constraint and controlled flexibility leads increased number of pathways taken to assemble into flexible square lattices.
Chapter 4 of this thesis

v. Heteroaggregation of colloids can be applied to other templating particles with other shapes/geometries, allowing for the preparation of various types of colloidal molecules.
Liu, Yang, et al. "Assembly of colloidal clusters driven by the polyhedral shape of metal–organic framework particles." 143.33 (2021): 12943-12947.

vi. By applying an external magnetic field to a sample containing aqueous ferrofluid and colloids functionalized by complementary DNA strands A and B, promotes the formation of out-of-equilibrium structures such as polymer-like chains over square lattices.

McMullen, Angus, et al. "Freely jointed polymers made of droplets." Phys. Rev. Lett. 121.13 (2018): 138002 and "Self-assembly of emulsion droplets through programmable folding." Nature 610.7932 (2022): 502-506.

vii. Crystallization of micron-scale DNA-coated colloids often results in kinetically arrested aggregates and random rigid structures. These require heating above the melting temperature to reconfigure into crystal structures. However, by using colloids functionalized with surface-mobile DNA linkers, these steps can be entirely eliminated.
Wang, Yu, et al. "Crystallization of DNA-coated colloids." Nat. Commun. 6.1 (2015): 7253, van der Meulen, Stef AJ, and Mirjam E. Leunissen. "Solid colloids with surface-mobile DNA linkers." J. Am. Chem. Soc., 135.40 (2013): 15129-15134 and this thesis, Chapter 4.

viii. When crystallizing equal-sized colloids with surface-mobile DNA linkers, the length of the single-stranded linker DNA plays a crucial role: long strands yield fractal structures, while short strands produce square lattices under analogous conditions.
van der Meulen, Stef AJ, and Mirjam E. Leunissen. "Solid colloids with surface-mobile DNA linkers." J. Am. Chem. Soc., 135.40 (2013): 15129-15134 and this thesis, Chapter 4.

ix. In scientific research, exploration driven by curiosity should have clear boundaries.

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