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Beyond rings and chains: exploring porous crystals and flexible networks with two patch magnetic particles

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We report on the self-assembly of magnetic colloids engineered with two distinct magnetic patches positioned at their poles, an advancement from traditional Janus particles with a single magnetic dipole. While Janus particles are known to form a variety of superstructures—including chains, rings, and close-packed arrangements [1,2] —the two-patch design significantly expands the range of achievable structures. Our simulation study reveals the formation of porous networks with adjustable flexibility, variable pore sizes, and controllable crystalline order. Notably, we observe the formation of a porous Kagome lattice, reminiscent of the experimental Kagome lattice observed colloids with two hydrophobic patches, the well known "Janus-triblock"system [3]. The richness of observed structures also lends itself to the usage of automatic structure detection of topological, positional and orientational features of the assemblies via Machine Learning methods.
Summarizing, the enhanced self-assembly behavior in two-patch magnetic particles opens up further possibilities for creating fully tunable, field-responsive ferrofluids. Such systems could be useful for applications requiring externally modulated viscosity, such as adaptive damping systems in automotive and aerospace engineering.

References

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