Supporting Information

Biomimetic submicromotor with NIR light triggered motion and cargo release inspired by cuttlefish

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Experimental Details

1. Synthesis of PDA nanospheres

The synthesis of PDA nanospheres (diameter: ~ 440 nm) was based on the previous method.[1] Typically, 0.75 mL of aqueous ammonia solution (NH_4OH, 28-30%) was added to solution composed of 40 mL of ethanol (99.7%) and 90 mL of deionized (DI) water. The mixture was gently stirred for 30 min at room temperature. 0.5 g of dopamine hydrochloride was dissolved in 10 mL of DI water and then poured rapidly into the above mixture. The color of the solution immediately changed from clear to pale brown and eventually to dark brown. The reaction was allowed to proceed for 30 h. Finally, the as-synthesized PDA nanoparticles were obtained by centrifugation, water washing for three times, and drying at 60 ^{o}C for 4 h.

[1] K. Ai, Y. Liu, C. Ruan, L. Lu, G.M. Lu, *Adv. Mater.*, 2013, **25**, 998-1003.

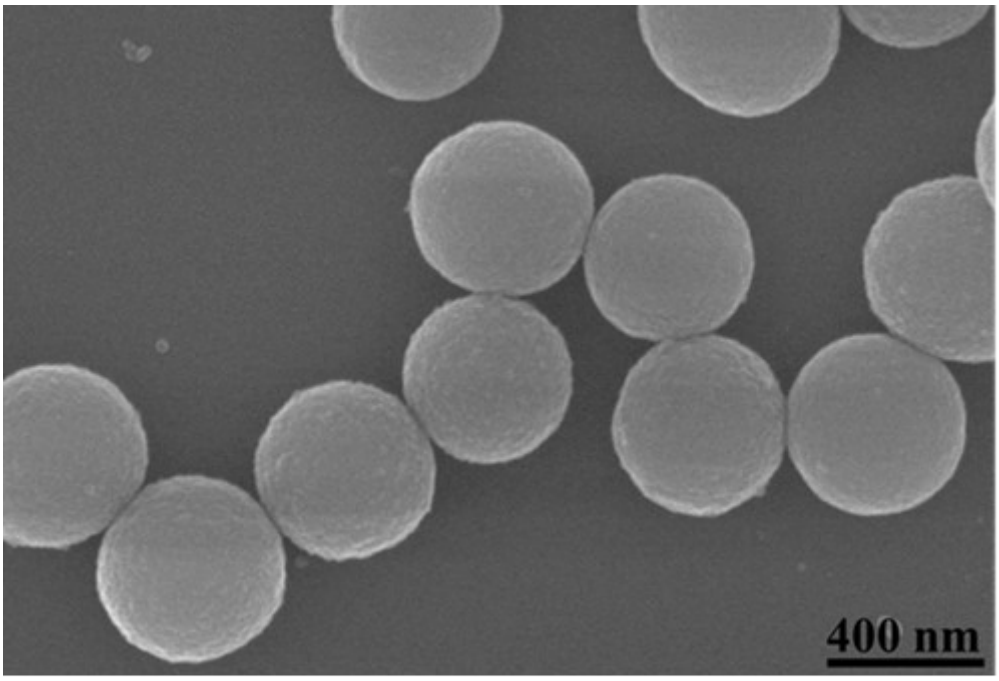

Fig. S1. SEM image of PDA nanospheres.

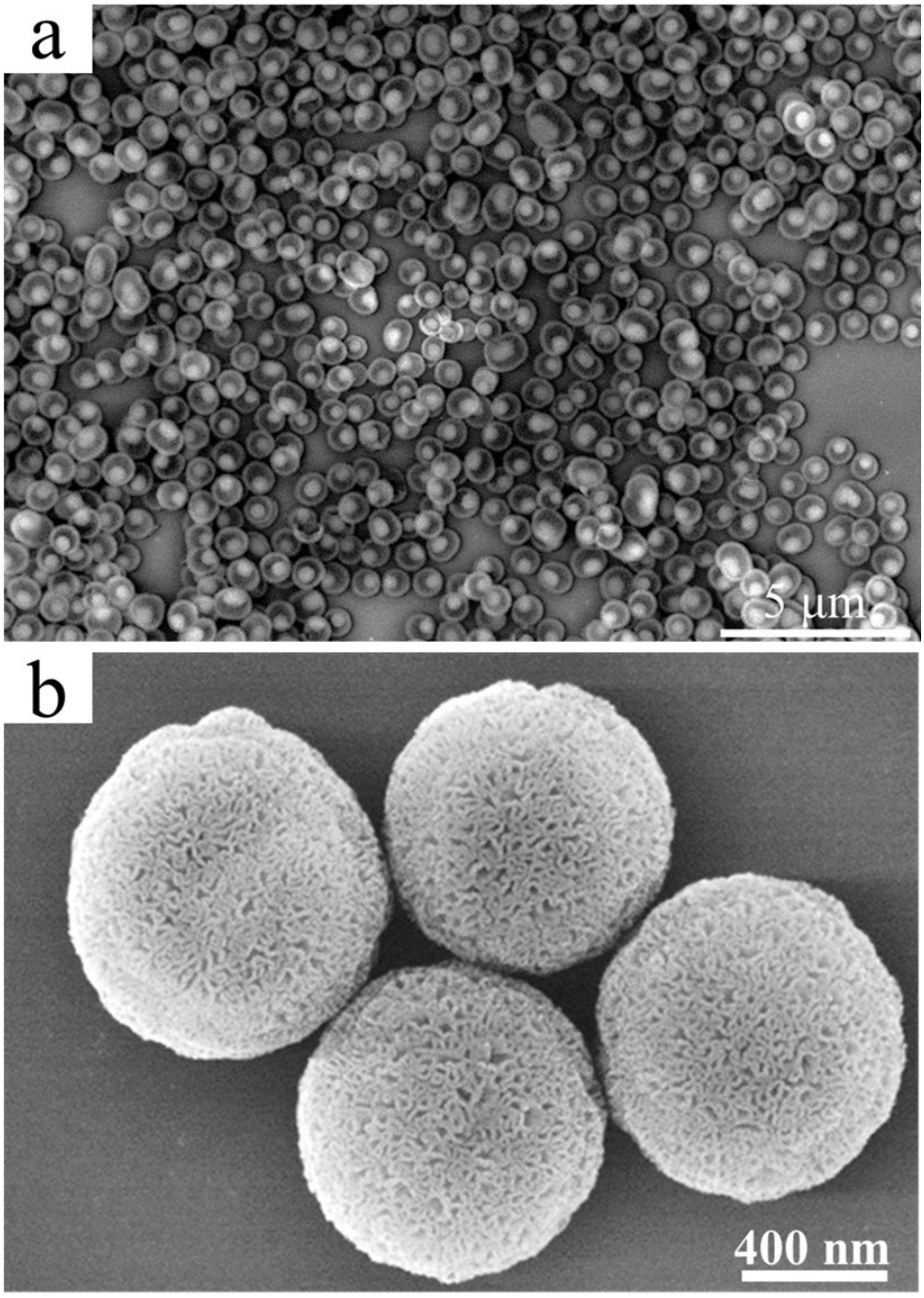

Fig. S2. (a-b) SEM images of PDA@MS_{60} with different magnifications.

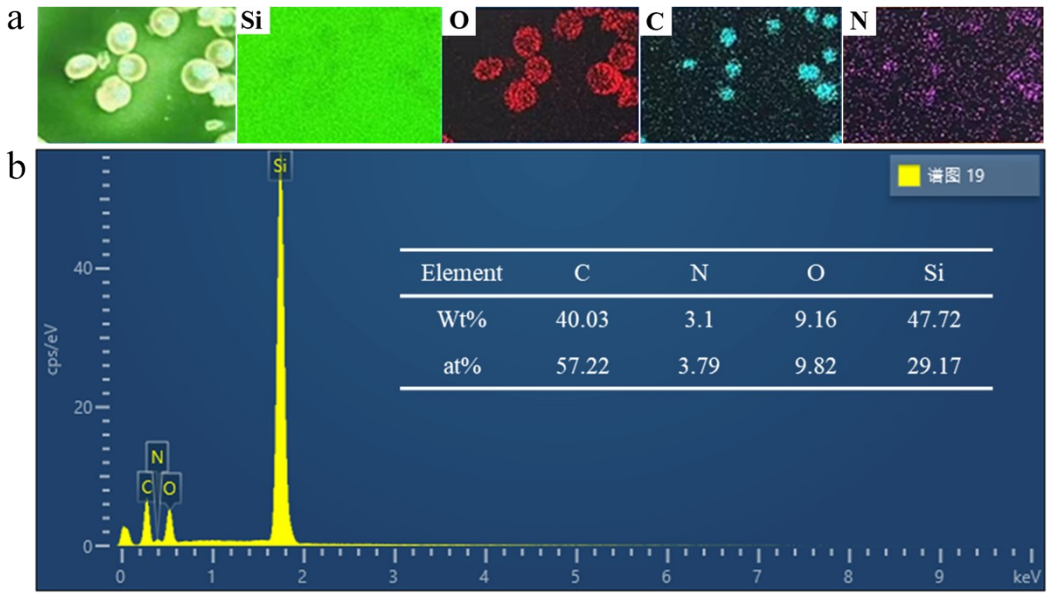

Fig. S3. (a) The EDX elemental (Si, O, C, N) mapping images and (b) EDX elemental content of PDA@MS_{60}. The anomalous color distribution of Si element is attributed to the existence of silicon wafer on which PDA@MS_{60} sample was placed. The existence of silicon wafer is also the reason of anomalous high content of Si element.

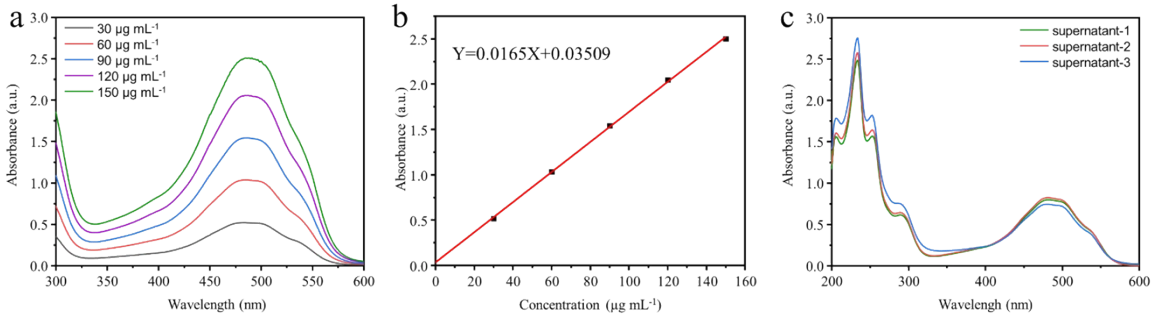

Fig. S4. (a) UV-vis absorption spectra of DOX aqueous suspension (in PBS) under different concentration. (b) The standard curve of DOX aqueous suspension (in PBS) at its characteristic absorption wavelength (480 nm). (c) UV-vis absorption spectra of the centrifuged supernatants containing the unloaded DOX after the DOX loading on PDA@MS_{60}.

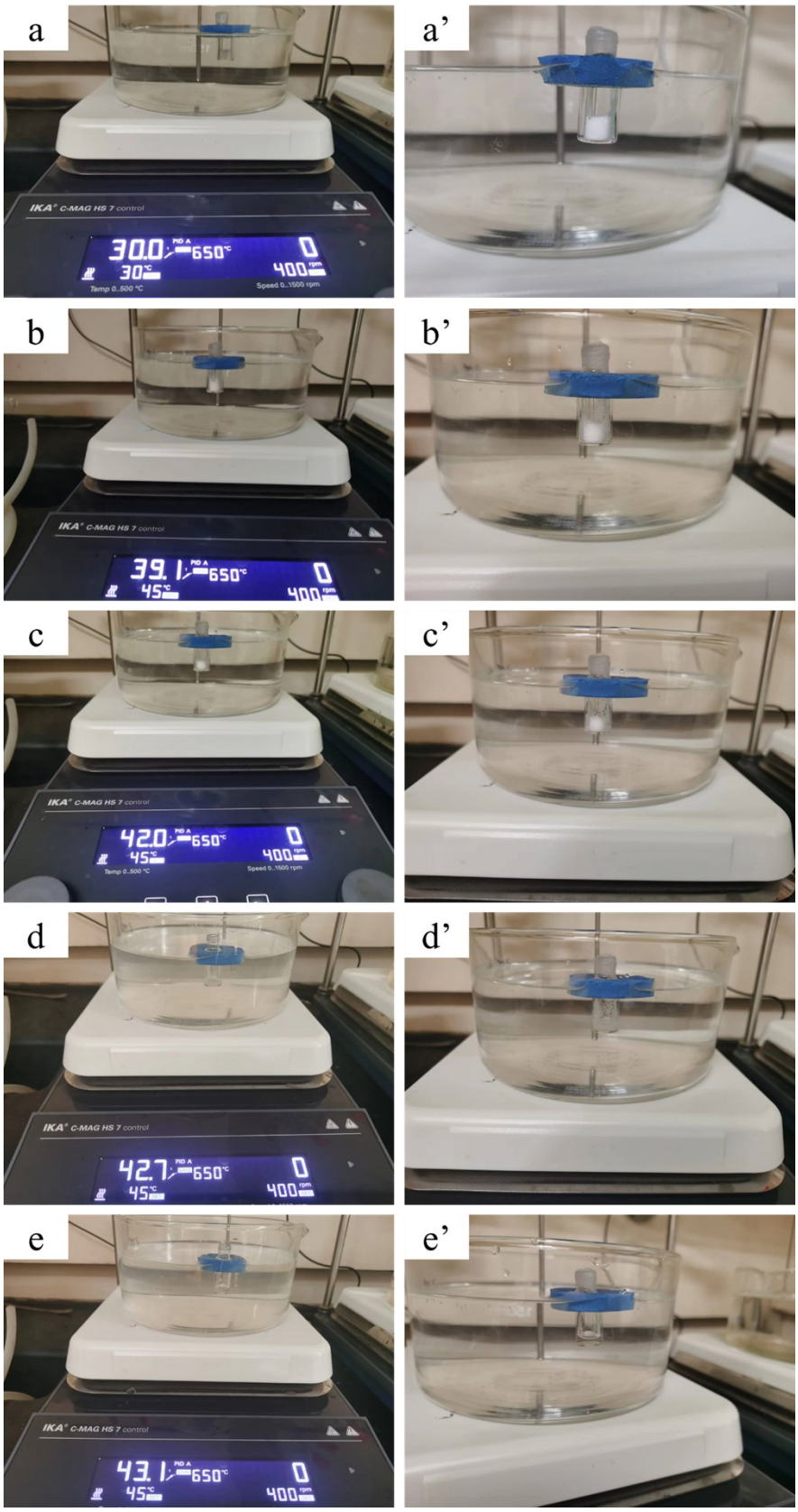

Fig. S5. The state of PCM powder under different reaction temperatures: a,a') 30 ℃, b,b') 39.1 ℃; c,c') 42 ℃, d,d') 42.7 ℃, e,e') 43.1 ℃.

In the experiment, 200 mg of PCM powder is added to 1 mL glass bottle, and then is preheated at 30 ℃ for 10 min (Fig. S5a,a'). Next, the sample is heated to 45 ℃ at an average rate of 0.5 ℃ min^{-1}. When the temperature reaches 39 ℃, the powder shows no trace of melting at all (Fig. S5b,b'). When the temperature reaches 42 ℃, the droplets of melted powder can be seen visibly hanging from the walls of the glass bottle (Fig. S5c,c'). All the powder meltes and takes on a milky white liquid state at 42.7 ℃ (Fig. S5d,d'), and the liquid becomes completely transparent at 43.1 ℃ (Fig. S5e,e'). Thus, the temperature range of PCM from initial to total melt is 42.0-43.1 ℃. Because the melting point should be expressed as the temperature range at which the solid started to melt and at which it was completely converted to liquid,[2] the melting point of the PCM is 42.0-43.1℃. It coincides with the fact that the explosive release of the drug in the experiment bagin at 43.0 ℃.

[2] C. John, O.C. Young, *Chem. Educator.*, **2013**, 18, 203-208.

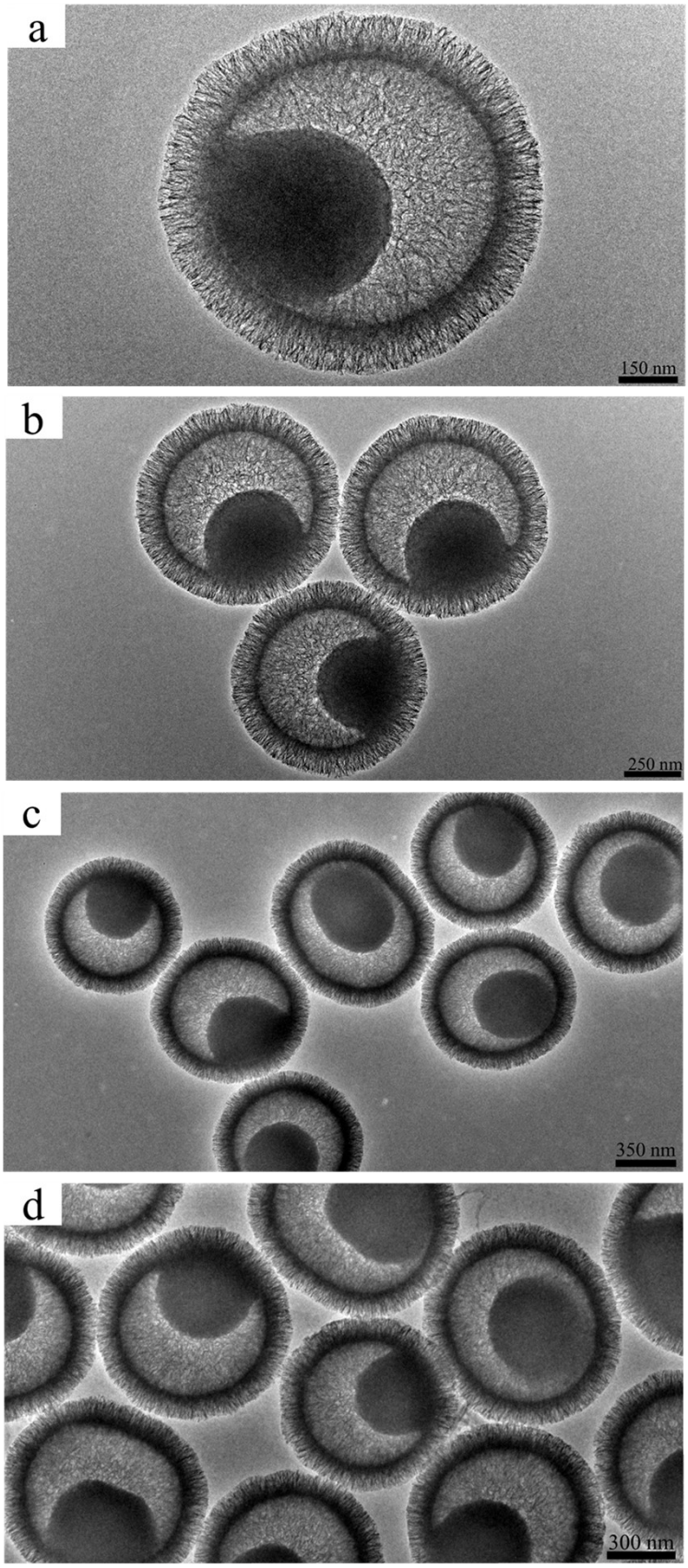

Fig. S6. (a-d) TEM images of the PDA@MS_{60} with different magnifications after three cycles of NIR laser-induced temperature heating.

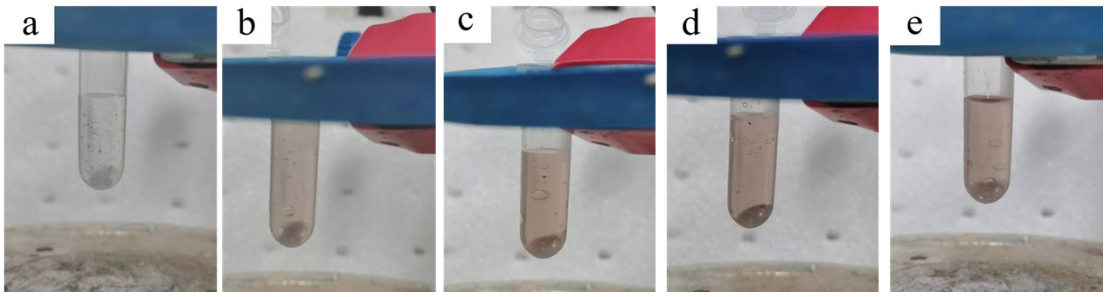

Fig. S7. The digital images of color change of the PCM-DOX-PDA@MS_{60} aqueous suspension at 0 h (a), 0.5 h (b), 1.0 h (c), 1.5 h (d) and 2.0 h (e) during DOX release process under NIR light irradiation (808 nm, 1.5 W cm^{-2}).

Table S1. The absorbance of DOX (in PBS) with different concentration at 480 nm, corresponding to the Fig. S4 (a).

DOX concentration (μg mL^{-1})	30	60	90	120	150
Wavelength (nm)			480		
A (a.u.)	0.348	0.710	1.075	1.450	1.808

Table S2. The absorbance and volome of the centrifuged supernatant containing unloaded DOX after the DOX loading on PDA@MS_{60} at 480 nm in three repetitions, corresponding to the Fig. S4 (c).

	Wavelength (nm)	Absorbance (a.u.)	Volume (mL)
supernatant-1	480	0.798	9.2
supernatant-2		0.823	9.1
supernatant-3		0.741	8.4

Table S3. The loading capacity of PDA@MS_{60}.

	Absorbance (a.u.)	Concentration (μg mL^{-1})	Volume (mL)	Mres (μg)	LC (%)
1	0.798	46.21	9.2	556.38	57
2	0.823	47.73	9.1	434.34	57
3	0.741	42.80	8.4	359.52	64

The DOX loading capacity (LC) in PDA@MS_{60} is calculated according to the following equation.

$LC=(M_{ini}- M_{res}) / M_{pm} \times 100\%$

where M_{ini} is the initial amount of DOX, M_{res} is the residual amount of DOX, and M_{pm} is the mass of PDA@MS_{60}. In our experiment, M_{ini}=1000 μg; M_{pm}=1000 μg.

Captions for Supporting Videos

Video S1. Representative motion movies of PDA@MS_{40}, PDA@MS_{60} and PCM-DOX-PDA@MS_{60} under the irradiation of NIR light (1.5 W cm^{-2}, 808 nm) and corresponding Brownian motion in the absence of NIR light.

Video S2. Comparison of motion movies of PCM-DOX-PDA@MS_{60} under the irradiation of NIR light (808 nm) with different power densities (0, 0.5, 1.0 and 1.5 W cm^{-2}).