Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Supplementary Information for

Covalent Capture of Supramolecular Species in Aqueous Solutions of Water-Miscible Small Organic Molecules

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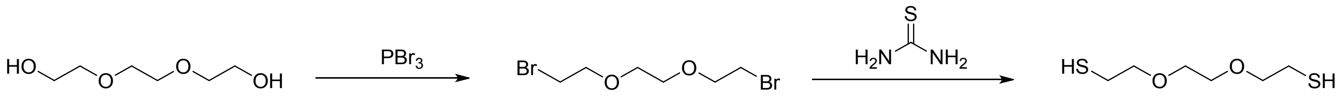
Synthesis

Scheme 1S. Synthesis of cross-linker **3**



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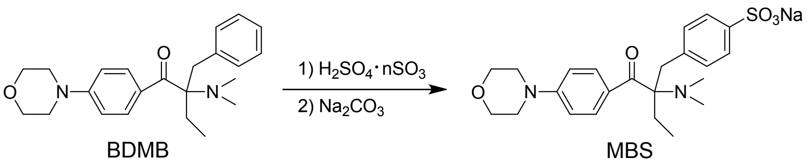
1,2-bis(2-bromoethoxy)ethane.[1] To a solution of triethylene glycol (1.5 g, 10 mmol) in 20 mL of anhydrous dichloromethane, phosphorous tribromide (8.1 g, 30 mmol) was added dropwise, and the reaction mixture was stirred under reflux for 24 hr. The reaction solution was then diluted with dichloromethane (40 mL) and neutralized by saturated aqueous $NaHCO_3$ solution. The organic phase was collected, washed with brine and dried over anhydrous $MgSO_4$. The solvent was removed under vacuum and the residue was purified by column chromatography (petroleum ether: ethyl acetate = 10:1) to give 1,2-bis (2-bromoethoxy)ethane as a yellow oil (1.9 g, 69%). ^{1}H NMR ($CDCl_3$, 400 MHz): δ 3.44 (t, J = 1.2 Hz, 4H), 3.65 (s, 4H), 3.79 (t, J = 1.2 Hz, 4H).

Cross-linker 3.[1] 1,2-Bis(2-bromoethoxy)ethane (304 mg, 1.0 mmol) and thiourea (365.8 mg, 4.8 mmol) were dissolved in 95% ethanol (30 mL). The reaction mixture was stirred under reflux for 3hr, and then a solution of 1 M sodium hydroxide (20 mL) was added and continued to reflux for another 2 hr. The aqueous layer was separated and acidified (pH = 1) by the addition of diluted hydrochloric acid (2.0 M). The acidic solution was then extracted with petroleum ether (3 × 30 mL). The organic phase was combined and washed with brine and dried over anhydrous $MgSO_4$. The solvent was removed under vacuum and the residue was purified by column chromatography (petroleum ether: ethyl acetate = 3:1) to give compound **3** as a colorless oil (156 mg, 85.7%). ^{1}H NMR ($CDCl_3$, 400 MHz): δ 1.56 (t, J = 1.6 Hz, 2H), 2.66−2.72 (m, 4H), 3.60−3.63 (m, 8H).

Scheme 2S. Synthesis of photo-initiator MBS[2]



To 12.2 g of fuming sulfuric acid, a solution of sulfonation of 2-benzyl-2-(dimethylamino)-1-(4-morpholinophenyl)-1-butanone (BDMB, 3.5 g, 9.6 mmol) in chloroform (5 mL) was added slowly at room temperature. The reaction mixture was stirred for 1 hr, and then poured slowly into 500 mL of water. Barium carbonate (19.7 g, 100 mmol) was added to the solution until it was completely neutralized, and the precipitated barium sulfate was filtered off. The pH of the filtrate was adjusted to a pH of 10 with a calibrated NaOH solution (0.1 M). The filtrate was concentrated and the residue was purified by column chromatography (dichloromethane : methanol = 10:1) to give the water-soluble sodium 4-[2-(4-morpholino)benzoyl-2-dimethylamino]-butylbenzenesulfonate (MBS) as a pale white powder (3.5 g, 75.3%). ^{1}H NMR (DMSO-d_6, 400 MHz): δ 0.54−0.60 (m, 3H), 1.72−1.96 (m, 2H), 2.29 (s, 6H), 3.09 (s, 2H), 3.25−3.28 (t, 4H), 3.71−3.72 (t, 4H), 6.91−3.93 (d, J = 8 Hz, 2H), 7.15−7.17 (d, J = 8 Hz, 2H), 7.44−7.46 (d, J = 8 Hz, 2H), 8.21−8.24 (d, J = 12 Hz, 2H).

References

1 C. Li, S. Zhang, J. Pang, Y. Wu and Z. Gu, *Adv. Funct. Mater.* 2015, **25**, 3764−3774.

2 K. Kojima, M. Ito, H. Morishita and N. Hayashi, *Chem. Mater.* 1998,**10**, 3429−3433.

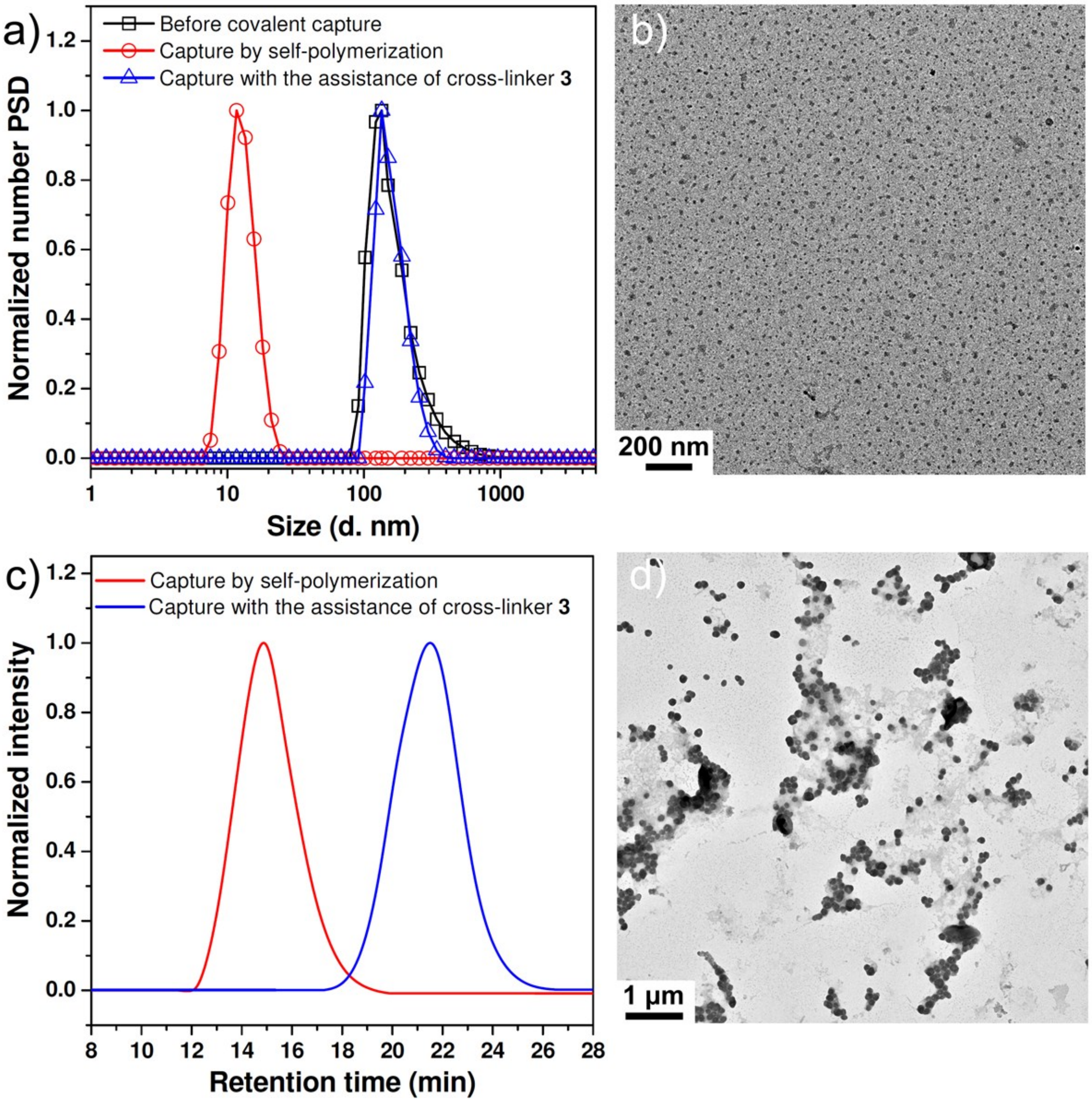


Figure S1. Characterization of supramolecular species formed in an aqueous solution of hydroxyethyl acrylate **2** in the presence of decane (0.1 wt%) upon different capturing methods. (a) Distribution of the hydrodynamic diameters of the supramolecular species itself after self-polymerization and after polymerization with the assistance of cross-linker **3**. (b) TEM micrograph after self-polymerization. (c) GPC curve of the supramolecular species after self-polymerization (M_n = 6.30 × 10^3, PDI = 1.98) and after polymerization with the assistance of cross-linker **3** (M_n = 4.78 × 10^5, PDI = 1.91). (d) TEM micrograph after polymerization with the assistance of cross-linker **3**.

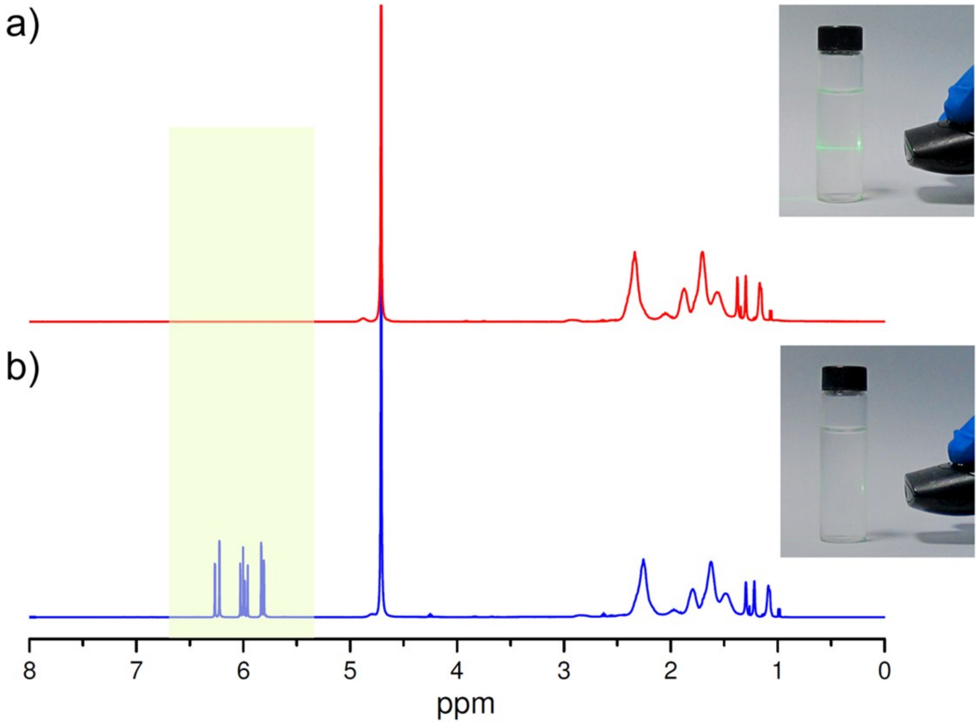


Figure S2. Comparison of ^1H NMR spectra of supramolecular species formed by compound **1** in D_2O in the presence of decane after 30 min of self-polymerization (a) and the homogeneous solution of compound **1** in D_2O in the absence of decane after 30 min of self-polymerization (b). The insets show the photographs of corresponding solutions irradiated with a 532 ± 10 nm continuous laser.

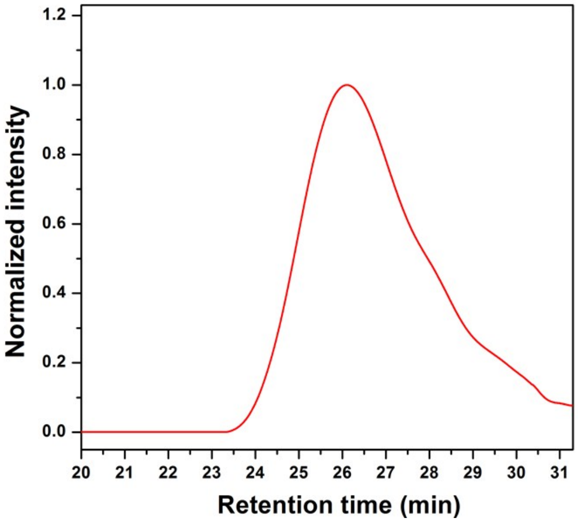


Figure S3. GPC curve of the homogeneous solution of acrylic acid after 30 min of self-polymerization in the absence of impurities ($M_n = 0.82 \times 10^3$, PDI = 2.55).

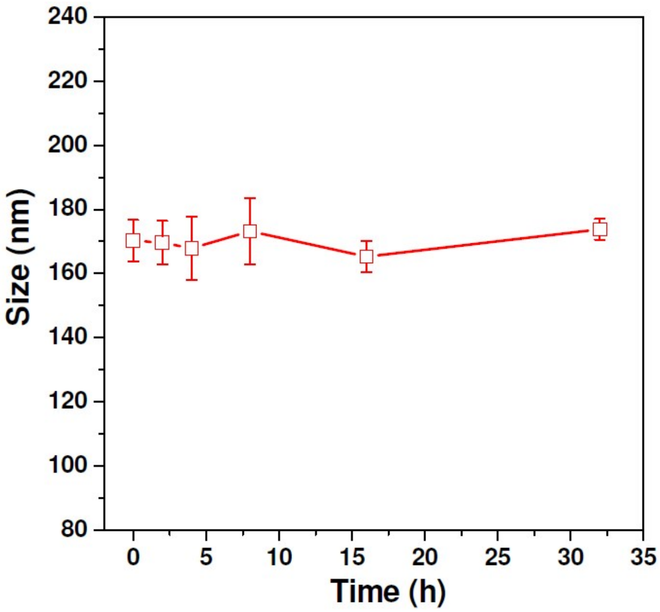
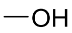
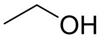
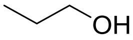
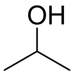
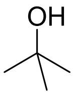
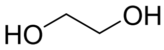
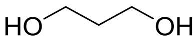
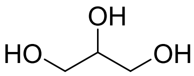
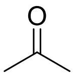
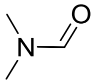
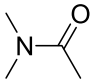
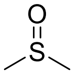
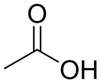
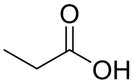
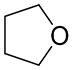
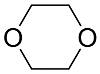
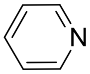


Figure S4. Particle sizes of supramolecular species formed by acrylic acid **1** after incubation with 0.02% MBS photo-initiator at room temperature. [**1**] = 0.73 M.

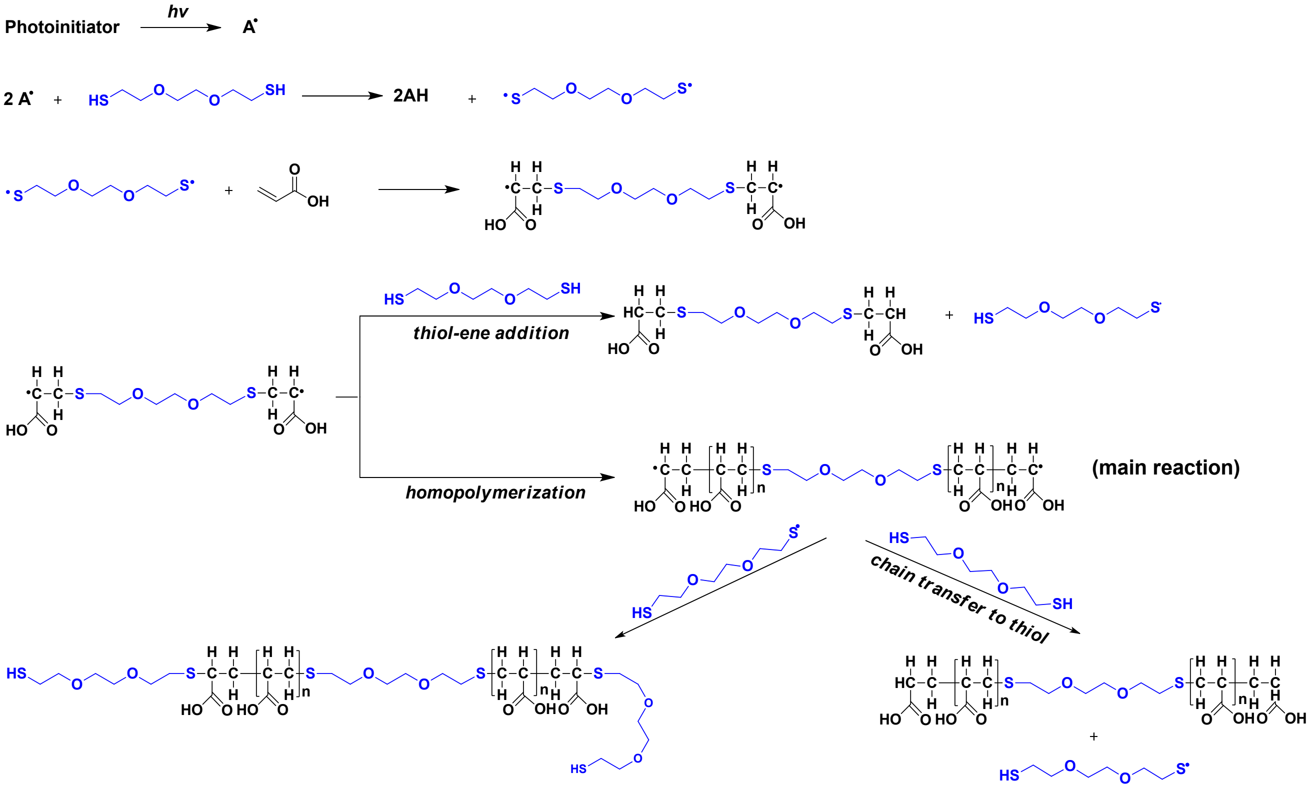
Table S1. Investigation by DLS measurements of the formation of supramolecular species in an aqueous solution of various water-miscible small organic molecules.[a]

Entry	Structure	Count Rate (kcps)	Polydispersity	Size (nm)
1		357.7	0.094	130 ± 2.3
2		146.1	0.050	194 ± 9.9
3		341.8	0.073	128 ± 7.7
4		334	0.254	307 ± 9.3
5		211.8	0.142	195 ± 2.8
6		**84.6**	**1.0**	—[b]
7		154.0	0.112	172 ± 23.0
8		**3.2**	**1.0**	—[b]
9		193.7	0.072	189 ± 12.7

10		458.9	0.110	130 ± 7.5
11		207.0	0.054	235 ± 4.5
12		235.7	0.146	342 ± 5.8
13		155.8	0.213	254 ± 14
14		154.7	0.113	324 ± 4.2
15		275	0.215	326 ± 20.5
16		**53.6**	**1.0**	—[b]
17		181.0	0.025	156 ± 9.4

[a] Condition: Small organic molecules (100 μL), decane (0.1 wt%), H_2O (2.0 mL), room temperature. [b] The measured size is meaningless when the polydispersity is a value of 1.0.

Scheme S3. Reaction mechanism of thiol-involved covalent capture of supramolecular species in aqueous solution of water-miscible small organic molecules.



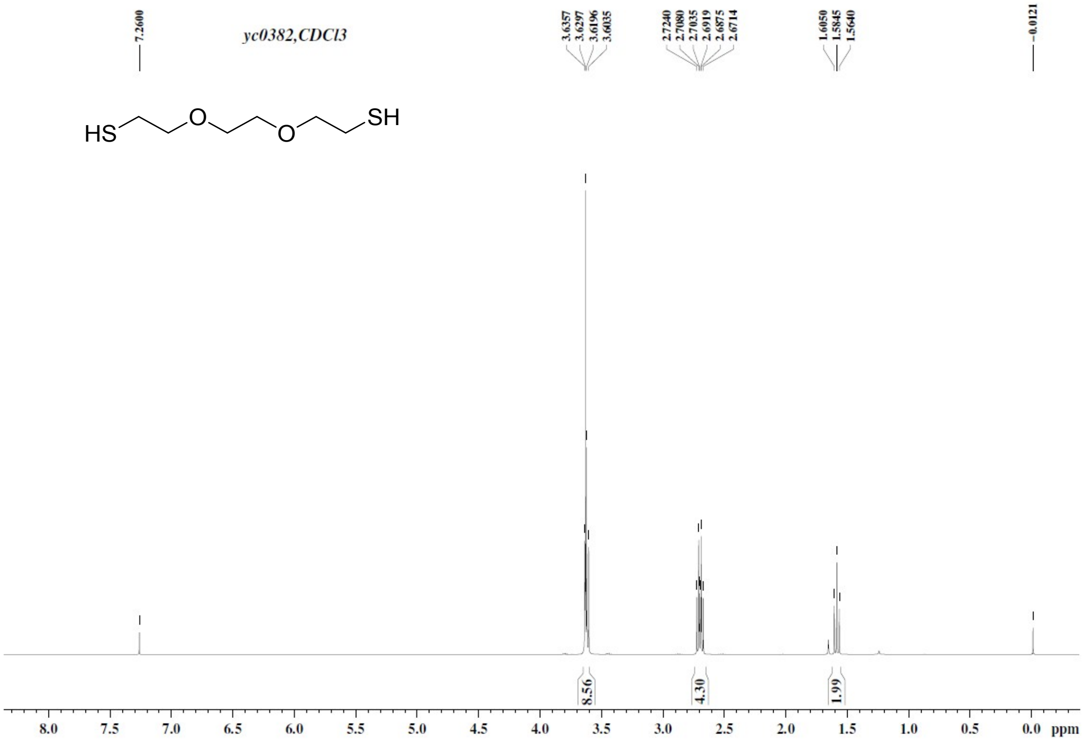


Figure S5. ^{1}H NMR spectrum of cross-linker **3** in CDCl$_3$.

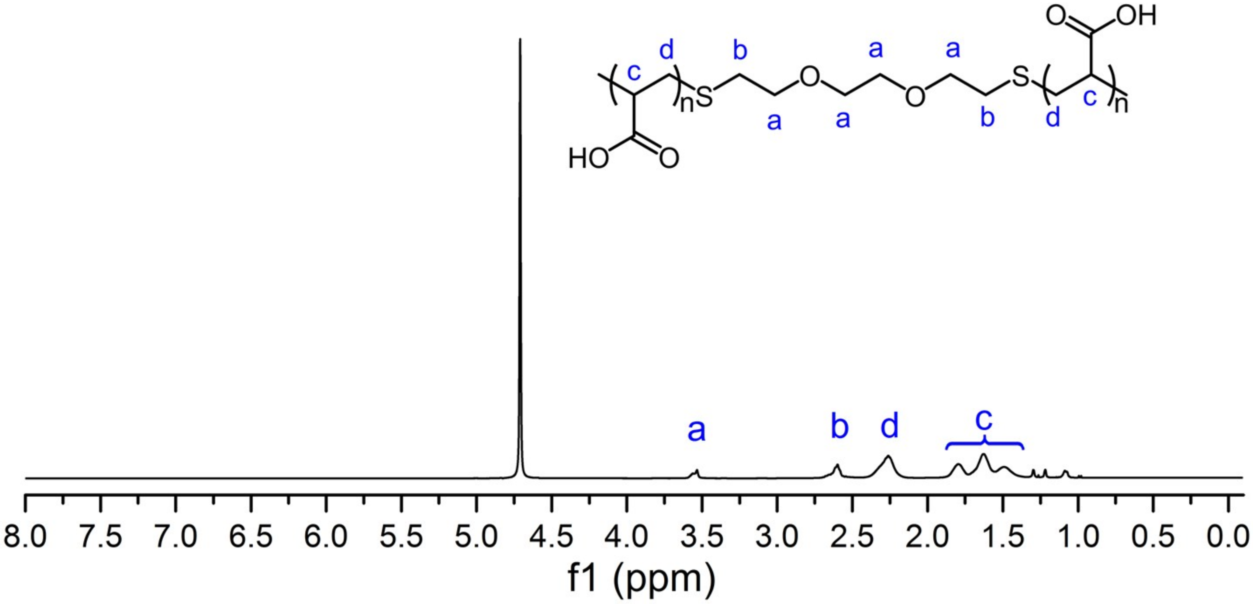


Figure S6. ^{1}H NMR spectrum of supramolecular species formed in an aqueous solution of compound **1** after polymerization with the assistance of thiol cross-linker **3**.

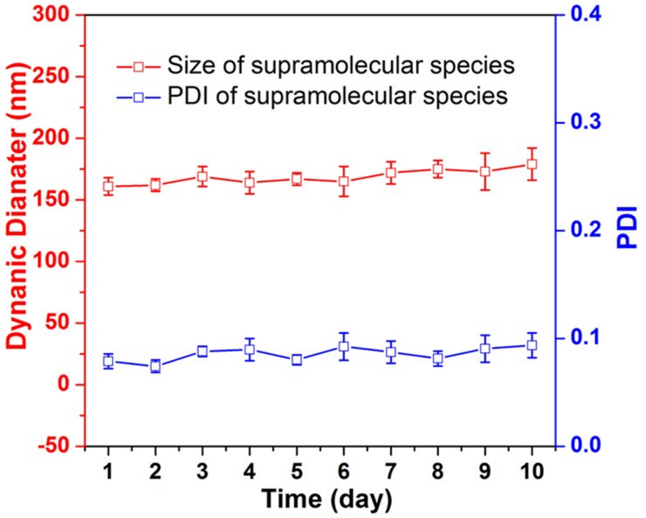


Figure S7. Size and PDI (particle dispersion index) of supramolecular species formed in an aqueous solution of acrylic acid **1** in the presence of decane (0.1 wt%) over time.