Supporting Information

Volatile microemulsion method of preparing water-dispersible photo absorbers for 3D printing of high resolution, high water-content hydrogel structures

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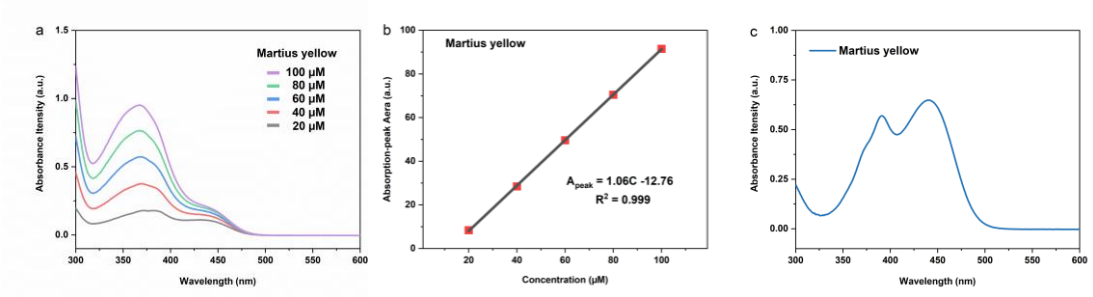

Figure S1. (a) UV-vis spectra of different concentrations of Martius yellow dissolved in ethanol. (b) Plot of absorption-peak aera vs. Martius yellow concentration. (c) UV-vis spectra of an ethanol dispersion of 0.5 mg/mL Martius yellow nanoparticles (W_{PA} = 1.7 wt.%).

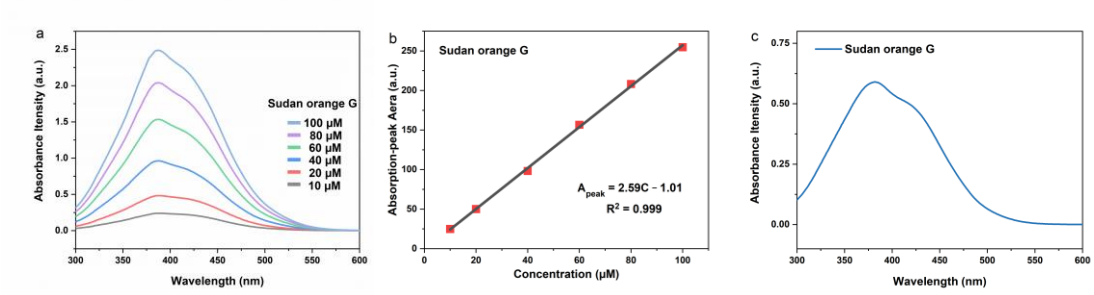

Figure S2. (a) UV-vis spectra of different concentrations of Sudan Orange G dissolved in ethanol (b) Plot of absorption-peak aera vs. Sudan Orange G concentration. (c) UV-vis spectra of an ethanol dispersion of 0.1 mg/mL Sudan Orange G nanoparticles (W_{PA} = 1.7 wt.%).

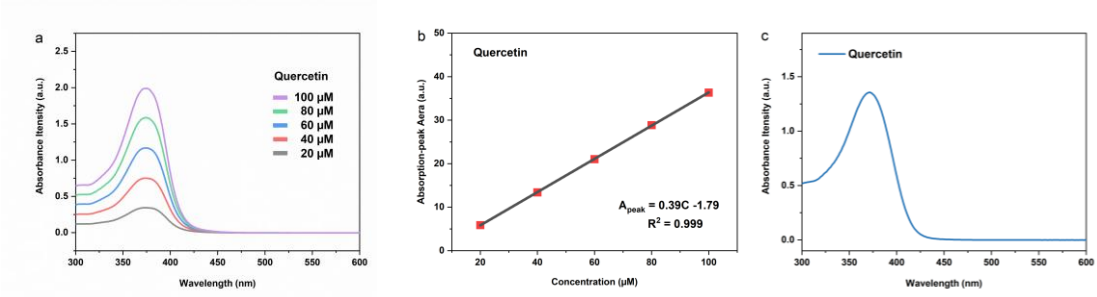

Figure S3. (a) UV-vis spectra of different concentrations of Quercetin dissolved in ethanol. (b) Plot of absorption-peak aera vs. Quercetin concentration. (c) UV-vis spectra of an ethanol dispersion of 0.2 mg/mL Quercetin nanoparticles (W_{PA} = 1.7 wt.%).

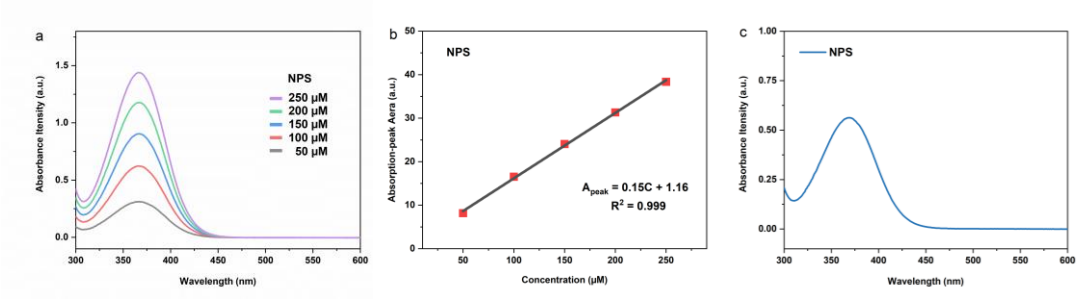

Figure S4. (a) UV-vis spectra of different concentrations of NPS dissolved in ethanol. (b) Plot of absorption-peak aera vs. NPS concentration. (c) UV-vis spectra of an ethanol dispersion of 1 mg/mL NPS nanoparticles (W_{PA} = 1.7 wt.%).

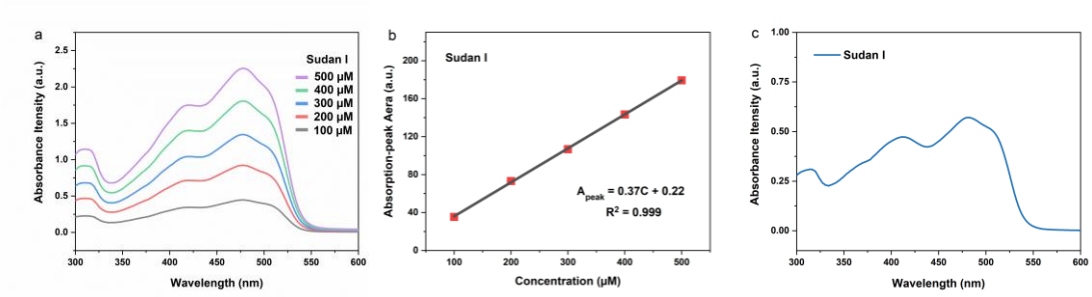

Figure S5. (a) UV-vis spectra of different concentrations of Sudan I dissolved in ethanol. (b) Plot of absorption-peak aera vs. Sudan I concentration. (c) UV-vis spectra of an ethanol dispersion of 1 mg/mL Sudan I nanoparticles (W_{PA} = 1.7 wt.%).

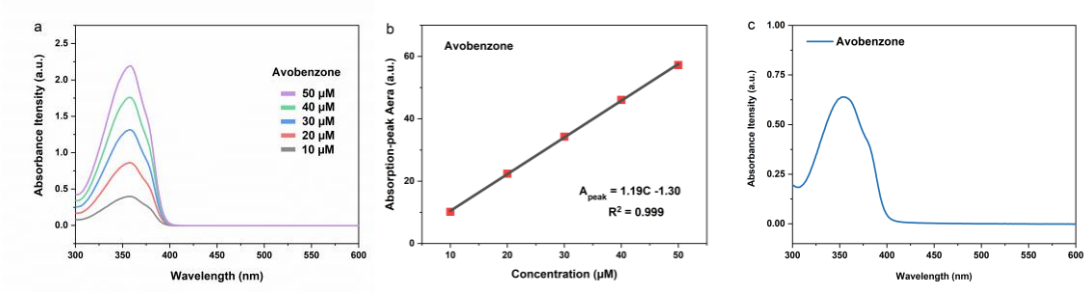

Figure S6. (a) UV-vis spectra of different concentrations of Avobenzone dissolved in ethanol. (b) Plot of absorption-peak aera vs. Avobenzone concentration. (c) UV-vis spectra of an ethanol dispersion of 0.2 mg/mL Avobenzone nanoparticles (W_{PA} = 1.7 wt.%).

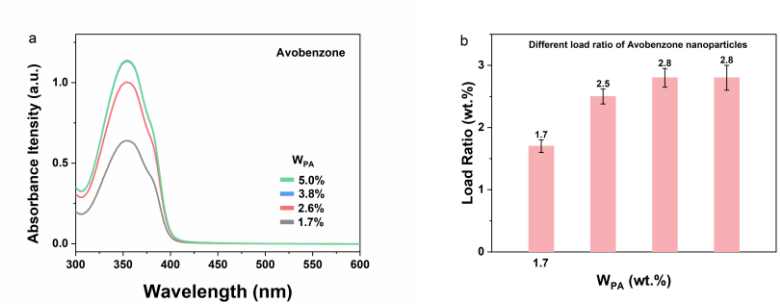

Figure S7. (a) UV-vis spectra of an ethanol dispersion of 1 mg/mL Avobenzone nanoparticles (W_{PA} from 0.8 wt.% to 5 wt.%). (b) Plot of Avobenzone load ratio in nanoparticles vs. the W_{PA} of Avobenzone.

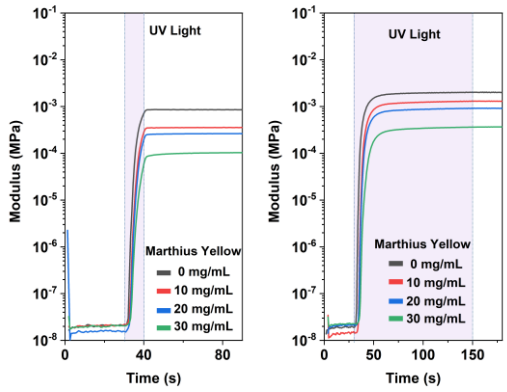

Figure S8. Photorheology curves of hydrogel with Martius Yellow nanoparticles (0 - 30 mg/mL) during short (10 s) and long (120 s) duration light exposures (purple shaded region).

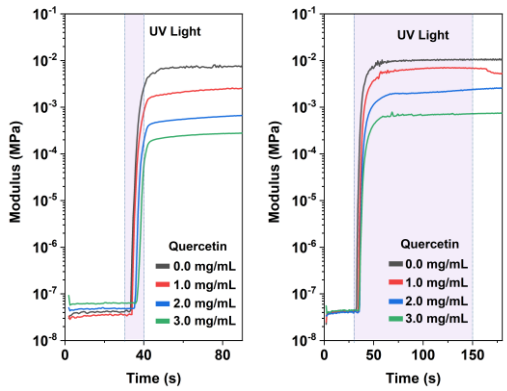

Figure S9. Photorheology curves of hydrogel with Quercetin nanoparticles (0 - 3 mg/mL) during short (10 s) and long (120 s) duration light exposures (purple shaded region).

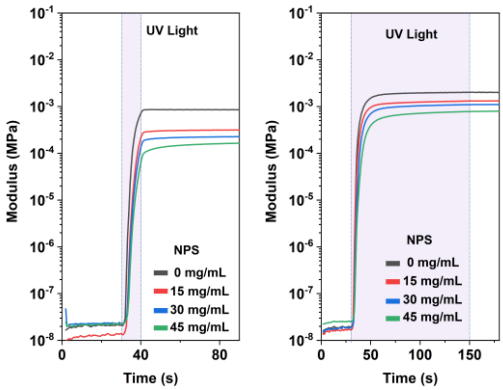

Figure S10. Photorheology curves of hydrogel with NPS nanoparticles (0 - 45 mg/mL) during short (10 s) and long (120 s) duration light exposures (purple shaded region).

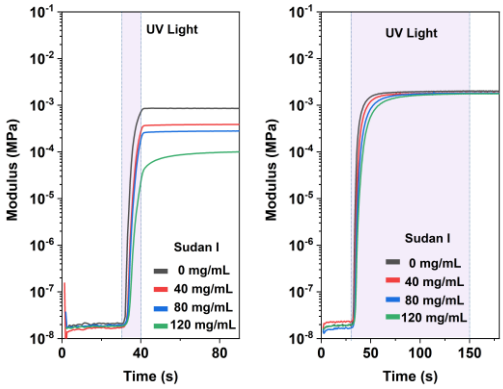

Figure S11. Photorheology curves of hydrogel with Sudan I nanoparticles (0 - 120 mg/mL) during short (10 s) and long (120 s) duration light exposures (purple shaded region).

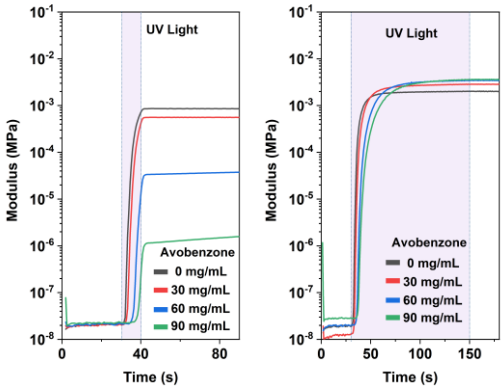

Figure S12. Photorheology curves of hydrogel with Avobenzone nanoparticles (0 - 90 mg/mL) during short (10 s) and long (120 s) duration light exposures (purple shaded region).

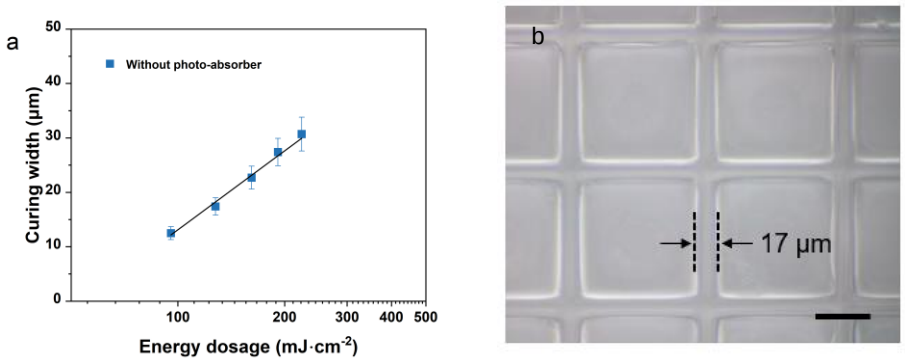

Figure S13. (a) Energy dosage on curing width without photo-absorber (light source: 405 nm). (b) 3D-printed hydrogel grid (30 wt.% PAAm hydrogel without photo-absorber, light source: 405 nm, 63.8 mW/cm^2, 2s). Scale bar: 50 μm.

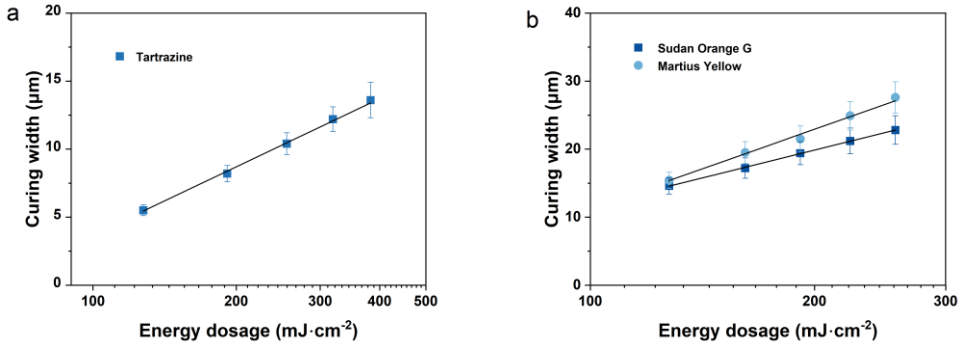

Figure S14. (a) Energy dosage on curing width with photo-absorber tartrazine (light source: 405 nm). (b) Energy dosage on curing width photo-absorber Sudan Orange G and Martius Yellow (light source: 405 nm).

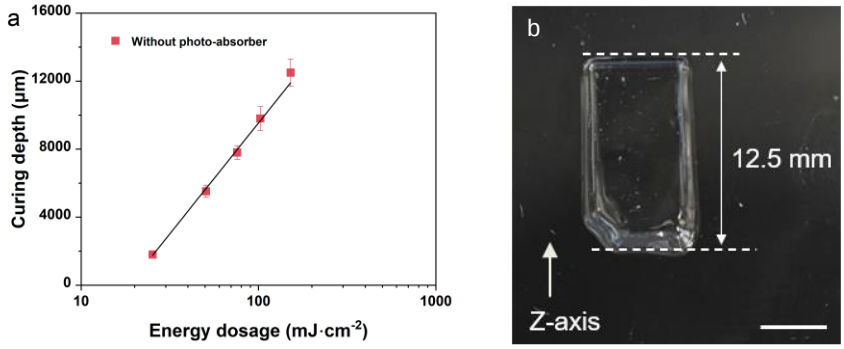

Figure S15. (a) Energy dosage on curing depth without photo-absorber (light source: 405 nm). (b) Curing depth of hydrogel under 50.6 mW/cm^2 405nm light source for 3 s (20 wt.% PAAm hydrogel without photo-absorber). Scale bar: 5 mm.

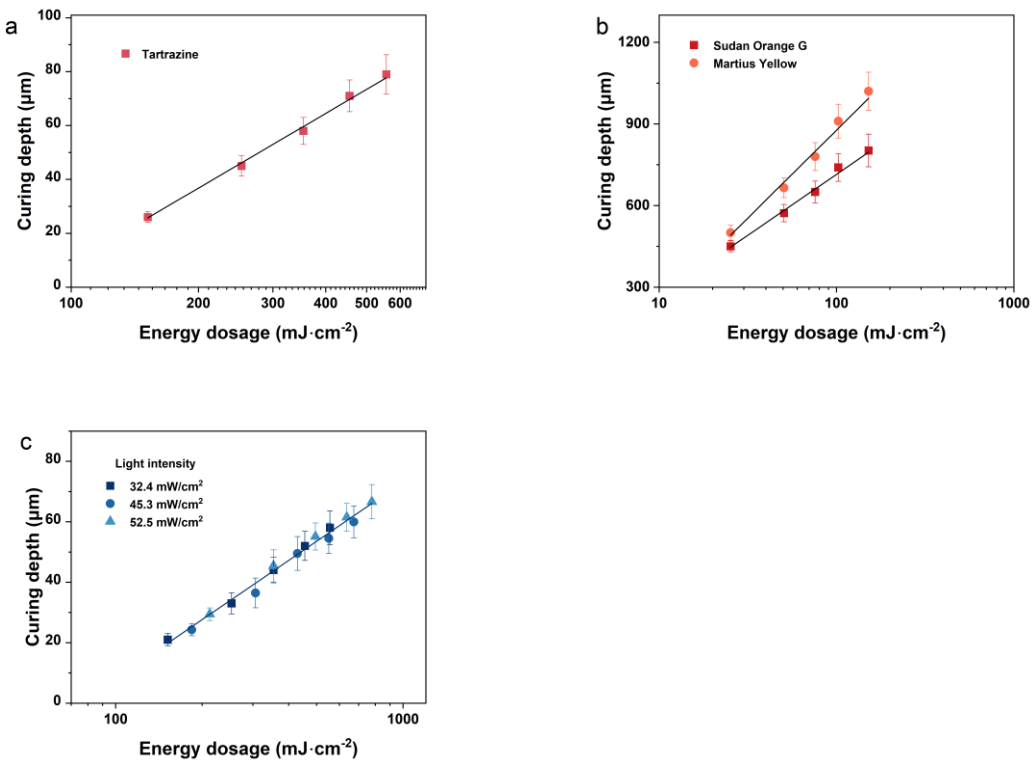

Figure S16. (a) Energy dosage on curing depth with photo-absorber tartrazine (light source: 405 nm). (b) Energy dosage on curing depth with photo-absorber Sudan Orange G and Martius Yellow (light source: 405 nm). (c) Energy dosage on curing depth under different light intensities (light source: 405 nm; photo-absorber nanoparticles: Sudan Orange G).

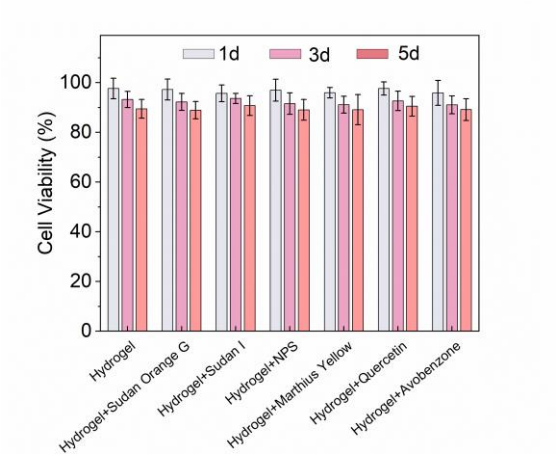

Figure S17. Live/dead assay for NIH 3T3 cells with hydrogels of different photo-absorber nanoparticles after 1d, 3d, and 5d.

Figure S18. The photos of printed PNIPAAm hydrogel QR code without photo-absorber in hot water. Scale bar: 5 mm.

Table S1. Composition [% (w/w)] of the microemulsions before freeze-drying.

	Photo-absorber	**Ethyl acetate**	**Ethanol**	**SDS**	**PVP**	**H_2O**
Martius yellow	1.7	22.3	21.0	7.5	7.5	40.0
Sudan orange G	1.7	22.3	21.0	7.5	7.5	40.0
Avobenzone	1.7	22.3	21.0	7.5	7.5	40.0
Quercetin	1.7	22.3	21.0	7.5	7.5	40.0
NPS	1.7	22.3	21.0	7.5	7.5	40.0
Sudan I	1.7	22.3	21.0	7.5	7.5	40.0

Table S2. Composition [% (w/w)] of the microemulsions before freeze-drying.

	Photo-absorber (Sudan orange G)	**Ethyl acetate**	**Ethanol**	**SDS**	**PVP**	**H_2O**
1	0.8	23.2	21.0	7.5	7.5	40.0
2	1.7	22.3	21.0	7.5	7.5	40.0
3	2.6	21.4	21.0	7.5	7.5	40.0
4	3.8	20.2	21.0	7.5	7.5	40.0
5	5.0	19.0	21.0	7.5	7.5	40.0
6	6.5	17.5	21.0	7.5	7.5	40.0
7	8.1	15.9	21.0	7.5	7.5	40.0
8	10.0	14.0	21.0	7.5	7.5	40.0

Table S3. Load ratio [% (w/w)] of the photo-absorber in the freeze-dried powders.

Photo-absorbers	**W_{PA}**	**Theoretical *LR***	**Effective *LR***
Marthius Yellow	1.7	10	2.2
Sudan Orange G	1.7	10	4.9
Avobenzone	1.7	10	1.6
Quercetin	1.7	10	8.3
NPS	1.7	10	3.1
Sudan I	1.7	10	3.6

Table S4. Load ratio [% (w/w)] of the photo-absorber (Sudan orange G) in the freeze-dried powders.

	W_{PA} (Sudan orange G)	**Theoretical *LR***	**Effective *LR***
1	0.8	5	3.0
2	1.7	10	4.9
3	2.6	15	7.4
4	3.8	20	9.6
5	5.0	25	13.0
6	6.5	30	14.5
7	8.1	35	17.9
8	10.0	40	17.9