Variable ordered structures of phage assembly controlled by magnetic field

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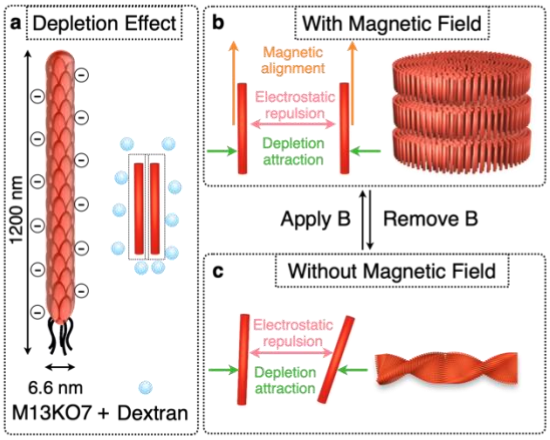
Ordered colloidal assemblies have multiple potential applications on optical, optoelectronic and material fields[1]. Many methods have been developed to achieve complex colloidal assemblies or responsive colloidal assemblies[1-4]. However, most of the current structural changes in colloidal assemblies are focused on simple behaviors, such as assembly and disassembly. Modulating the assembly to achieve the exchange of different ordered structures with large differences remains a challenge.

In this study, we developed a novel strategy to modulate the ordered structure of colloidal assembly by a magnetic field. We utilized filamentous phage M13KO7, a mutant of M13 bacteriophage with 1.2 μm in length and 6.6 μm in diameter, as a model system (**Figure a**). When M13KO7 was mixed with dextran (400 K Da), the phage rods self-assembled due to depletion effect[5] (**Figure a**). By applying a magnetic field (10T) to incubate the mixture, the phage rods were aligned along the magnetic field and formed uniform and large lamellar assemblies (**Figure b**). The maximum size of assembly could reach to centimeter scale. After removing the magnetic field, the large lamellar assemblies gradually changed their structure into helical fibers due to intrinsic chiral arrangement of negative charges of M13KO7 bacteriophage in order to achieve a new thermodynamically stable state (**Figure c**). These fibers could go back to the lamellar structure by applying a magnetic field again, which revealed the creation of an intriguing dynamic system that could transform between two different ordered structures. Detailed studies on mechanism will also be presented.



This work gives a promising solution on how to modulate between different ordered colloidal assemblies by the balance of intrinsic interactions and an external field.

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