Supporting Information

Microwave-Responsive Polymeric Core-Shell Microcarriers for High-Efficiency Controlled Drug Release

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1. SEM and STEM images of P*p*PD/PNIPAM microparticles

Fig. S1 shows the side view SEM and STEM images of P*p*PD/PNIPAM microparticles. We can find that the surface of hybrid particles became rough and an outer layer with highly porous structure was formed.

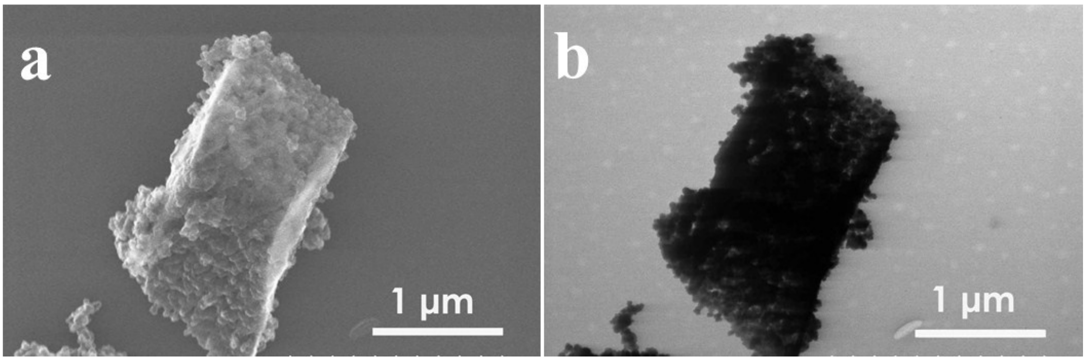

Fig. S1. SEM (a) and STEM (b) images of P*p*PD/PNIPAM microparticles.

2. Raman spectra of P*p*PD and P*p*PD/PNIPAM microparticles

Fig. S2 shows the Raman spectra of P*p*PD and P*p*PD/PNIPAM microparticles. The band between 1510 cm^{-1} and 1594 cm^{-1} could be ascribed to the N-H bending deformation mode and the C-C deformation of benzenoid rings and quinoid rings.

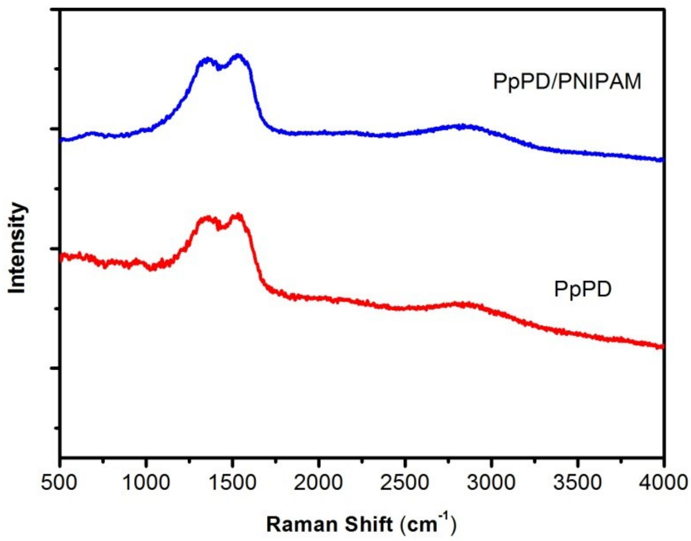

Fig. S2. Raman spectra of P*p*PD and P*p*PD/PNIPAM microparticles.

3. XRD pattern of PDA monomer

The XRD spectrum of PDA monomers showed sharp peaks at 12°, 17°, 19°, 22°, 24°, 26°, 27°, 29°, and 32° which were different from those of P*p*PD particles, confirming the successful polymerization of PpPD microparticles.

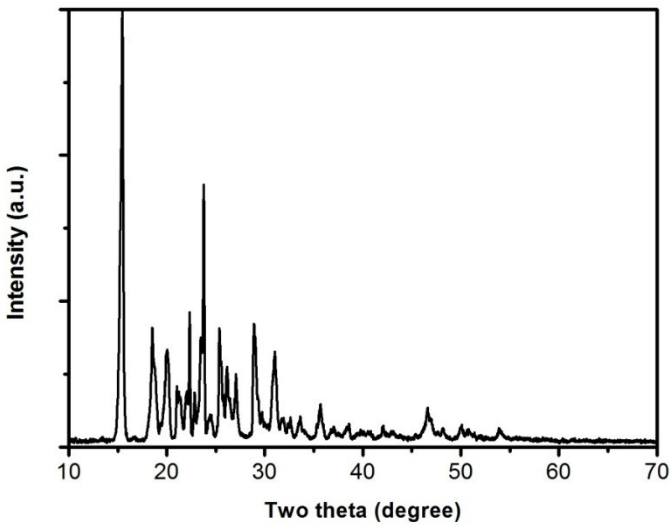

Fig. S3 XRD pattern of PDA monomers.

4. TGA test of PDA monomers

Fig. S4 shows the results of TGA test for PDA monomers. Before polymerization to P*p*PD particles, PDA monomers showed a significant weight loss in the range of 150 to 240 °C, which is much lower than those of P*p*PD and P*p*PD/PNIPAM microparticles. The results demonstrated that the thermal stability was significantly enhanced after polymerization.

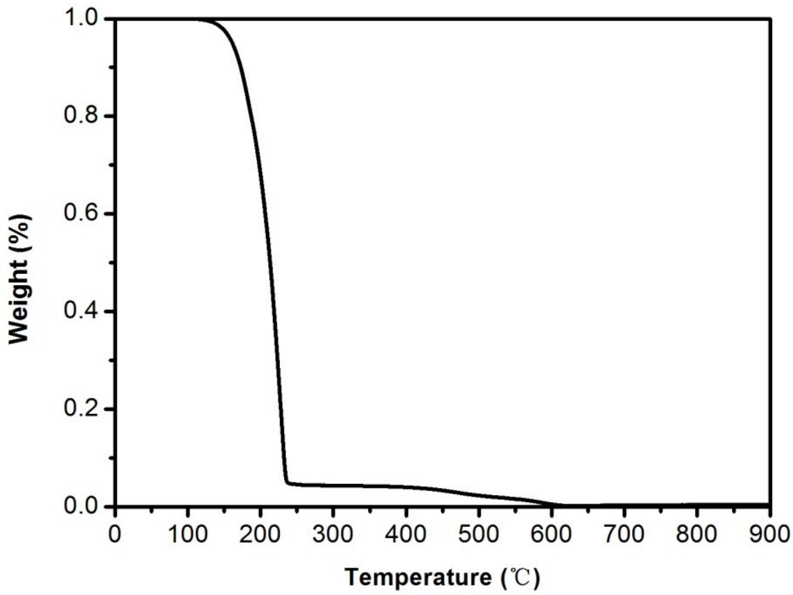

Fig. S4 TGA test for PDA monomers.

5. Microwave absorption ability of P*p*PD

Fig. S5 shows the reflection loss of P*p*PD films with different thickness. The curve shows that P*p*PD exhibits higher microwave absorption ability at high frequency range, which means it should exhibit better thermal conversion performance at high frequency range. Compared to PANI which is regarded as a typical organic microwave absorption material (Synth. Met. 1999, 105, 115–120), P*p*PD shows slightly lower reflection loss values at high frequency range but similar behavior at low frequency rage. The results demonstrate that P*p*PD exhibits similar microwave absorption ability to PANI, especially at low frequency range.

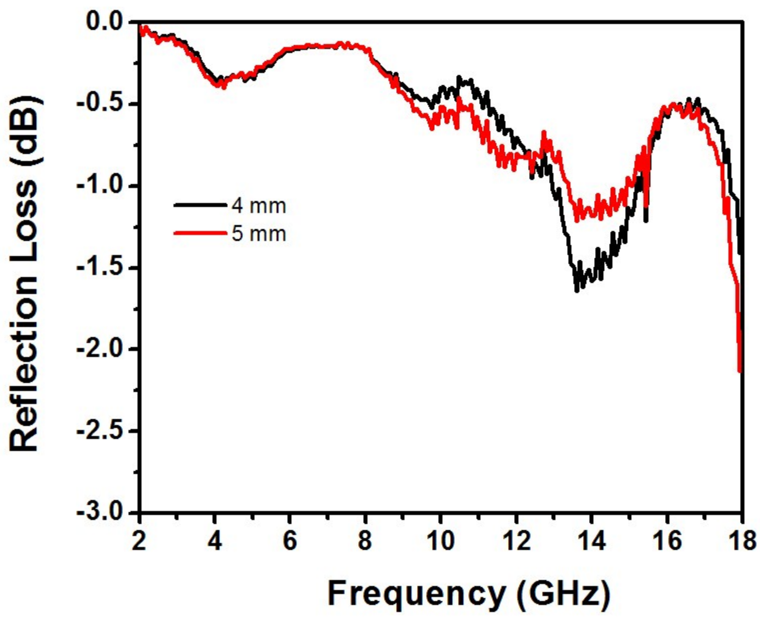

Fig. S5 Reflection loss of P*p*PD films with different thickness.

6. UV-vis spectra for samples collected during a typical controlled release test

Fig. S6 shows the UV-vis results during a typical controlled release test. The spectra with solid line represented the samples collected for the irradiation stages and the spectra with dash line represented the samples collected for the non-irradiation stages. The drug used here was folic acid.

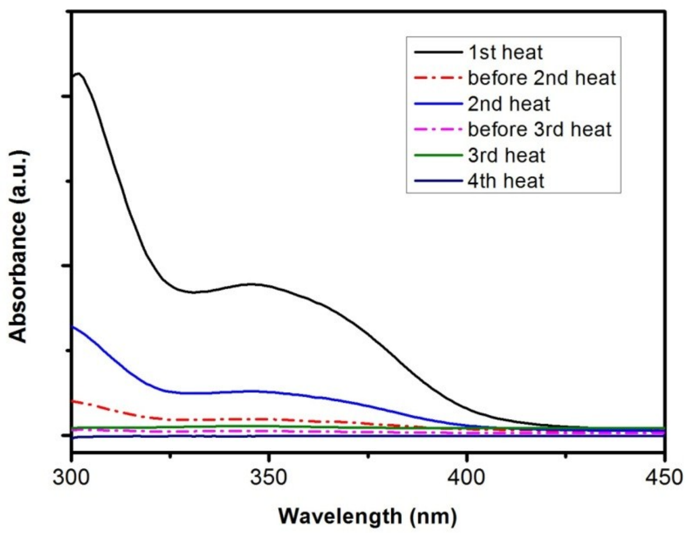

Fig. S6 UV-vis spectra for samples collected during a typical controlled release test.

7. UV-vis spectra for samples collected during a typical controlled release test

Fig. S7 shows the results of controlled drug release tests using SiO2/PNIPAM as drug carriers for folic acid and etoposide. The amounts of released drugs in the control experiments using SiO_2/PANIPAM core-shell microparticles are only slightly higher than those in control experiments using hot water bath. The reason is that within each 10s' microwave irradiation, the water is heated from 37 °C to around 45 °C, which is similar to the temperature of hot water bath. However, since the SiO_2 core is not able to respond to microwave irradiation and generate local heat, the PNIPAM shell can be only heated by surrounding water, just like in the control experiments using hot water bath.

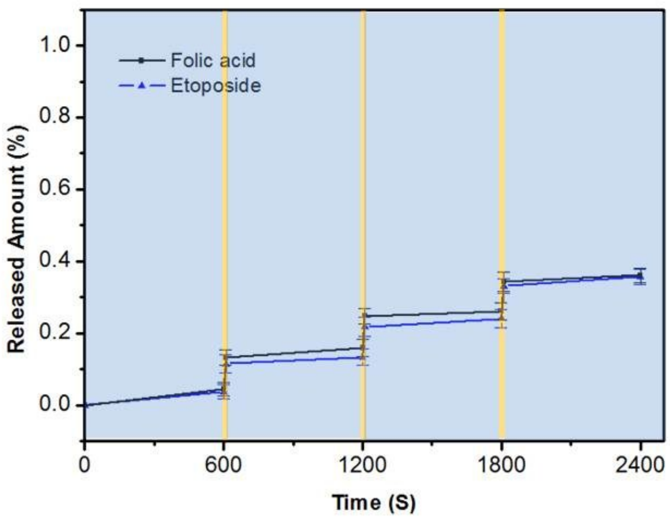

Fig. S7 Controlled drug release tests of SiO_2/PNIPAM carriers for folic acid and etoposide.

8. STEM image of SiO_2/PNIPAM particles

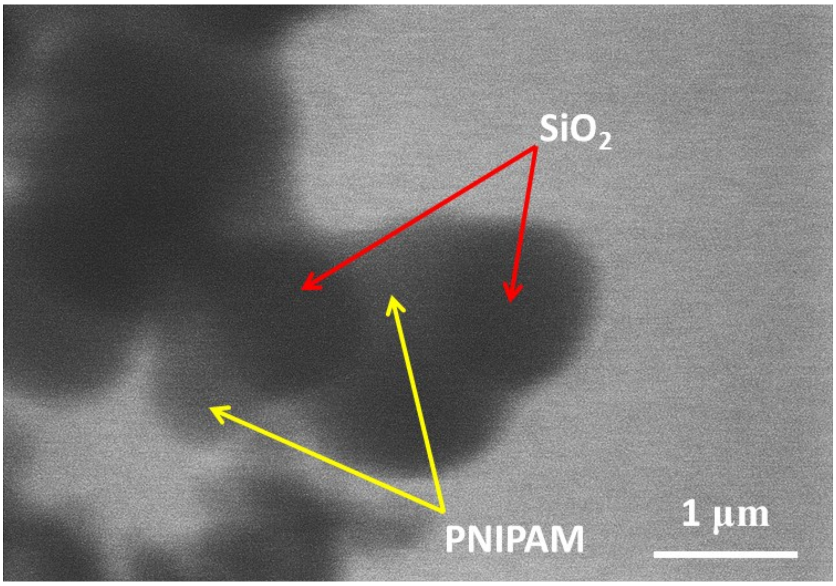

Fig. S8 STEM image of SiO_2/PNIPAM particles

9. Comparison of drug releasing efficiency of different stimuli-responsive drug carriers

Table S1 Composition of drug releasing efficiency of different stimuli-responsive drug carriers.

Drug carrier	Stimuli	Releasing efficiency	Reference
P*p*PD/PNIPAM	Microwave	~60% released in 10 s	This paper
Fe_3O_4@ZnO@mSiO_2	Microwave	25% released in 20 min	Ref. S1
Liposomal formulations	Hyperthermia	~8% released in 2 min	Ref. S2
PMEEECL-b-POCTCL	Hyperthermia	~50% released in 10 min	Ref. S3
Spiropyran-PEGylated lipid	UV light	~35% released in 4 min	Ref. S4
PLGA with gold layer	NIR laser	~12% released in 12 h	Ref. S5
Polyethylene oxide/pentaerythritol triacrylate/MWCNT	Electrical field	~27% released in 120 min	Ref. S6
poly(styrene) cyclodextrin and poly(ethylene oxide)-ferrocene	Electrical field	~50% released in 16 min	Ref. S7

References

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