

Electronic Supplementary Information (ESI)

Supramolecular organogels fabricated with dicarboxylic acids and primary alkyl amines: controllable self-assembled structure

Lieqiang Liao,^{ab‡} Xiang Zhong,^{b‡} Xinjian Jia,^b Caiyun Liao,^b Jinlian Zhong,^b Shunmin Ding,^a Chao Chen,^{*a} Sanguo Hong^{*a} and Xuzhong Luo^{*b}

^a Key Laboratory of Jiangxi Province for Environment and Energy Catalysis, College of Chemistry, Nanchang University, Nanchang 330031, P. R. China. E-mail: chaochen@ncu.edu.cn; honganguo2020@163.com

^b Key Laboratory of Organo-Pharmaceutical Chemistry of Jiangxi Province, College of Chemistry and Chemical Engineering, Gannan Normal University, Ganzhou 341000, P. R. China. E-mail: luoxuzhong@hotmail.com

[‡] These authors contributed equally to this work.

Table S1. Gelation data of dicarboxylic acids.

Number	Solvents		Dicarboxylic acids			
	Name	Polarity	TBA	ODA	IDA	PDA
1	H ₂ O	SP	S	S	S	S
2	DMSO	SP	I	S	I	S
3	Ethylene glycol	SP	I	S	I	S
4	Methanol	SP	I	S	I	S
5	Ethanol	SP	I	S	I	S
6	<i>n</i> -Amyl alcohol	MP	I	S	I	S
7	Aminobenzene	SP	I	S	I	S
8	DMF	SP	I	S	I	S
9	<i>o</i> -Xylene	MP	I	I	I	I
10	<i>m</i> -Xylene	MP	I	I	I	I
11	Mesitylene	MP	I	I	I	I
12	Nitrobenzene	MP	I	I	I	I
13	Tetralin	MP	I	I	I	I
14	<i>n</i> -Butyl methacrylate	MP	I	I	I	I
15	CH ₂ Cl ₂	MP	I	I	I	I
16	Pyridine	MP	I	S	I	S
17	CHCl ₃	MP	I	I	I	I
18	Ethyl acetate	MP	I	S	I	S
19	<i>o</i> -Dichlorobenzene	MP	I	I	I	I
20	Tetrahydrofuran	MP	I	I	I	I
21	Chlorobenzene	MP	I	I	I	I
22	Aether	MP	I	I	I	I
23	Benzene	MP	I	I	I	I
24	Isopropyl ether	MP	I	I	I	I
25	<i>p</i> -Xylene	MP	I	I	I	I
26	Toluene	MP	I	I	I	I
27	Triethylamine	MP	I	S	I	I
28	Triethanolamine	MP	S	I	S	I
29	CCl ₄	WP	I	I	I	I
30	Cyclohexane	WP	I	I	I	I
31	Petroleum ether	WP	I	I	I	I

* S = solution; I = insoluble. SP = strong polarity; MP = medium polarity; WP = weakly polarity.

Table S2. Gelation data of dicarboxylic acids.

	Solvents	Dicarboxylic acids			
		TDA	TPA	DPA	EDA
1	H ₂ O	S	S	S	S
2	DMSO	S	S	S	S
3	Ethylene glycol	S	S	S	S
4	Methanol	S	S	S	S
5	Ethanol	S	S	S	S
6	<i>n</i> -Amyl alcohol	S	S	S	S
7	Aminobenzene	S	S	S	S
8	DMF	S	S	S	S
9	<i>o</i> -Xylene	I	I	I	I
10	<i>m</i> -Xylene	I	I	I	I
11	Mesitylene	I	I	I	I
12	Nitrobenzene	S	S	S	S
13	Tetralin	I	I	I	S
14	<i>n</i> -Butyl methacrylate	I	S	S	S
15	CH ₂ Cl ₂	I	I	I	I
16	Pyridine	S	S	S	S
17	CHCl ₃	I	I	I	I
18	Ethyl acetate	I	I	I	I
19	<i>o</i> -Dichlorobenzene	I	I	I	I
20	Tetrahydrofuran	I	I	I	I
21	Chlorobenzene	I	I	I	I
22	Aether	I	I	S	S
23	Benzene	I	I	I	I
24	Isopropyl ether	I	I	I	I
25	<i>p</i> -Xylene	I	I	I	I
26	Toluene	I	I	I	I
27	Triethylamine	S	S	S	S
28	Triethanolamine	S	S	S	S
29	CCl ₄	I	I	I	I
30	Cyclohexane	I	I	I	I
31	Petroleum ether	I	I	I	I

* S = solution; I = insoluble.

Table S3. Gelation data of primary alkyl amine R-NH₂ (R₁₂, R₁₄, R₁₆, R₁₈).

	Solvents	R-NH ₂			
		R ₁₂	R ₁₄	R ₁₆	R ₁₈
1	H ₂ O	I	I	I	I
2	DMSO	S	S	S	P
3	Ethylene glycol	S	S	S	P
4	Methanol	S	S	S	S
5	Ethanol	S	S	S	S
6	<i>n</i> -Amyl alcohol	S	S	S	S
7	Aminobenzene	S	P	P	P
8	DMF	S	P	P	P
9	<i>o</i> -Xylene	S	S	S	P
10	<i>m</i> -Xylene	S	S	S	P
11	Mesitylene	S	S	S	P
12	Nitrobenzene	S	S	S	P
13	Tetralin	S	S	S	S
14	<i>n</i> -Butyl methacrylate	S	P	P	P
15	CH ₂ Cl ₂	S	S	S	S
16	Pyridine	S	P	P	P
17	CHCl ₃	S	S	S	S
18	Ethyl acetate	S	S	S	S
19	<i>o</i> -Dichlorobenzene	S	S	S	S
20	Tetrahydrofuran	S	P	P	P
21	Chlorobenzene	S	S	S	S
22	Aether	S	P	P	P
23	Benzene	S	S	S	S
24	Isopropyl ether	S	S	P	P
25	<i>p</i> -Xylene	S	S	S	S
26	Toluene	S	S	S	S
27	Triethylamine	S	P	P	P
28	Triethanolamine	S	P	P	P
29	CCl ₄	S	P	P	P
30	Cyclohexane	S	S	S	S
31	Petroleum ether	S	S	S	S

* S = solution; P = precipitate; I = insoluble.

Table S4. Gelation data of TBA-R₁₂, TBA-R₁₄, TBA-R₁₆ and TBA-R₁₈.

	Solvents	TBA-R _n			
		TBA-R ₁₂	TBA-R ₁₄	TBA-R ₁₆	TBA-R ₁₈
1	H ₂ O	S	P	P	S
2	DMSO	S	S	S	S
3	Ethylene glycol	I	S	S	S
4	Methanol	I	I	I	I
5	Ethanol	I	P	P	I
6	<i>n</i> -Amyl alcohol	I	I	I	I
7	Aminobenzene	I	S	S	S
8	DMF	S	S	S	I
9	<i>o</i> -Xylene	I	I	I	I
10	<i>m</i> -Xylene	I	I	I	I
11	Mesitylene	I	I	I	I
12	Nitrobenzene	I	I	I	I
13	Tetralin	I	I	I	I
14	<i>n</i> -Butyl methacrylate	I	I	I	I
15	CH ₂ Cl ₂	I	I	I	I
16	Pyridine	I	I	I	I
17	CHCl ₃	I	P	P	I
18	Ethyl acetate	I	I	I	I
19	<i>o</i> -Dichlorobenzene	I	I	I	I
20	Tetrahydrofuran	I	I	I	I
21	Chlorobenzene	I	I	I	I
22	Aether	I	I	I	I
23	Benzene	I	I	I	I
24	Isopropyl ether	I	P	P	I
25	<i>p</i> -Xylene	I	I	I	I
26	Toluene	I	I	I	I
27	Triethylamine	I	P	P	I
28	Triethanolamine	I	I	I	I
29	CCl ₄	I	I	I	I
30	Cyclohexane	I	I	I	I
31	Petroleum ether	I	I	I	I

* S = solution; P = precipitate; I = insoluble.

Table S5. Gelation data of ODA-R₁₂, ODA-R₁₄, ODA-R₁₆ and ODA-R₁₈.

	Solvents	ODA-R _n			
		ODA-R ₁₂	ODA-R ₁₄	ODA-R ₁₆	ODA-R ₁₈
1	H ₂ O	P	P	P	P
2	DMSO	P	P	P	P
3	Ethylene glycol	S	P	P	P
4	Methanol	S	S	S	P
5	Ethanol	S	P	P	P
6	<i>n</i> -Amyl alcohol	S	P	P	P
7	Aminobenzene	P	P	P	S
8	DMF	P	P	P	P
9	<i>o</i> -Xylene	P	P	P	I
10	<i>m</i> -Xylene	P	P	P	I
11	Mesitylene	P	P	P	I
12	Nitrobenzene	S	S	S	I
13	Tetralin	S	S	S	I
14	<i>n</i> -Butyl methacrylate	P	P	P	S
15	CH ₂ Cl ₂	P	I	I	I
16	Pyridine	P	P	P	S
17	CHCl ₃	P	I	I	I
18	Ethyl acetate	P	I	I	I
19	<i>o</i> -Dichlorobenzene	S	S	S	S
20	Tetrahydrofuran	P	P	P	P
21	Chlorobenzene	S	S	S	S
22	Aether	I	I	I	I
23	Benzene	I	I	I	I
24	Isopropyl ether	I	I	I	P
25	<i>p</i> -Xylene	I	I	I	I
26	Toluene	I	I	I	I
27	Triethylamine	P	P	P	S
28	Triethanolamine	S	S	S	S
29	CCl ₄	S	S	S	S
30	Cyclohexane	I	I	I	I
31	Petroleum ether	P	I	I	I

* S = solution; P = precipitate; I = insoluble.

Table S6. Gelation data of IDA-R₁₂, IDA-R₁₄, IDA-R₁₆ and IDA-R₁₈.

Solvents	IDA-R _n			
	IDA-R ₁₂	IDA-R ₁₄	IDA-R ₁₆	IDA-R ₁₈
1 H ₂ O	I	S	P	S
2 DMSO	P	I	P	P
3 Ethylene glycol	I	I	I	I
4 Methanol	I	I	I	I
5 Ethanol	I	I	I	I
6 <i>n</i> -Amyl alcohol	I	P	I	P
7 Aminobenzene	I	I	I	I
8 DMF	I	I	S	I
9 <i>o</i> -Xylene	I	I	I	I
10 <i>m</i> -Xylene	I	I	I	I
11 Mesitylene	I	I	I	I
12 Nitrobenzene	I	I	I	I
13 Tetralin	I	I	I	I
14 <i>n</i> -Butyl methacrylate	I	P	I	P
15 CH ₂ Cl ₂	I	I	I	I
16 Pyridine	P	I	I	I
17 CHCl ₃	I	P	I	P
18 Ethyl acetate	I	I	I	I
19 <i>o</i> -Dichlorobenzene	I	I	I	I
20 Tetrahydrofuran	I	I	I	I
21 Chlorobenzene	I	I	I	I
22 Aether	I	I	I	I
23 Benzene	I	I	I	I
24 Isopropyl ether	I	P	I	P
25 <i>p</i> -Xylene	I	I	I	I
26 Toluene	I	I	I	I
27 Triethylamine	I	I	I	P
28 Triethanolamine	I	I	I	I
29 CCl ₄	I	P	I	I
30 Cyclohexane	I	I	I	I
31 Petroleum ether	I	I	I	P

* S = solution; P = precipitate; I = insoluble.

Table S7. Gelation data of PDA-R₁₂, PDA-R₁₄, PDA-R₁₆ and PDA-R₁₈.

Solvents	PDA-R _n			
	PDA-R ₁₂	PDA-R ₁₄	PDA-R ₁₆	PDA-R ₁₈
1 H ₂ O	S	S	I	I
2 DMSO	S	G	G	G
3 Ethylene glycol	S	S	G	G
4 Methanol	S	S	S	S
5 Ethanol	S	S	P	G
6 <i>n</i> -Amyl alcohol	S	S	S	G
7 Aminobenzene	G	G	S	S
8 DMF	S	S	G	G
9 <i>o</i> -Xylene	S	S	S	P
10 <i>m</i> -Xylene	S	G	G	G
11 Mesitylene	S	S	G	S
12 Nitrobenzene	S	S	S	G
13 Tetralin	P	G	S	G
14 <i>n</i> -Butyl methacrylate	P	P	G	G
15 CH ₂ Cl ₂	P	S	S	P
16 Pyridine	P	P	S	S
17 CHCl ₃	S	S	S	S
18 Ethyl acetate	P	P	I	I
19 <i>o</i> -Dichlorobenzene	P	S	G	S
20 Tetrahydrofuran	P	S	I	S
21 Chlorobenzene	S	S	G	S
22 Aether	I	P	I	P
23 Benzene	S	S	G	S
24 Isopropyl ether	I	P	I	I
25 <i>p</i> -Xylene	S	S	G	G
26 Toluene	S	S	G	S
27 Triethylamine	S	S	G	S
28 Triethanolamine	S	S	S	S
29 CCl ₄	S	S	S	S
30 Cyclohexane	P	I	G	S
31 Petroleum ether	I	I	I	I

* G = gel; S = solution; P = precipitate; I = insoluble.

Table S8. Gelation data of TDA-R₁₂, TDA-R₁₄, TDA-R₁₆ and TDA-R₁₈.

Solvents	TDA-R _n			
	TDA-R ₁₂	TDA-R ₁₄	TDA-R ₁₆	TDA-R ₁₈
1 H ₂ O	I	I	I	I
2 DMSO	S	S	S	S
3 Ethylene glycol	S	G	G	G
4 Methanol	S	G	G	G
5 Ethanol	S	S	S	S
6 <i>n</i> -Amyl alcohol	S	S	S	S
7 Aminobenzene	S	S	S	S
8 DMF	S	S	S	S
9 <i>o</i> -Xylene	S	S	S	S
10 <i>m</i> -Xylene	S	S	S	S
11 Mesitylene	S	S	S	S
12 Nitrobenzene	S	S	S	S
13 Tetralin	S	S	S	S
14 <i>n</i> -Butyl methacrylate	S	S	S	S
15 CH ₂ Cl ₂	S	S	S	S
16 Pyridine	S	S	S	S
17 CHCl ₃	S	S	S	S
18 Ethyl acetate	G	G	G	G
19 <i>o</i> -Dichlorobenzene	S	S	S	S
20 Tetrahydrofuran	G	G	G	G
21 Chlorobenzene	S	S	S	S
22 Aether	P	P	P	P
23 Benzene	G	G	G	G
24 Isopropyl ether	S	S	S	S
25 <i>p</i> -Xylene	G	G	G	G
26 Toluene	G	G	G	G
27 Triethylamine	S	S	S	S
28 Triethanolamine	S	S	S	S
29 CCl ₄	S	S	S	S
30 Cyclohexane	G	G	G	G
31 Petroleum ether	G	G	G	G

* G = gel; S = solution; P = precipitate; I = insoluble.

Table S9. Gelation data of TPA-R₁₂, TPA-R₁₄, TPA-R₁₆ and TPA-R₁₈.

Solvents	TPA-R _n			
	TPA-R ₁₂	TPA-R ₁₄	TPA-R ₁₆	TPA-R ₁₈
1 H ₂ O	I	I	I	I
2 DMSO	S	G	G	G
3 Ethylene glycol	G	G	G	G
4 Methanol	S	G	G	G
5 Ethanol	S	G	G	G
6 <i>n</i> -Amyl alcohol	S	G	G	G
7 Aminobenzene	S	G	G	G
8 DMF	S	S	S	S
9 <i>o</i> -Xylene	S	S	S	S
10 <i>m</i> -Xylene	S	S	S	S
11 Mesitylene	S	S	S	S
12 Nitrobenzene	S	S	S	S
13 Tetralin	S	S	S	S
14 <i>n</i> -Butyl methacrylate	G	G	G	G
15 CH ₂ Cl ₂	G	G	G	G
16 Pyridine	G	G	G	G
17 CHCl ₃	S	S	S	S
18 Ethyl acetate	S	S	S	S
19 <i>o</i> -Dichlorobenzene	G	G	G	G
20 Tetrahydrofuran	G	G	G	G
21 Chlorobenzene	G	G	G	G
22 Aether	G	G	G	G
23 Benzene	G	G	G	G
24 Isopropyl ether	S	S	S	S
25 <i>p</i> -Xylene	G	G	G	G
26 Toluene	G	G	G	G
27 Triethylamine	S	S	S	S
28 Triethanolamine	S	S	S	S
29 CCl ₄	G	G	G	G
30 Cyclohexane	G	G	G	G
31 Petroleum ether	S	S	S	S

* G = gel; S = solution; P = precipitate; I = insoluble.

Table S10. Gelation data of EDA-R₁₂, EDA-R₁₄, EDA-R₁₆ and EDA-R₁₈.

Solvents	EDA-R _n			
	EDA-R ₁₈	EDA-R ₁₆	EDA-R ₁₄	EDA-R ₁₂
1 H ₂ O	I	I	I	I
2 DMSO	G	G	G	S
3 Ethylene glycol	G	G	G	S
4 Methanol	G	G	S	S
5 Ethanol	G	G	S	S
6 <i>n</i> -Amyl alcohol	G	G	G	S
7 Aminobenzene	G	G	G	S
8 DMF	G	G	G	S
9 <i>o</i> -Xylene	P	S	S	S
10 <i>m</i> -Xylene	P	S	S	S
11 Mesitylene	P	S	S	S
12 Nitrobenzene	G	G	G	S
13 Tetralin	P	S	S	S
14 <i>n</i> -Butyl methacrylate	G	G	G	S
15 CH ₂ Cl ₂	P	P	P	P
16 Pyridine	G	G	G	S
17 CHCl ₃	S	S	S	S
18 Ethyl acetate	P	P	P	P
19 <i>o</i> -Dichlorobenzene	G	G	G	S
20 Tetrahydrofuran	G	G	G	P
21 Chlorobenzene	G	G	G	S
22 Aether	I	I	I	I
23 Benzene	P	S	S	S
24 Isopropyl ether	G	G	G	P
25 <i>p</i> -Xylene	P	S	S	S
26 Toluene	P	S	S	S
27 Triethylamine	P	P	P	P
28 Triethanolamine	P	P	P	P
29 CCl ₄	P	P	P	P
30 Cyclohexane	G	G	G	S
31 Petroleum ether	P	P	P	P

* G = gel; S = solution; P = precipitate; I = insoluble.

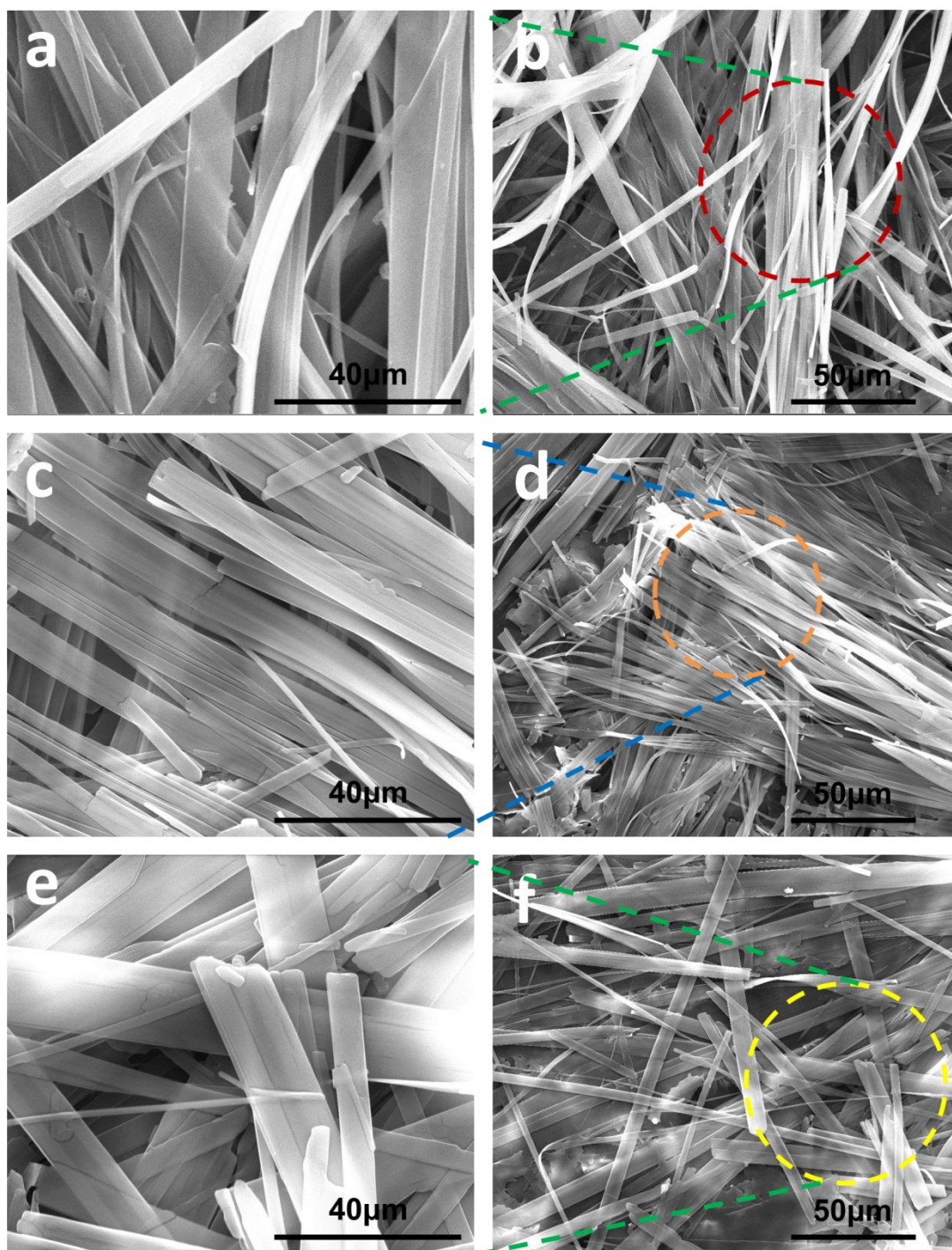


Figure S1. FE-SEM images of DPA-R₁₈ xerogels prepared with various solvents: (a, b) DMSO; (c, d) methanol; (e, f) ethanol.

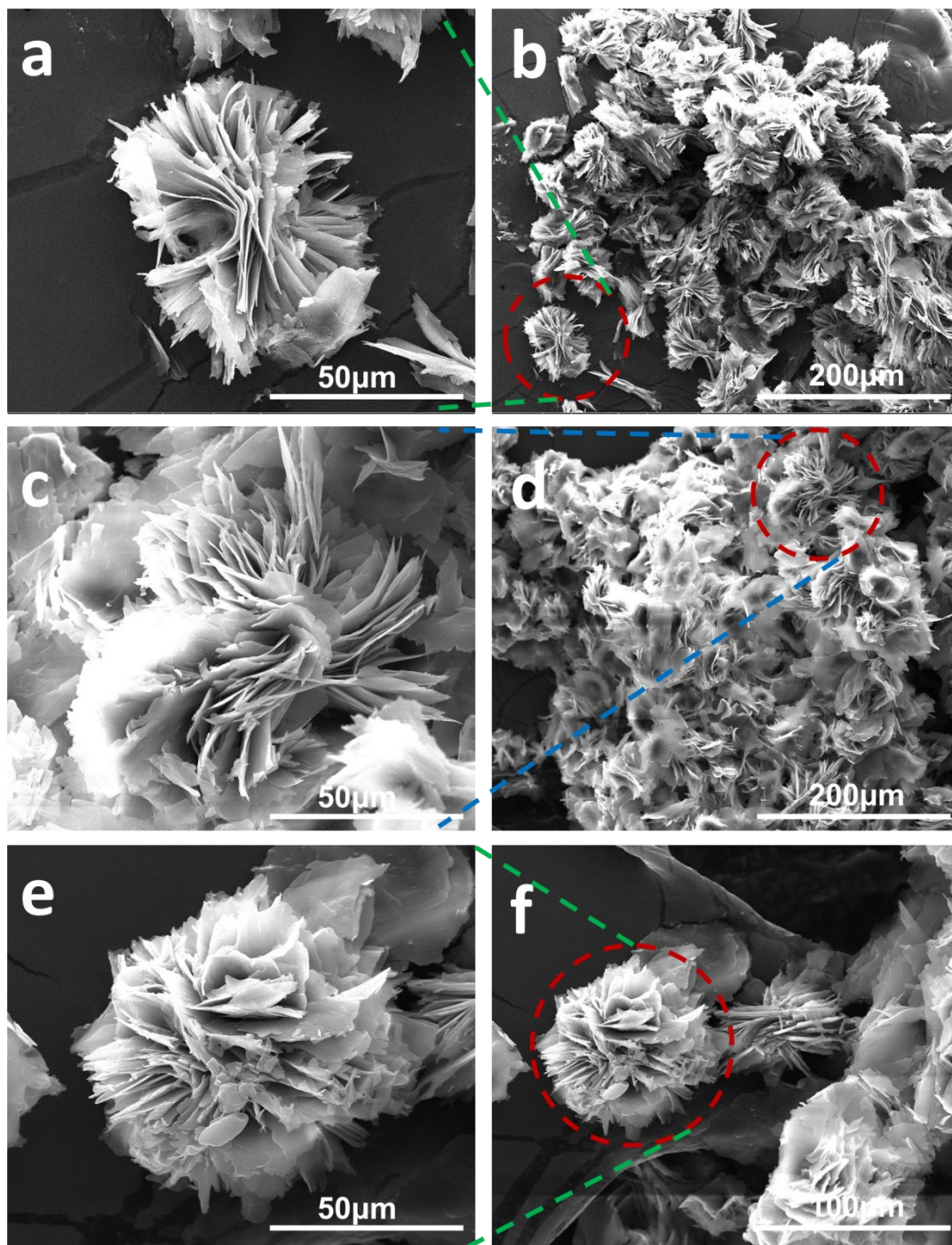


Figure S2. FE-SEM images of DPA-R₁₈ xerogels prepared with various solvents: (a, b) CH₂Cl₂; (c, d) pyridine; (e, f) CHCl₃.

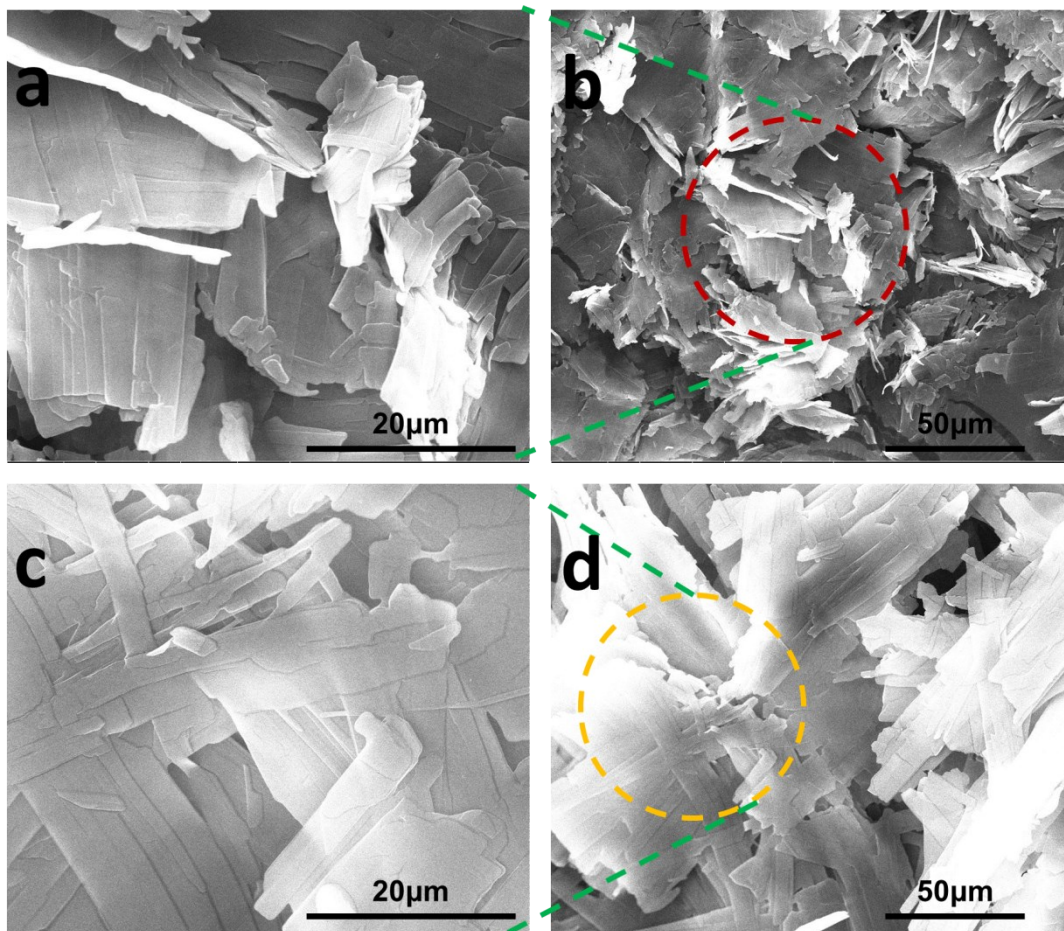


Figure S3. FE-SEM images of DPA-R₁₈ xerogels prepared with various solvents: (a, b) cyclohexane; (c, d) petroleum ether.

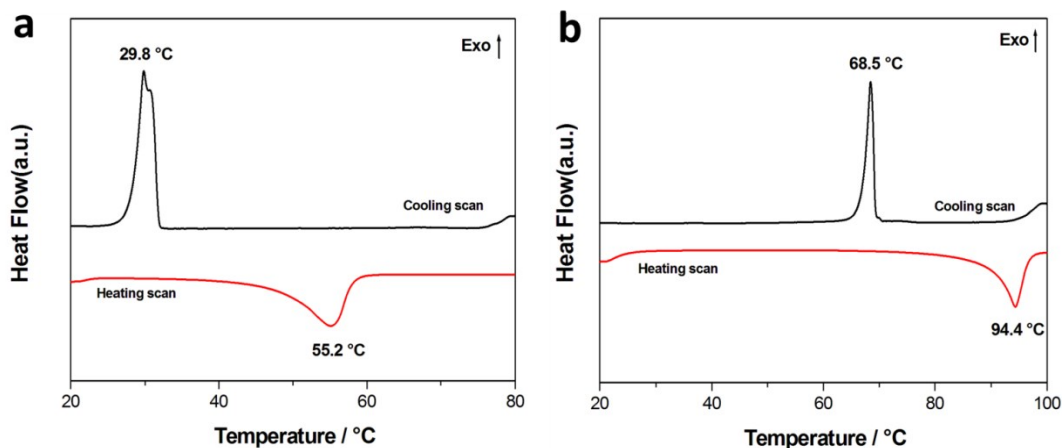


Figure S4. DSC thermograms of the gels formed from (a) DPA-R₁₈ in cyclohexane (7.49 wt.%) and (b) EDA-R₁₈ in DMF (7.49 wt.%).

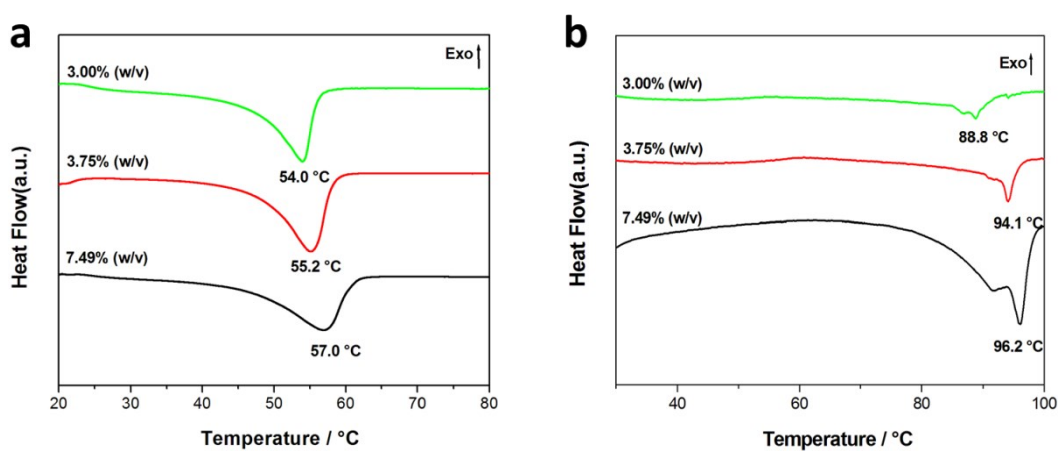


Figure S5. DSC thermograms of the gels formed from (a) DPA-R₁₈ in cyclohexane and (b) EDA-R₁₈ in DMSO with different gelator concentrations.

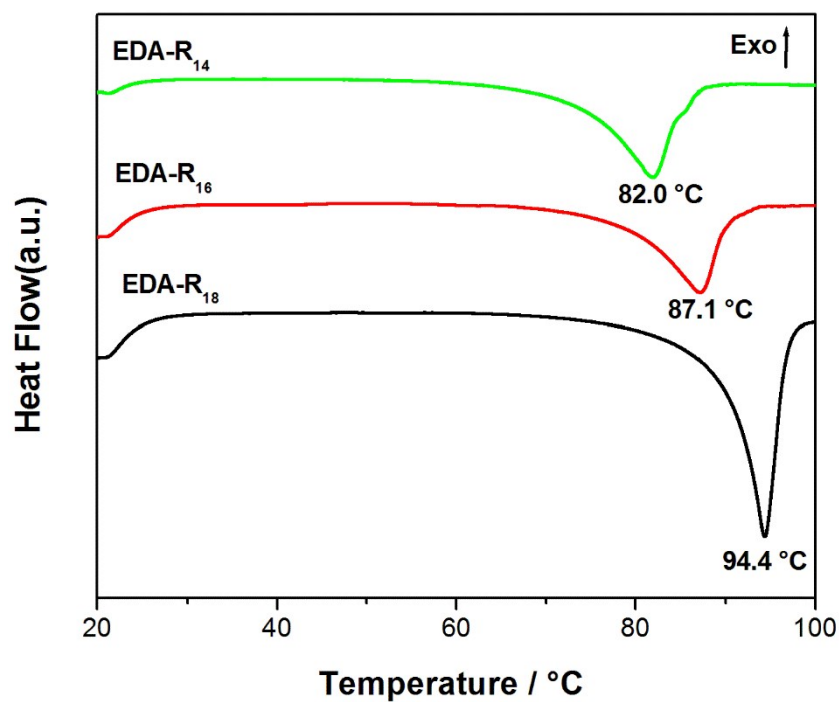


Figure S6. DSC thermograms of the gels formed from EDA-R₁₄, EDA-R₁₆ and EDA-R₁₈ in cyclohexane (7.49 wt.%).

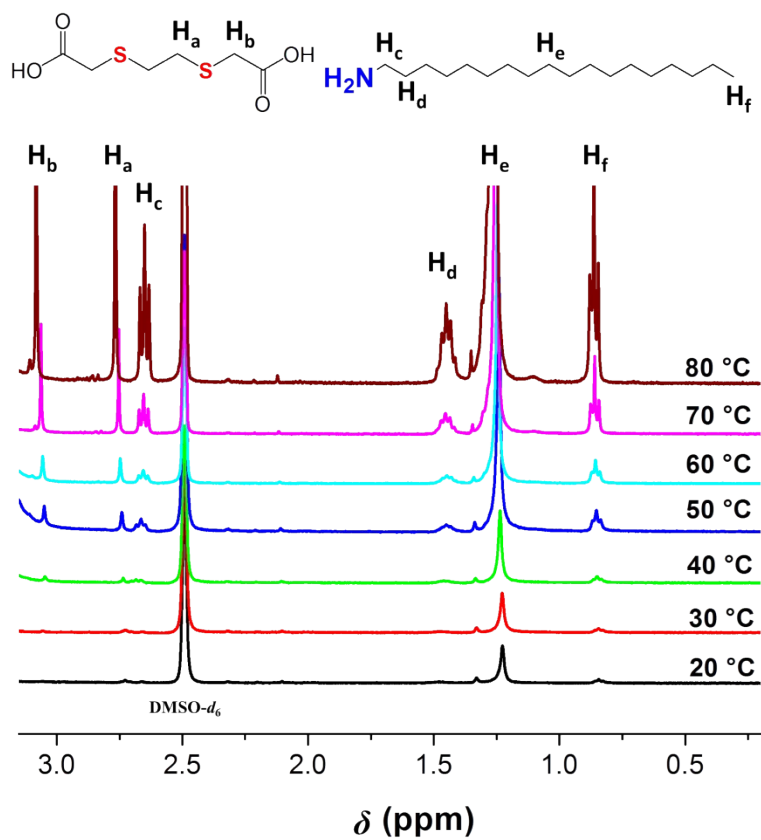


Figure S7. Variable-temperature ¹H NMR spectra of the gel formed from EDA-R₁₈ in DMSO-*d*₆.

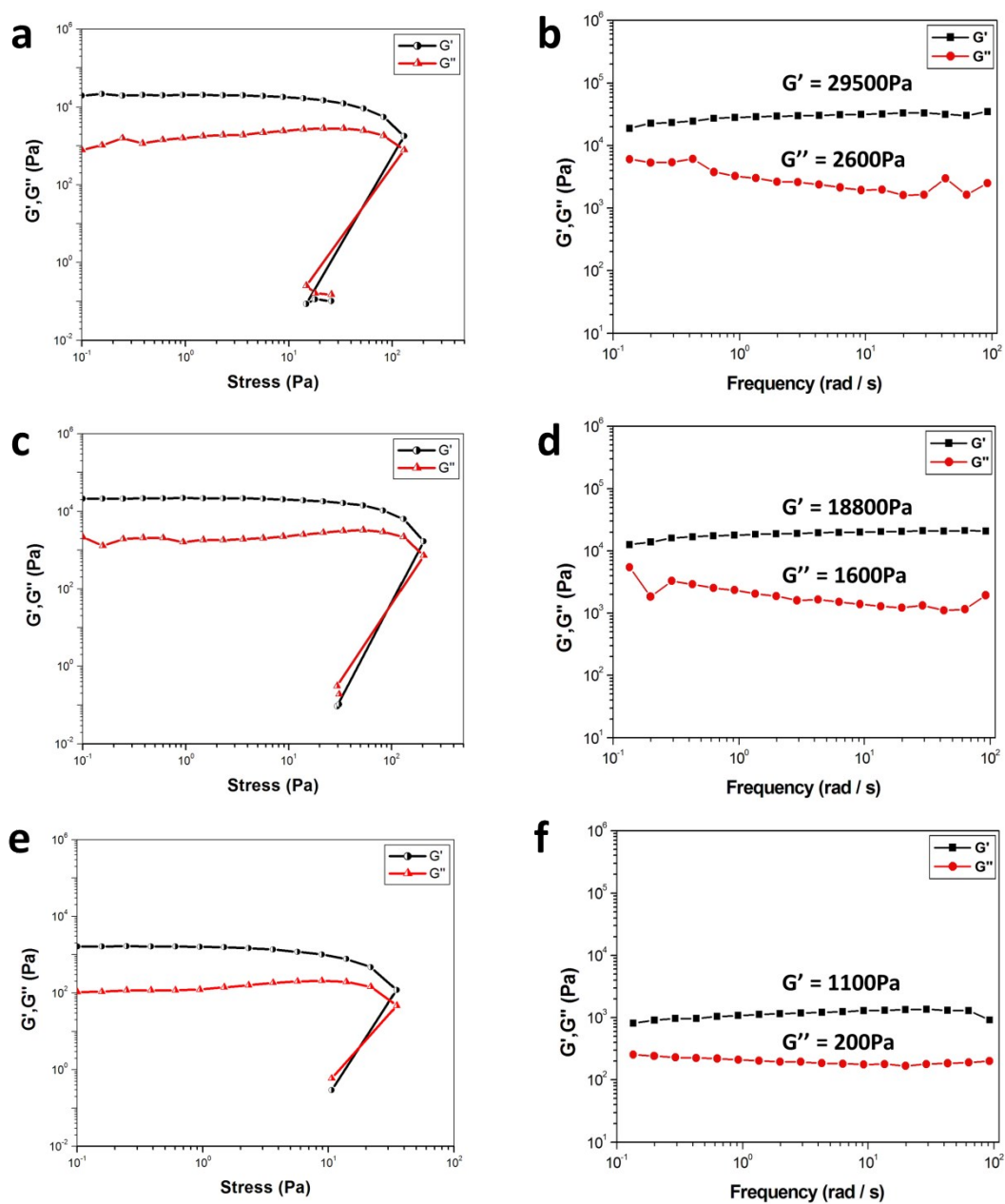


Figure S8. Rheological behaviors of the organogels formed separately from DPA-R₁₈, DPA-R₁₆ and DPA-R₁₄ in DMSO (7.49 wt.%): (a, c, e) strain sweep results and (b, d, f) frequency sweep results at a constant strain of 5Pa.

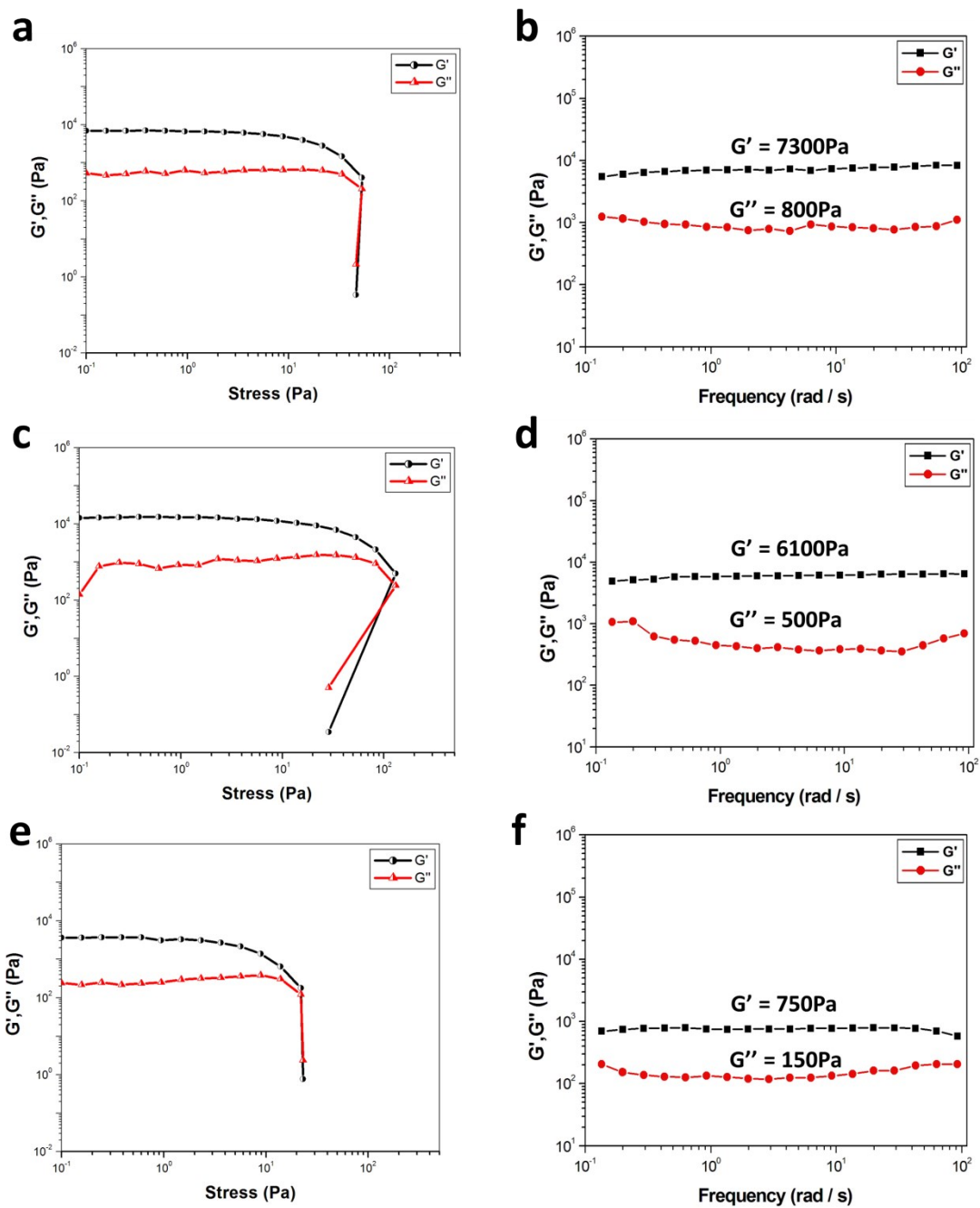


Figure S9. Rheological behaviors of the organogels formed separately from EDA-R₁₈, EDA-R₁₆ and EDA-R₁₄ in DMSO (7.49 wt.%): (a, c, e) strain sweep results and (b, d, f) frequency sweep results at a constant strain of 5Pa.

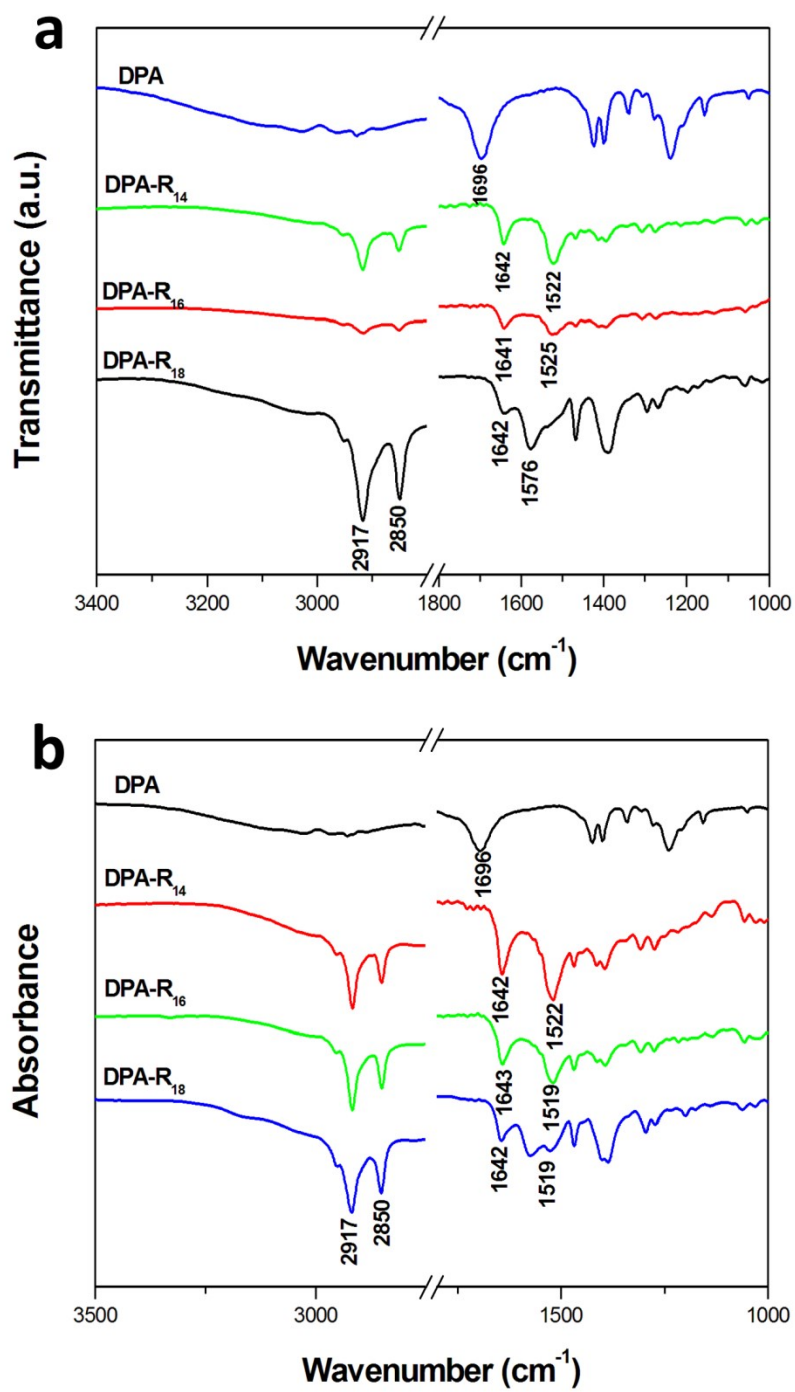


Figure S10. FT-IR spectra of DPA and the xerogels formed from DPA-R_n in (a) CHCl₃ and (b) cyclohexane, respectively.

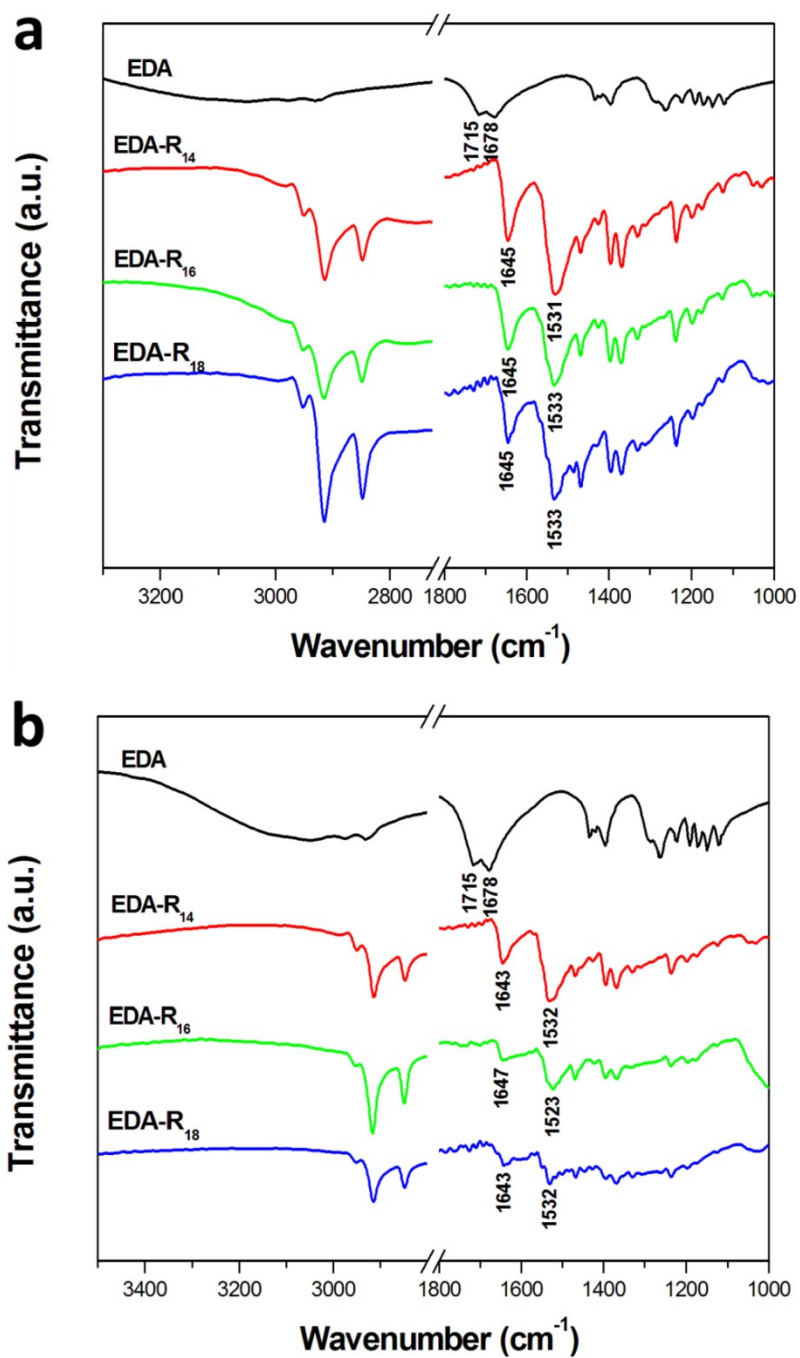


Figure S11. FT-IR spectra of EDA and the xerogels formed from EDA-R_n in (a) DMSO and (b) THF, respectively.

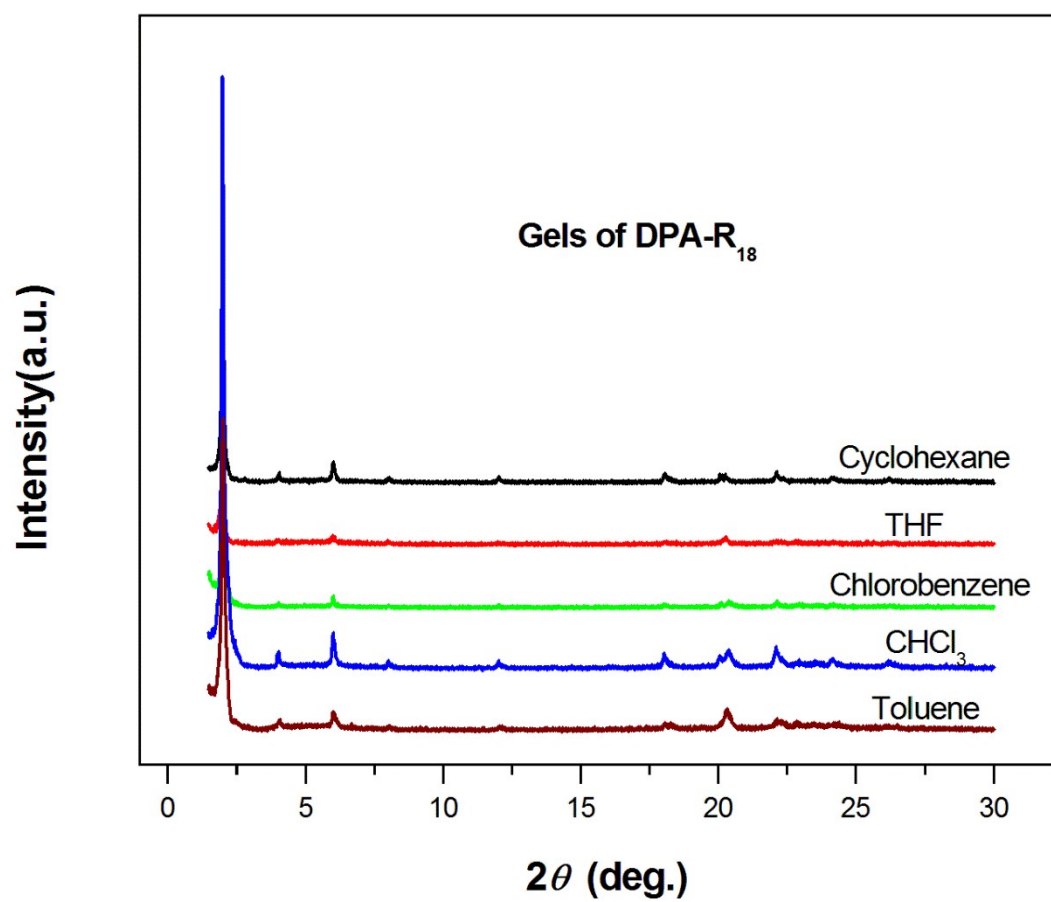


Figure S12. XRD patterns of DPA-R₁₈ xerogels in various organic solvents.