Supracolloidal reconfigurable polyhedra via hierarchical self-assembly

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Supplementary Results

In Table S1, we present some geometric features for the set of *convex snub polyhedra*.[1] It is evident that the snub tetrahedron is the smallest in this series. We note here that the snub tetrahedron is an icosahedron for having twenty faces; however, we have preferred to use the name 'snub tetrahedron' when it is of tetrahedral symmetry as it is then informative of the symmetry of the structure it refers to.

Table S1: A comparison of the geometric features of convex snub polyhedra. Here V is the number of vertices, F is the number of faces and E denotes the number of edges.

Polyhedron	Symmetry	V	F	E
Snub tetrahedron	T	12	20	30
Snub cube	O	24	38	60
Snub dodecahedron	I	60	92	150

Table S2: A comparison of the anti-parallel arrangements of the dipoles in two neighbouring secondary building blocks of two low-lying minima for $N = 12$ charge-stabilised colloidal magnetic particles, where $\theta = 0°$. ϕ is the angle between the dipole vectors, R_{ij} is the distance between the centers of the spherical colloidal particles, r_{ij} is the distance between the point-dipoles and E_{ap} is the potential energy contribution arising from the two dipoles.

Minimum	ϕ	R_{ij}/σ	r_{ij}/σ	E_{ap}/ε_Y
The bowl structure	172.8	1.02	0.8	-7.66
The spherical structure	164.8	1.05	0.86	-6.04

Table S3: A comparison of the anti-parallel arrangements of the dipoles in two neighbouring secondary building blocks of two low-lying minima for $N = 12$ charge-stabilised colloidal magnetic particles, where $\theta = 10°$. ϕ is the angle between the dipole vectors, R_{ij} is the distance between the centers of the spherical colloidal particles, r_{ij} is the distance between the point-dipoles and E_{ap} is the potential energy contribution arising from the two dipoles.

Minimum	ϕ	R_{ij}/σ	r_{ij}/σ	E_{ap}/ε_Y
The spherical structure	166.3	1.07	0.94	-4.74
The bowl structure	174.7	1.05	0.92	-5.11

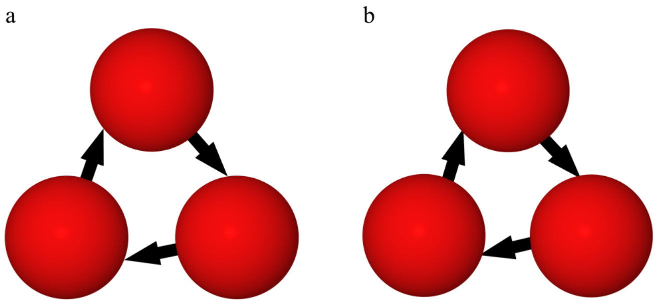

Figure S1: The triangular subunits formed as the secondary building blocks in the hierarchical self-assembly route to hollow spherical structures. (a) The triangular subunit for $\theta = 0°$; (b) the triangular subunit for $\theta = 10°$.

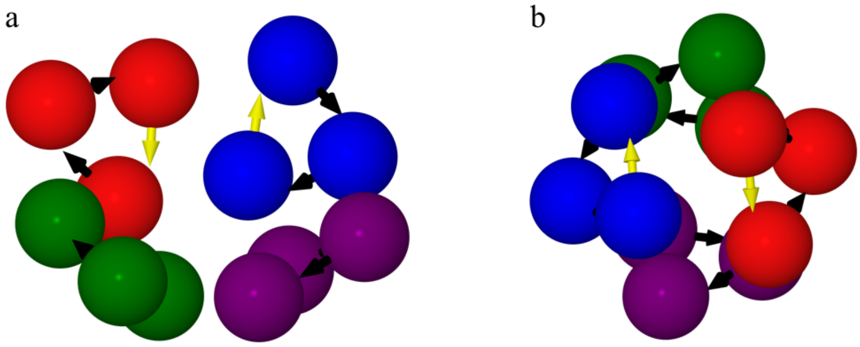

Figure S2: The competing structures, characterised as the low-lying minima on the energy landscape, for $N = 12$ charge-stabilised magnetic colloids. Representative examples of the anti-parallel arrangement of the dipoles in neighbouring secondary building blocks are clearly shown here and the dipoles concerned are highlighted in yellow. (a) The ground state structure for $\theta = 0°$; (b) the ground state structure for $\theta = 10°$. Here θ defines the angle between the direction of the dipole and the radial shift.

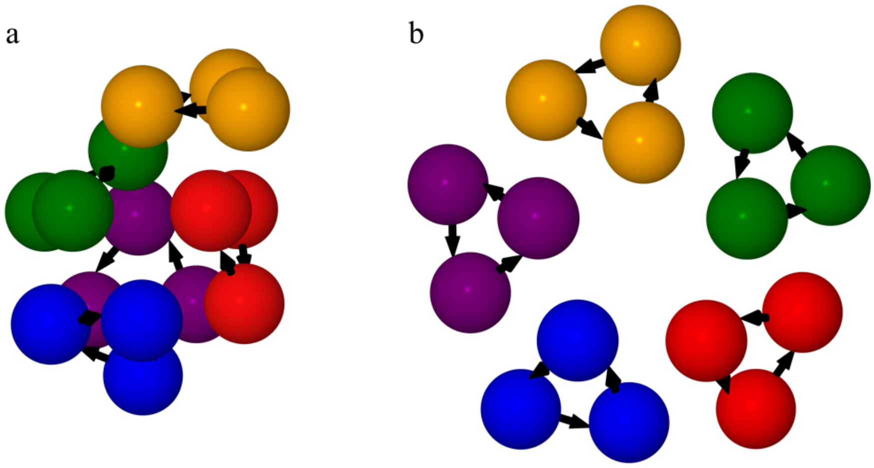

Figure S3: The two structures characterised as the low lying minima on the energy landscape for $N = 15$ charge-stabilised colloidal magnetic particles, where $\theta = 10°$. (a) The ground state structure, which consisted of the snub tetrahedron plus an additional triangular subunit; (b) the bowl structure, a low lying minimum, with an emergent five-fold rotational symmetry.

Movies

- **Movie 1**: The dominant pathway characterised for the self-assembly into the tubular anti-prismatic ground state structure for $N = 16$ charge-stabilised magnetic colloidal particles where $\theta = 90^\circ$ and $\alpha = 0.3$, starting from a high-energy, relatively disordered local minimum. The secondary building blocks are colour-coded distinctly as they are formed for visual aid.

- **Movie 2**: The dominant pathway characterised for the self-assembly into the ground state structure, topologically equivalent to the snub tetrahedron, for $N = 12$ charge-stabilised magnetic colloidal particles where $\theta = 10^\circ$ and $\alpha = 0.6$, starting from a high-energy, relatively disordered local minimum. The secondary building blocks are colour-coded distinctly as they are formed for visual aid.

References

[1] P. R. Cromwell, *Polyhedra*, Cambridge University Press, Cambridge, 1997.