Fabrication of Uniform Biodegradable Microcages with Predesigned Shape Printed from Microarrays for Sustained Release of Small Hydrophilic Molecules

Jiaxin Zhang *[a,c], Rui Sun [b], Valeriya Kudryavtseva[a], David J. Gould [c], Gleb B. Sukhorukov [a,d]

1 School of Engineering and Material Science, Queen Mary University of London, London, E1 4NS, United Kingdom

2 Centre for Oral Bioengineering, Bart's and the London, School of Medicine and Dentistry, Queen Mary University of London, Turner Street, London E1 2AD, United Kingdom

3 Biochemical Pharmacology, William Harvey Research Institute, Queen Mary University of London, London EC1M 6BQ, United Kingdom

4 Life Improvement by Future Technologies (LIFT) Center, Moscow, 143025, Russia

*Jiaxin Zhang Email: j.zhang23@imperial.ac.uk

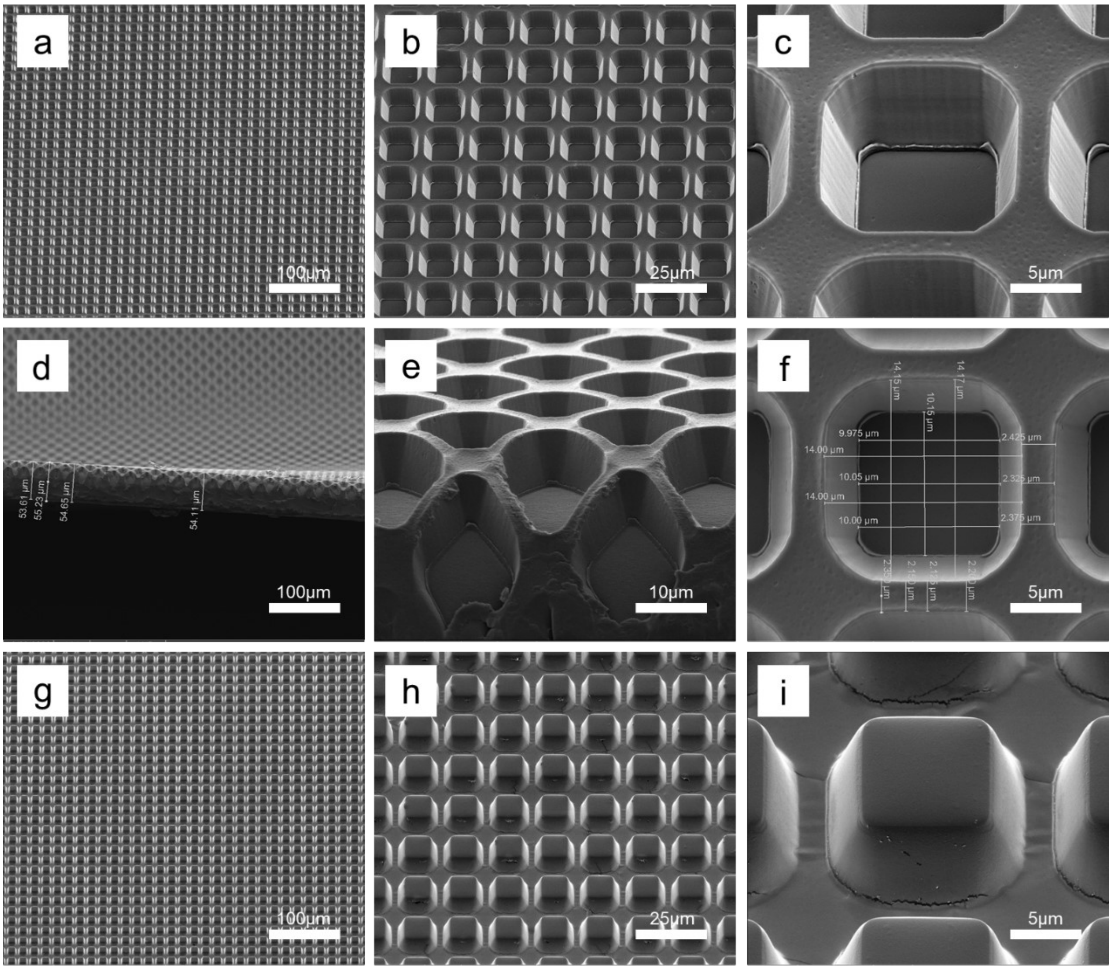

Figure S1. The specification of PMMA template as well as the PDMS template for preparing patterned PDMS stamp. (a-f) The SEM images of PMMA template at various magnifications and angles. (g-i) The SEM images of PDMS template of different magnifications. The period of microwell arrays is 16.35μm. The microwell is in the shape of rounded quadrangular frustum pyramid, with the short side, long side, depth as 10μm, 14μm, 8μm respectively. The distance between microwells (wall thickness) is 2.35μm. Moreover, the thickness of PMMA template films is about 54μm including the 8μm depth of microwells.

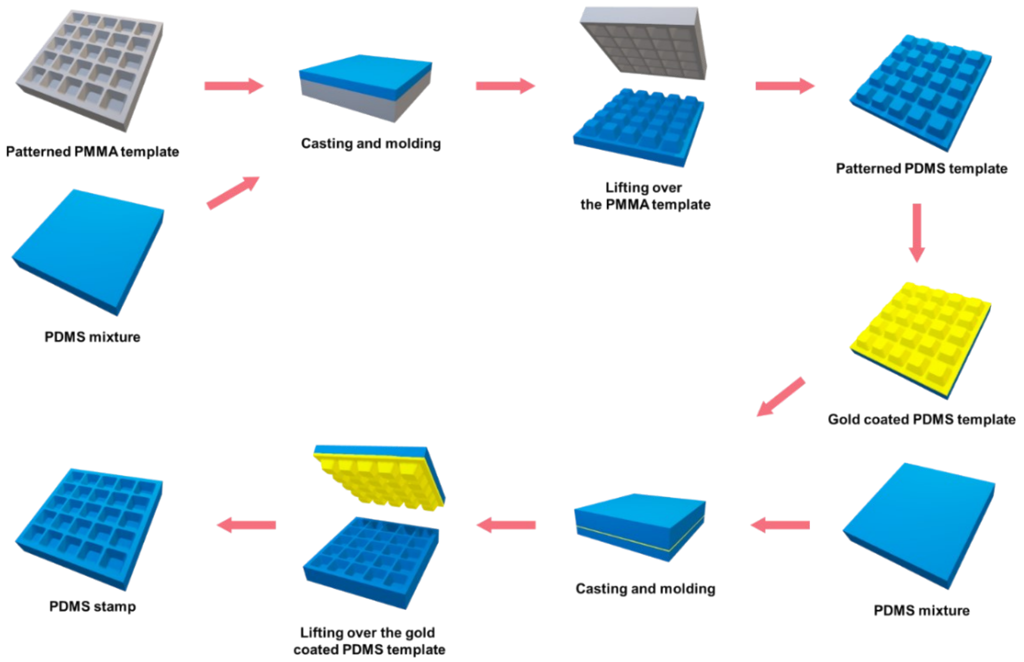

Figure S2. Schematically illustration of the procedures for preparing microwell-patterned PDMS stamp.

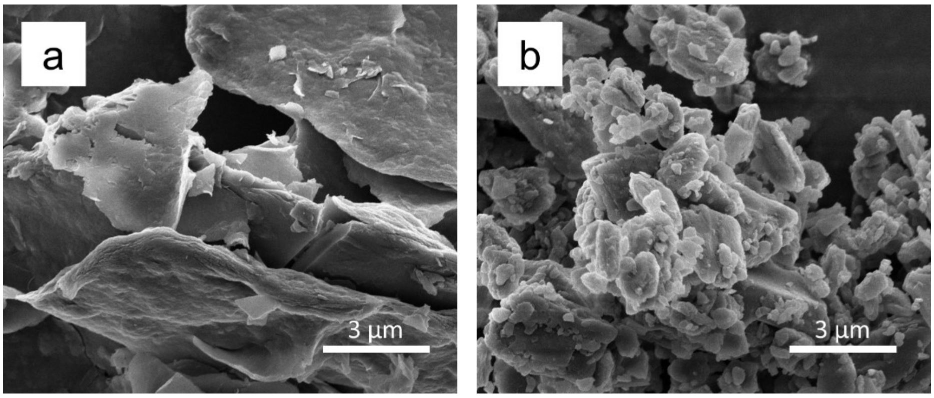

Figure S3. SEM images of 5(6)-carboxyfluorescein (CF) dye particles. (a) CF particles before homogenization and (b) Submicron size CF particles

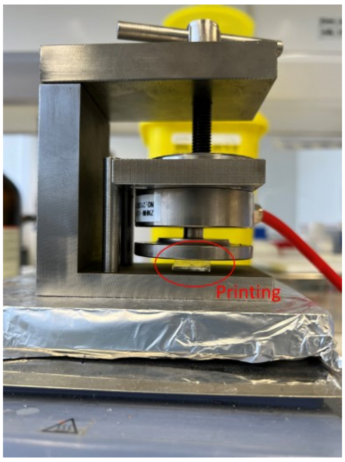

Figure S4. The home-made fixture for fixing and printing the microcages.

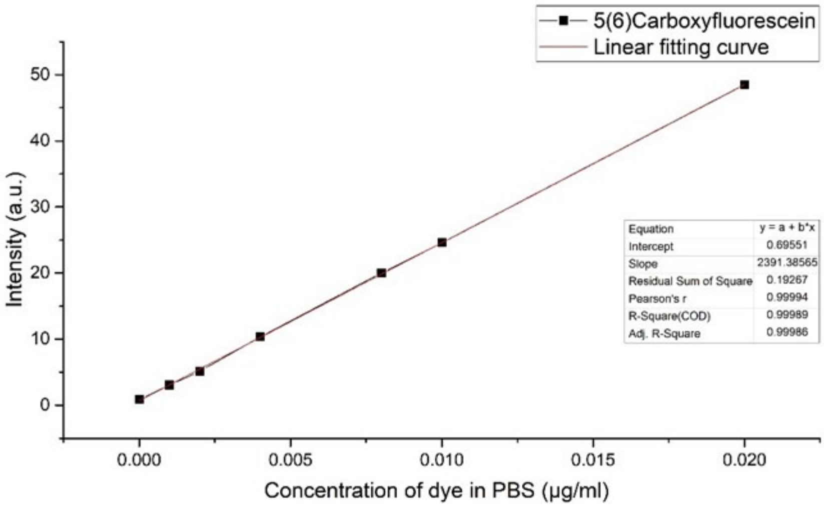

Figure S5. The calibration curve of 5(6)-carboxyfluorescein in PBS solutions at the excitation wavelength of 494nm.

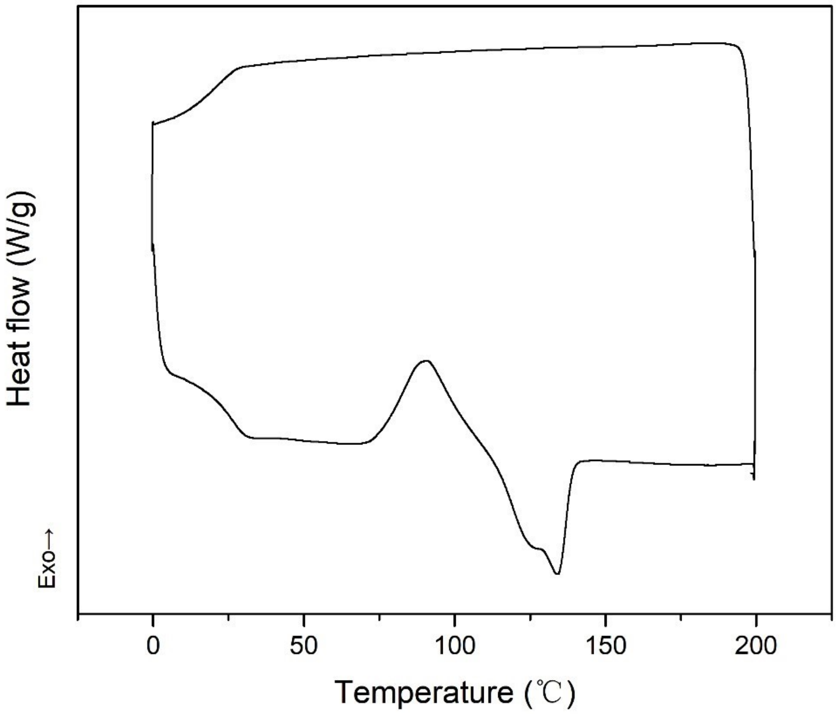

Figure S6. DSC results of polylactic acid (PLA). The curve is constituted by 5 minutes isothermal at 200℃, temperature decrease from 200℃ to 0℃ at rate of 10℃/min, 5 minutes isothermal at 0℃ and temperature increase from 0℃ to 200℃.

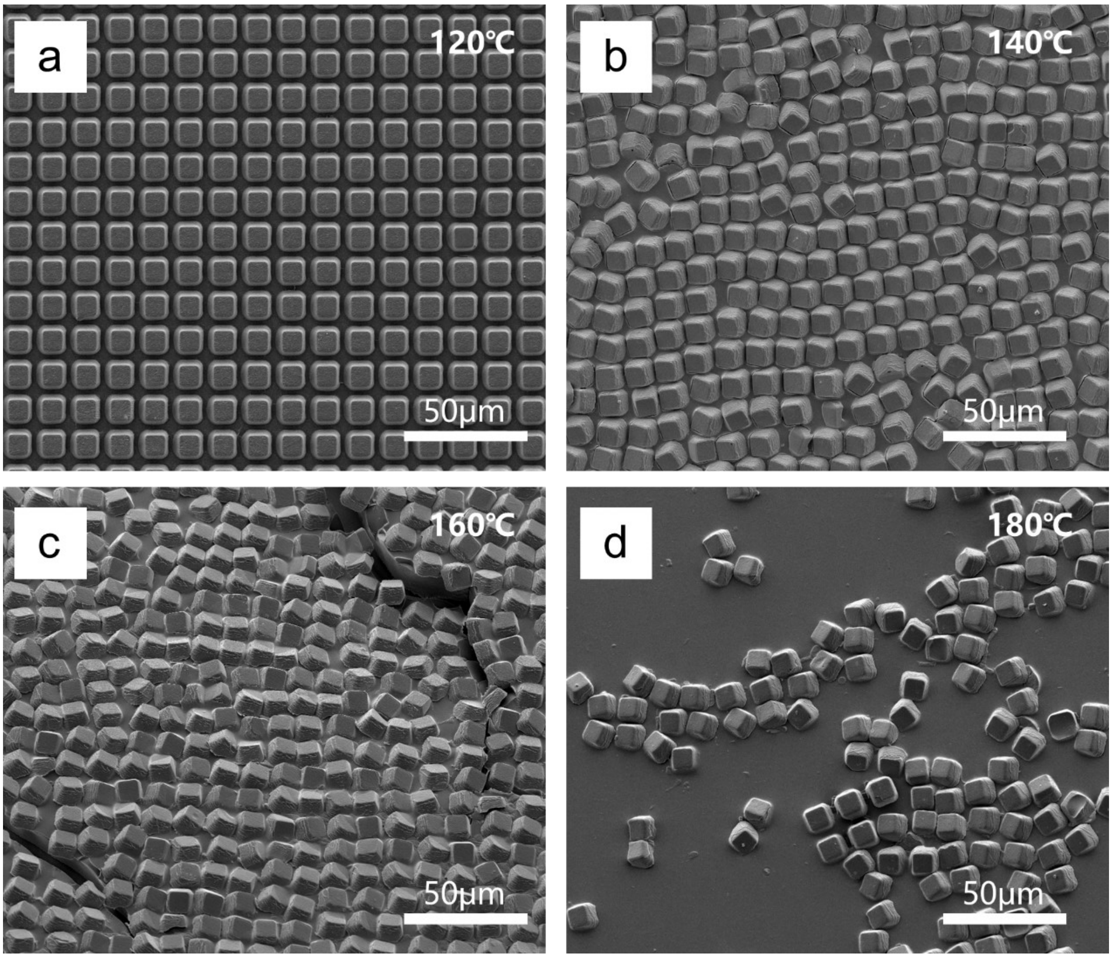

Figure S7. After the sandwiched structure of PDMS template - polymer films - flat PDMS being heated and pressed at different structure and lifting over the flat PDMS, the resulted structure transferred onto glass slide by gelatin. (a) Heated and pressed at 120℃. The PLA polymer films were not separated by the wall of microwells due to the low temperature. (b) Heated and pressed at 140℃. The temperature reached the melting temperature of PLA, thus the PLA films were separated and the individual microcages were forms. (c) Heated and pressed at 160℃. The results were similar to (b) that the individual microcages were successfully printed. (d) Heated and pressed at 180℃. The temperature was so high that some of the melted PLA were attached onto flat PDMS and only partial microcage were embedded in microwells of PDMS stamp and being transferred onto glass slide by gelatin.

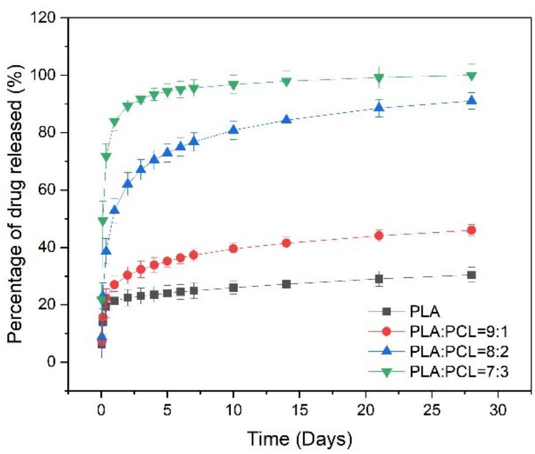

Figure S8. Cumulative CF release amount of different polymer composition in percentage form.

Table S1. Microcage parameters and weight calculations. Here, a1 and b1 refers to microcage long side length and width, and a2 and b2 represents the short side length and width. While h means the height of the microcage. This calculation is assuming the shape as truncated pyramid without considering the rounded edges.

	a1	**b1**	**a2**	**b2**	**h**
Average Length (µm)	12.088	12.238	9.163	9.216	6.921
Standard Deviation (±)	1.545	1.109	0.698	0.498	0.552
Volume equation	$V = \frac{[a_{\square} \times \mathrm{b}_{\square} + a_{\square} \times b_{\square} + (a_{\square} + a_{\square}) \times (b_{\square} + b_{\square})] \times h}{6}$				
Microcage volume (µm3)	793.913				
Density of polymer (pg/µm3)	1.2				
Weight of microcage (pg)	952.695				