Supporting Information

Tunable Janus Colloidal Photonic Crystal Supraballs with Dual Photonic Band Gaps

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Supplementary Movies

Movie S1 Rolling-over of CPC Janus supraballs Controlled under Magnetic field.wmv

Movie S2 Rotation of CPC Janus supraballs Controlled under Magnetic field.wmv

Supplementary Figures

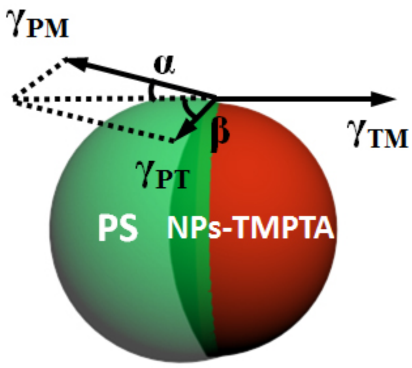


Figure S1 Schematic illustration of the balancing of the interfacial tensions between triple phases and the formation of CPC supraparticles.

The geometry of the biphase droplet arises from the minimization of the interfacial free energies, which follows the rules of Young-Dupre's equations [Equations (1) and (2)] and is presented in Figure S2.

$$\gamma_{TM} = \gamma_{PM} \cos\alpha + \gamma_{PT} \cos\beta \qquad (1)$$

$$\gamma_{MP} \sin\alpha = \gamma_{PT} \sin\beta \qquad (2)$$

where γ_{PT} means the interfacial tension between the PS solution and NPs-TMPTA, γ_{PM} means the interfacial tension between the PS solution and methylsilicone oil, γ_{TM} means the interfacial tension between TMPTA and methylsilicone oil, and α and β are the contact angles depicted in Figure S2. Through adjusting γ_{TM}, γ_{PM} and γ_{PT}, we could calculate α and β and obtain stable biphase droplets with predictable geometries.

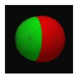
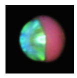
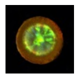
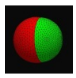
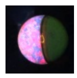
To gain further insight into the self-assembly behavior of the biphasic droplets, the spreading coefficient (S) showing the spread behavior of the liquid phase was necessary to be investigated [Equation (3)].

$$S_a = \gamma_{bc} - (\gamma_{ab} + \gamma_{bc}) \qquad (3)$$

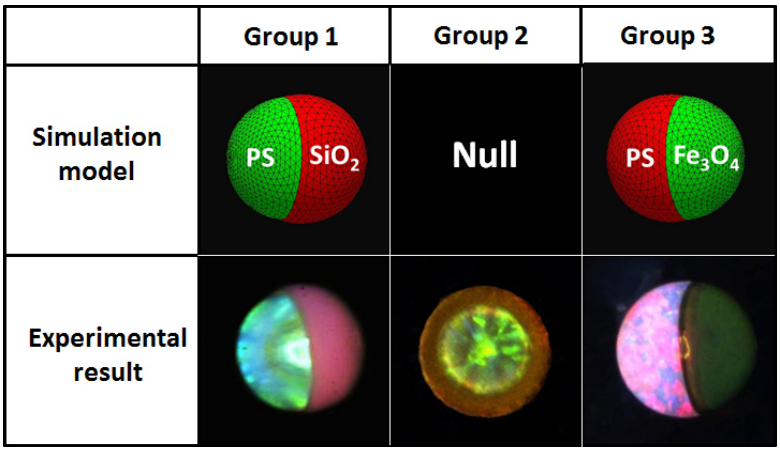
where γ_{bc} means the interfacial tension between phase b and c.

As listed in Table S1. When $S_T < 0$, NPs-TMPTA covered a part of PS droplet surface to achieve a CPC Janus supraparticles as Group 1 and 3 displayed. When $S_T > 0$ NPs-TMPTA spread entirely across the whole PS spherical phase to generate a core-shell structure as Group 2 showed.

Table S1 Three groups of interfacial tension for fabrication of CPC supraparticles

Group	Triton X-100 (wt% in PS)	γ_{PT}	γ_{PM}	γ_{TM}	S_M	S_T	α	β	model	experimental
		(mN/m)					(°)			
1	0.4	1.0	4.2	3.7	-6.9	-0.5	12.6	113.5		
2	0	10.8	20.9	3.7	-13.8	6.4	Null	Null	Null	
3	0.5	0.9	3.6	4.1	-6.8	-1.4	11.2	50.8		

In Group 1 and 2, the two phases are PS solutions and SiO_2-TMPTA. In Group 3, the two phases are PS solutions and Fe_3O_4-TMPTA. The models in Table S1 are theoretically simulated according to the interfacial values by using Surface Evolver software.[1] For Group 2, because of the null of values of α and β according to Young-Dupre's equations, the simulation is invalid for Group 2.


Group 1
Group 2
Group 3
Simulation model
PS
SiO_2
Null
PS
Fe_3O_4
Experimental result

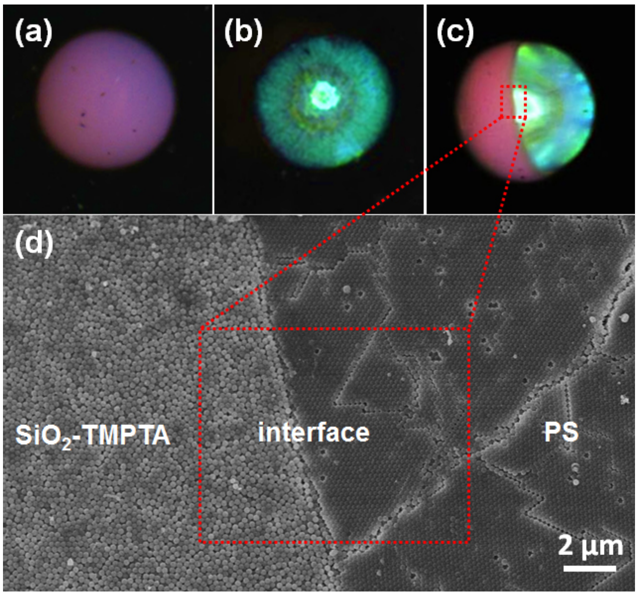


Figure S2 Optical microscope images of the PS/SiO_2-TMPTA JSs: (a) SiO_2-TMPTA hemispheres, (b) PS hemispheres and (c) interface of the biphase Janus supraballs and (d) corresponding SEM images.

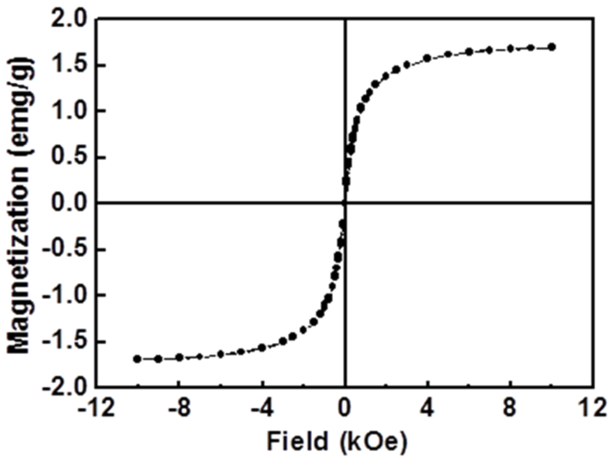


Figure S3 Field dependence of the magnetization for dried PS/Fe_3O_4-TMPTA JSs at 300 K.

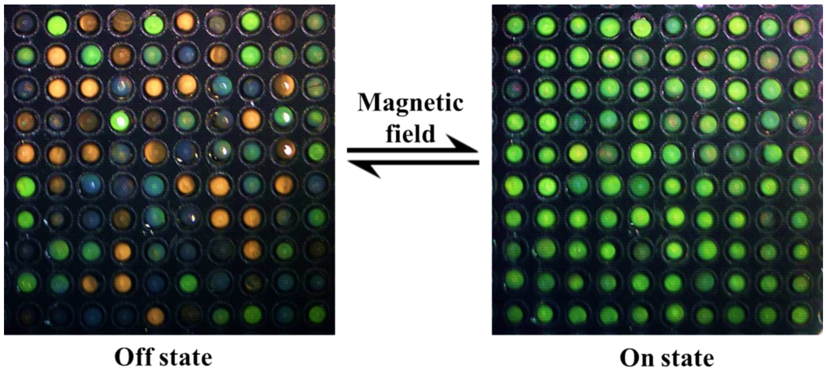


Figure S4 Rotation control of single-phase Fe_3O_4-TMPTA supraballs. Without adding magnetic field, the supraballs arranged disorderly in the template holes, while adding a vertically magnetic field, all of the supraballs rotate to the same orientation with green color upside.

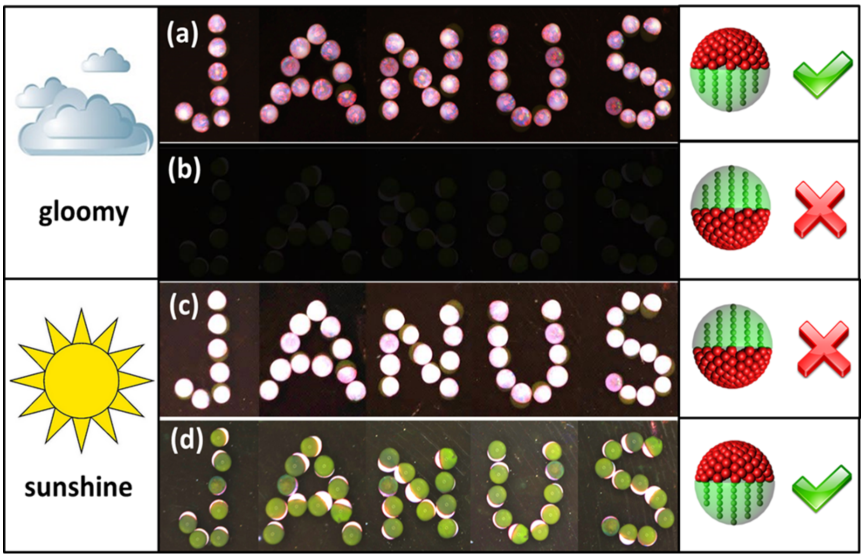


Figure S5 Photographs taken under weak light intensity when J-2 supraballs were controlled by external magnetic field for rolling-over to (a) PS hemispheres upside and (b) Fe_3O_4-TMPTA hemispheres upside. Photographs taken under strong light intensity when Janus supraballs were controlled by external magnetic field for rotation to (c) PS hemispheres upside and (d) Fe_3O_4-TMPTA hemispheres upside.

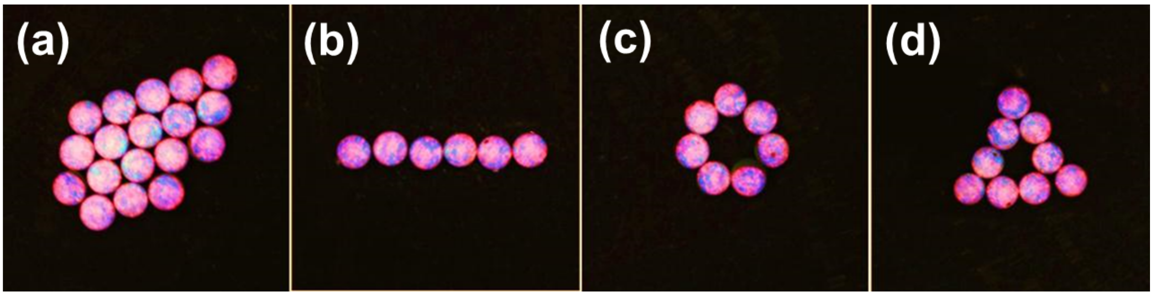


Figure S6 Magnetic-controllable patterning of PS/Fe_3O_4 JSs (a) array, (b) line, (c) circle and (d) triangle.

The self-assembly behavior of these Janus particles were affected by magnetic field of different orientation or intensities. The self-assembly behavior of these Janus particles were affected by magnetic field of different orientation or intensities. As shown in Figure S6a, close-packed assembly were formed when large bar permanent magnet were posited underneath. The J-2 JSs arranged into a line along the edge of the big circle magnet in Figure S6b. For Figure S6c, a mini cylindrical magnet was placed under the particles, so the particles arranged into a small round. In Figure S6d, a triangle pattern was formed randomly when we paralleled moved the underlaying large bar magnet.

References

1 http://www.susqu.edu/facstaff/b/brakke/evolver/evolver.html