Programmable assembly of hybrid colloidal molecules

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Patchy colloids with directional interactions have spurred enormous interest in the research community, where they have been applied for the formation of colloidal superstructures or as self-propelled, actively moving objects. They have also been termed 'colloidal molecules' because of their compositional symmetries and their directional interaction capabilities. Still, it remained a tremendous challenge to prepare colloidal molecules controlling their geometry, composition and functionality, independently.

We developed sequential capillarity-assisted particle assembly (sCAPA) to prepare colloidal molecules of high compositional complexity in a variety of shapes. sCAPA is based on the well-known capillary assembly on topographically patterned templates. Some simple – yet important – modifications of the process allow us to selectively deposit only a single colloidal particle per assembly step (Figure 1a) [1,2]. As a consequence, it becomes possible to independently define the geometry and the composition of the colloidal molecules: the prior by the shape of the trap and the latter by the sequence of assembly steps. In further steps, the assembled particles can be linked and the colloidal molecules released and dispersed in water [2]. The assembly process works for particles from a wide variety of materials. We prepared chain-like colloidal molecules that resemble barcodes, block copolymer chains and surfactants from polystyrene micro spheres, silica spheres, and silica spheres containing magnetic nanoparticles (Figure 1b and c) [2].

The programmability of our approach opens up new directions not only to assemble and study complex materials with single-particle-level control, but also to fabricate new microscale devices for sensing, patterning and delivery applications.

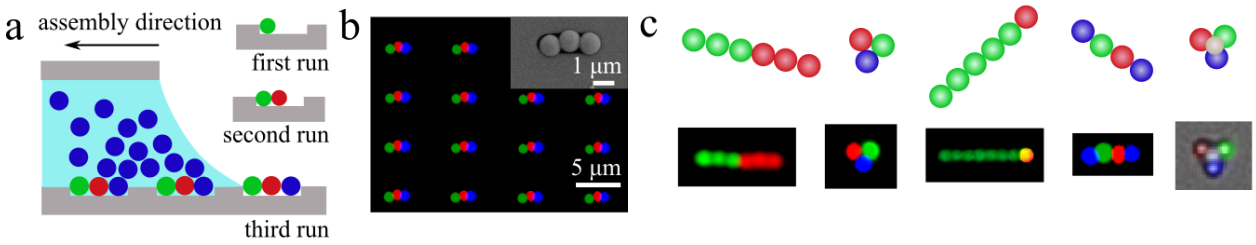

Figure 1 (a) Schematic representation of sCAPA for linear molecules. (b) Merged fluorescence image of colloidal chains composed of green, red and blue polystyrene particles. Inset: SEM of colloidal chains in the template. (c) Library of various colloidal molecules fabricated by sCAPA (top: schemes, bottom: merged fluorescence images).

[1] S. Ni, J. Leemann, H. Wolf and L. Isa, *Faraday Discuss.,* 2015, **181**, 225
[2] S. Ni, J. Leemann, I. Buttinoni, L. Isa and H. Wolf, *Science Advances*, 2016, **2**, e1501779