

Colloidal Robots with Physical Intelligence

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Colloidal scale robotic systems offer exciting opportunities for intelligent behavior without relying on conventional computational hardware. Unlike macroscale robots, micro- and nanorobots at the colloidal level achieve sensing, control, and adaptation through their material composition and physical design. In this talk, I will present two recent colloidal assembly strategies for engineering colloids with programmable structures and responsive functionalities, aimed at applications in biomedicine and environmental sustainability. First, we harness evaporation-driven self-assembly to construct colloidal assemblies with tunable geometries and multi-compartment architectures, enabling controlled motion and cargo release [1,2]. Second, we employ capillarity-assisted particle assembly to achieve modular integration of colloidal building blocks with high spatial precision. This technique supports the incorporation of distinct liquid compartments and functional components, allowing for autonomous motion and localized sensing [3,4]. Together, these approaches establish a versatile colloidal platform for embedding multiple functional components and various responsive mechanisms within a single microsystem. By exploiting colloidal assembly approaches, we aim to develop intelligent colloidal materials capable of performing complex tasks in dynamic environments.

Keywords:

colloidal robots, self-assembly, physical intelligence, microrobotics

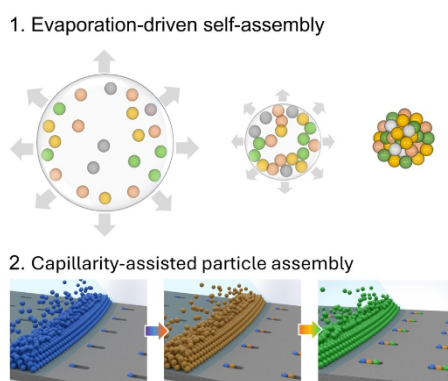


Figure 1. Schematic picture of two colloid assembly strategies.

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