

Programmable and Reversible Assembly of Charged Hybrid Janus and Non-Janus Particles: From (Half-)Raspberry to Chain-Like Clusters

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Self-assembly is the basic concept to form complex structures in nature and can serve the development of novel materials with controlled properties due to the rich functionality of the individual particles.[1-3] In this context, the internal dynamics of biological processes are a source of inspiration to form controllable and reversible structures using stimuli-responsive colloidal particles. The variation of a chosen parameter induces a programmable adaptation of the system, which is reversible in absence of the stimulus. Assemblies of isotropic building blocks typically lead to symmetric structures, whereas multifunctional anisotropic building blocks, such as Janus particles, can assemble into more sophisticated structures with significantly different macroscopic properties.

Herein, we investigate the pH-triggered programmed and reversible assembly of binary mixtures of oppositely charged hairy polyacrylic acid-modified non-Janus and poly(2-dimethylamino)ethyl methacrylate- and poly(N-isopropylacrylamide)-modified Janus particles driven by electrostatic interactions. Three different target structures are obtained both in dispersions and in dry state: half-raspberry structures (Fig. 1a), colloidal chains (Fig. 1b), and clusters (Fig. 1c) depending on the mass ratio.[3] The structures also show a bistable behavior: they can be disassembled on demand by changing the pH value, and then reassembled into new stable structures many times.[3] The particle size ratio strongly determines the geometry of the assemblies as well as the quality of the reversibility of the self-assembly.[3] The obtained results point out a further step regarding the reversible self-assembly of (Janus) particles into complex hierarchical reconfigurable architectures, which may open up a variety of self-assembly-based applications towards miniaturization of machines, catalysis, photonics/plasmonics, photovoltaics, and nanoscale electronics.

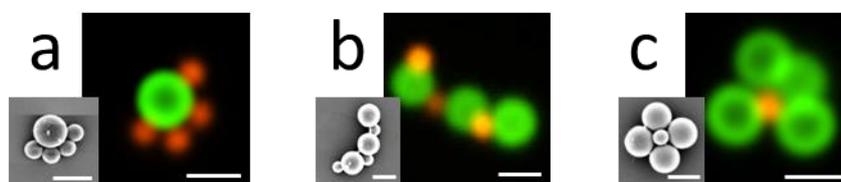


Figure 1: Observed micro-clusters: Representative SEM and fluorescence microscopy images, formed in dispersion from PAA-450 nm and 1 μ m Janus particles: (a) half-raspberry structure; (b) colloidal chain; (c) cluster-like structure. Scale bars: 1 μ m.

[1] A. Kirillova, G. Stoychev, L. Ionov, and A. Synytska, *Langmuir* **30** (2014), 12765.

[2] A. Kirillova, G. Stoychev and A. Synytska, *Faraday Discuss.* **191** (2016), 89.

[3] C. Marschelke, O. Diring and A. Synytska, manuscript under preparation.

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