New approach to reconfigurable colloidal assemblies paves way for adaptive smart materials

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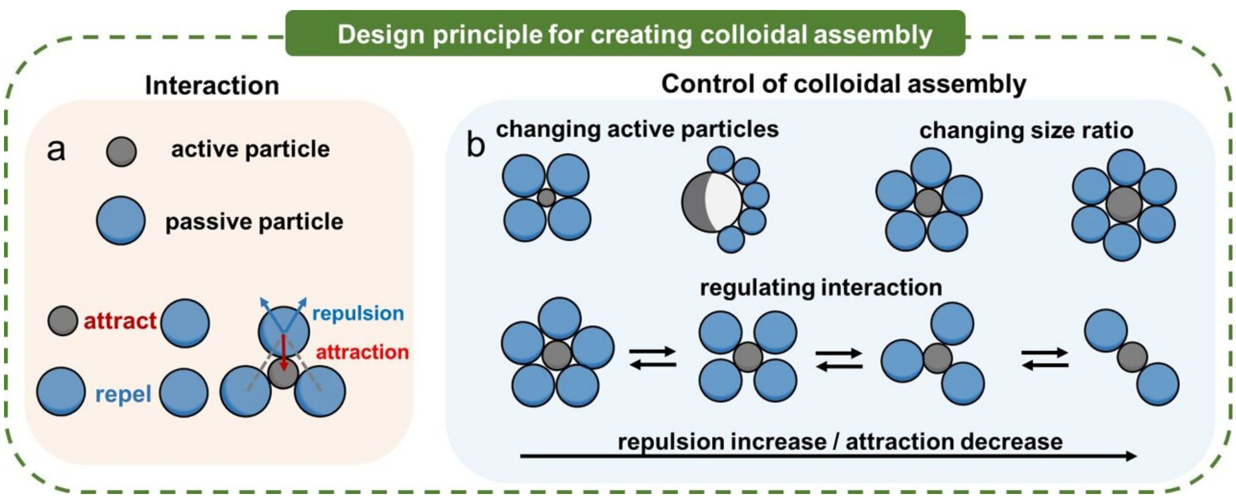

Schematic illustration of designing principle for creating reconfigurable colloidal assembly. Credit: 2024 Xi Chen et al.

Colloidal self-assembly is a process where colloidal particles spontaneously organize into ordered structures under specific conditions. Colloidal self-assembly serves as a foundation for designing materials like optoelectronic devices and sensors. One of the most intriguing frontiers in colloidal self-assembly is the development of active colloidal assemblies, which exhibit dynamic behavior and can adapt to external stimuli.

Active colloids—colloidal particles that convert external energy into autonomous motion—are a typical assembled unit for active colloidal assemblies. Although these active particles can demonstrate fascinating self-assembly behaviors, controlling these behaviors with precision and in real-time remains a major challenge. The ability to adjust and manipulate colloidal assemblies dynamically is key to creating adaptive, reconfigurable functional materials.

A research project led by Prof. Wei Wang from Harbin Institute of Technology (Shenzhen) and Dr. Xi Chen from Chengdu University of Technology has introduced a novel strategy for constructing active colloidal assemblies. This work, published in *Research*, provides fresh insights into the design of smart materials with real-time, on-demand reconfiguration.

In their recent study, the research group took a step forward by combining chemical reactions and electric polarization to achieve reversible assembly and in situ regulation of assembled structures. The assembled unit includes active and passive colloidal particles, where the active particles react with chemicals in the solution to generate a chemical gradient. This gradient induces phoresis and osmosis, which attract surrounding passive particles to form colloidal clusters.

Furthermore, an alternating electric field is employed to polarize the passive particles, creating dipole-dipole repulsive forces that help assemble the particles into a specific configuration. By fine-tuning the chemical and electric fields, the group achieved precise control over the attraction and repulsion between particles, enabling the in situ regulation of structures of colloidal assemblies.

Looking ahead, the team envisions applying these strategies to design a wide array of colloidal materials capable of dynamically altering their structure and function. This marks a step toward developing adaptive materials with diverse applications, ranging from responsive sensors to self-healing systems and reconfigurable devices.

More information: Xi Chen et al, Reconfigurable Assembly of Planar Colloidal Molecules via Chemical Reaction and Electric Polarization, *Research* (2024). DOI: 10.34133/research.0490

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