Electronic Supplementary Material (ESI) for Soft Matter.
This journal is © The Royal Society of Chemistry 2018

Supporting Information

Synthesis of layered double hydroxide/poly(*N*-isopropylacrylamide) nanocomposite hydrogels with excellent mechanical and thermoresponsive performances

Yaping Zhang,[a] Jingwen Ji,[a] Haiping Li,[b] Na Du,[a] Shue Song,[a] Wanguo Hou [a, b] *

[a] Key Laboratory of Colloid & Interface Chemistry (Ministry of Education), Shandong University, Jinan, 250100, China.

[b] National Engineering Technology Research Center for Colloidal Materials, Shandong University, Jinan, 250100, China.

Fig. S1 Photographs of the BIS/PNIPAM and LDHs/PNIPAM hydrogels.

Upper: The hydrogels were synthesized in columnar glass vessels.

Lower: The hydrogels keep the shape of the vessels.

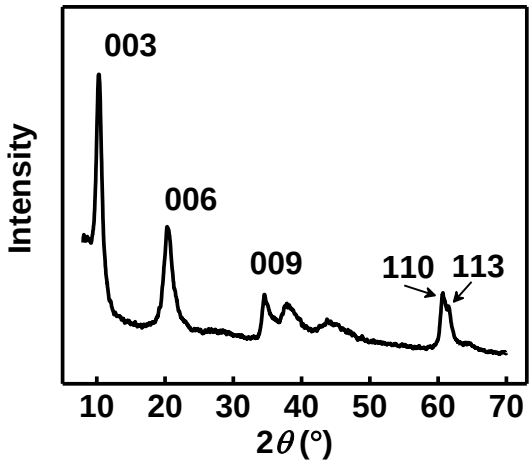

Fig. S2 XRD patterns of bulk Mg-Al-NO_3^- LDHs.

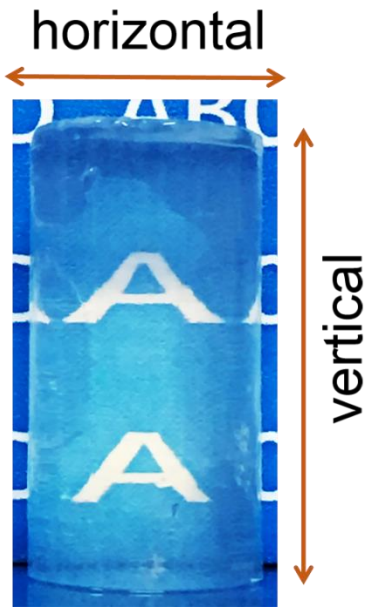

Fig. S3 Illustration of horizontal and vertical directions for SEM observations.

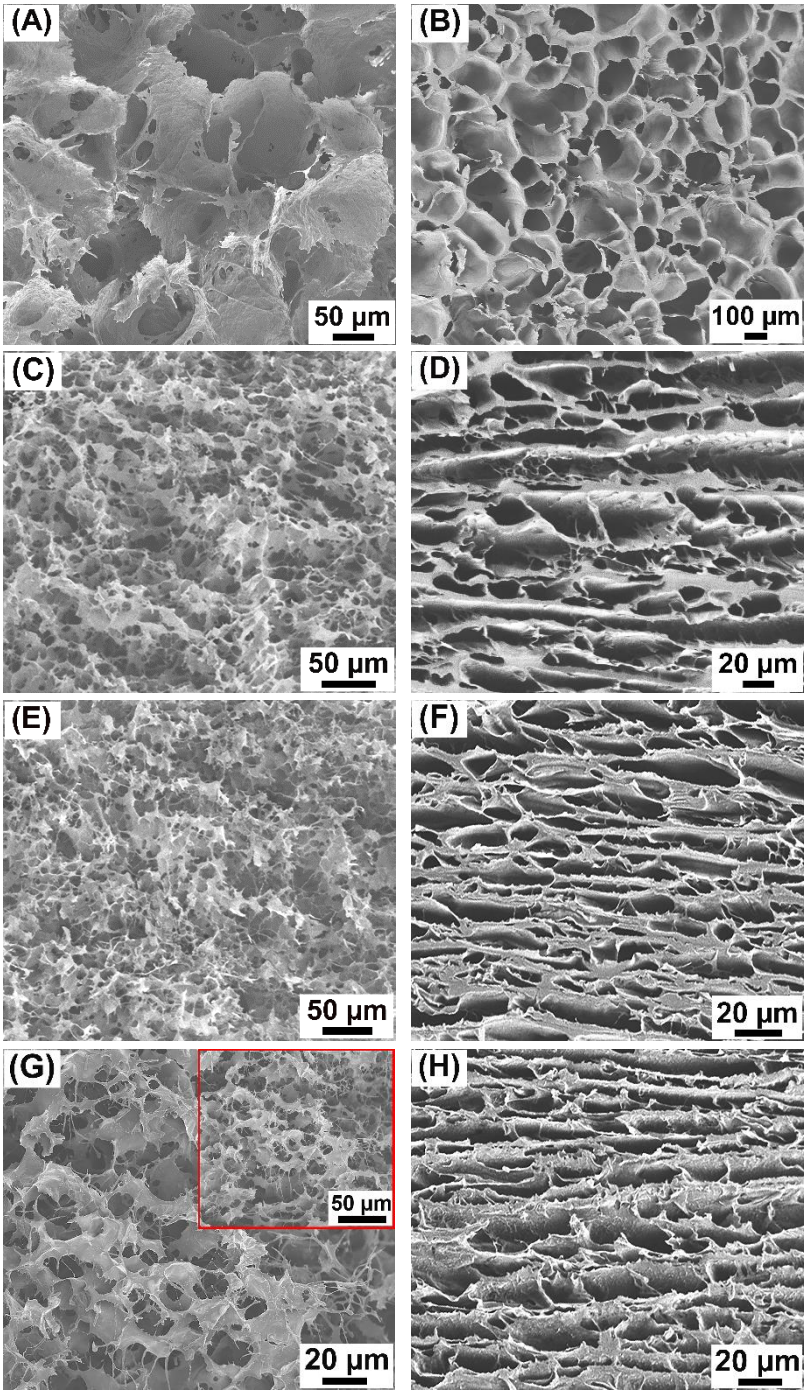

Fig. S4 SEM images of freeze-dried (A, B) L_0PN, (C, D) L_1PN, (E, F) L_3PN, and (G, H) L_4PN NC hydrogels. Left: horizontal section; Right: vertical section.

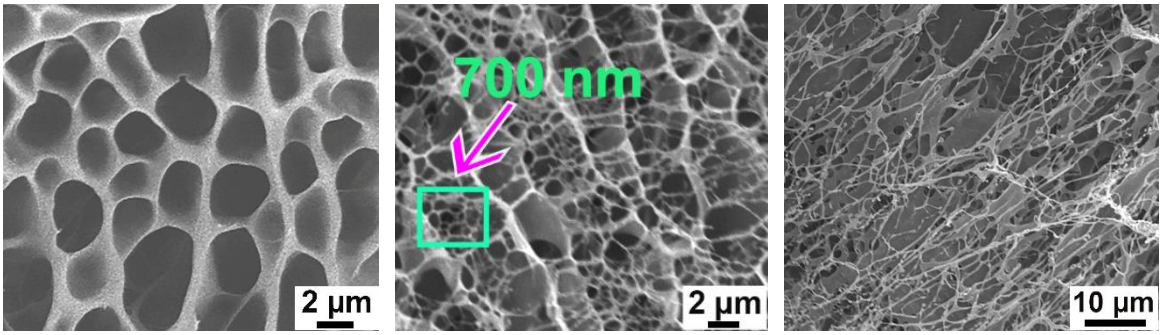

Fig. S5 SEM images of freeze-dried L_2PN hydrogel as an example. Micron-scale (~5 μm) and nano-sized (~700 nm) pores and interconnected filaments are also observed for the NC hydrogels along the horizontal direction.

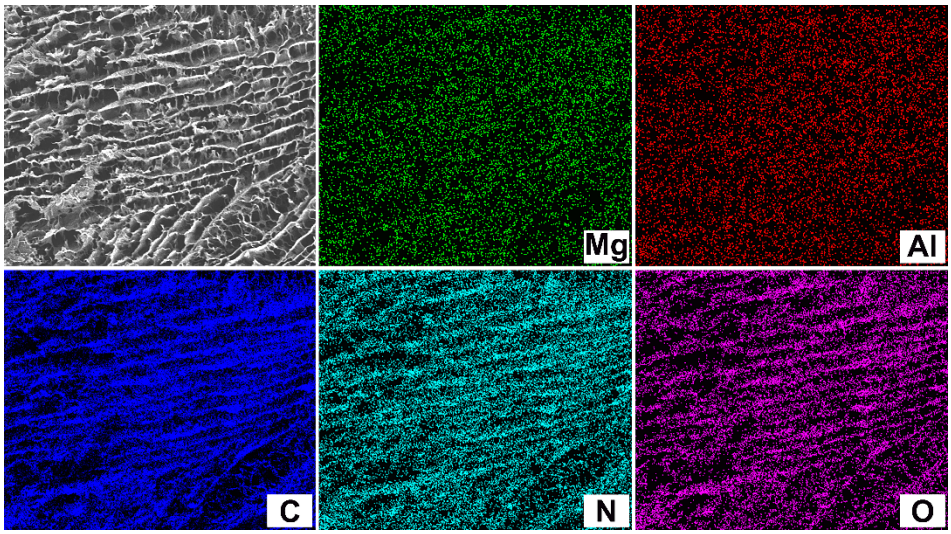

Fig. S6 EDS mapping images of Mg, Al, C, N, and O for L_2PN along vertical sections.

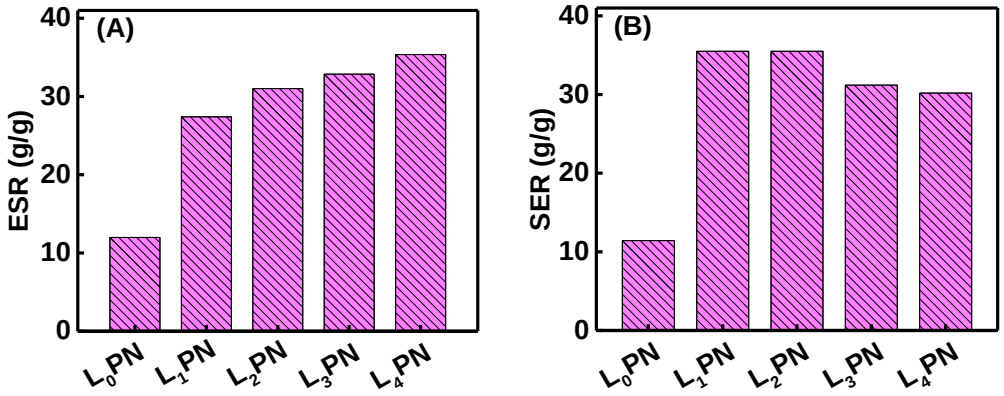

Fig. S7 Equilibrium swelling ratios of freeze-dried OR and NC hydrogels (xerogels) in (A) water and (B) ethanol at 25 ºC.

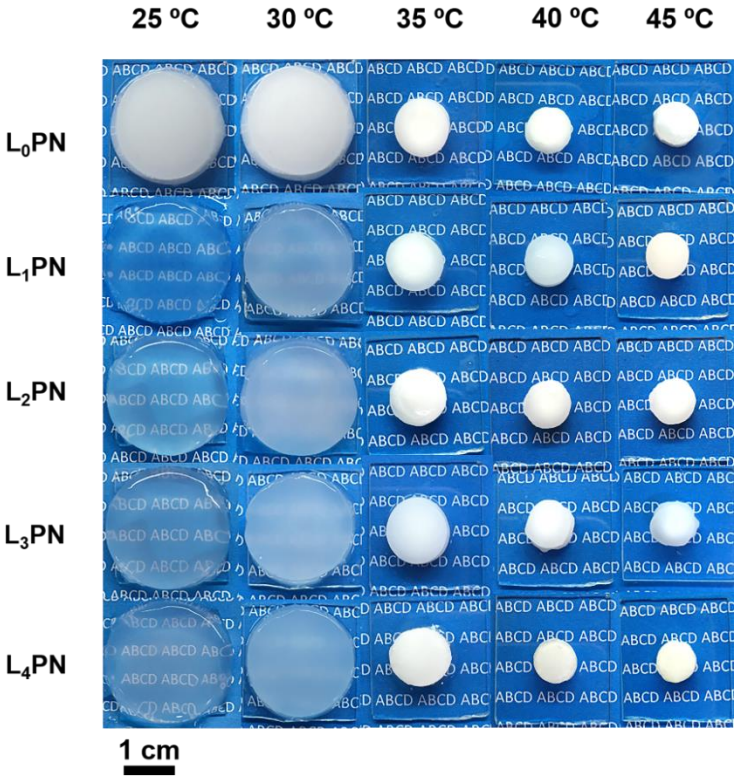

Fig. S8 Photographs of thermo-responsive shrinking process of hydrogels.

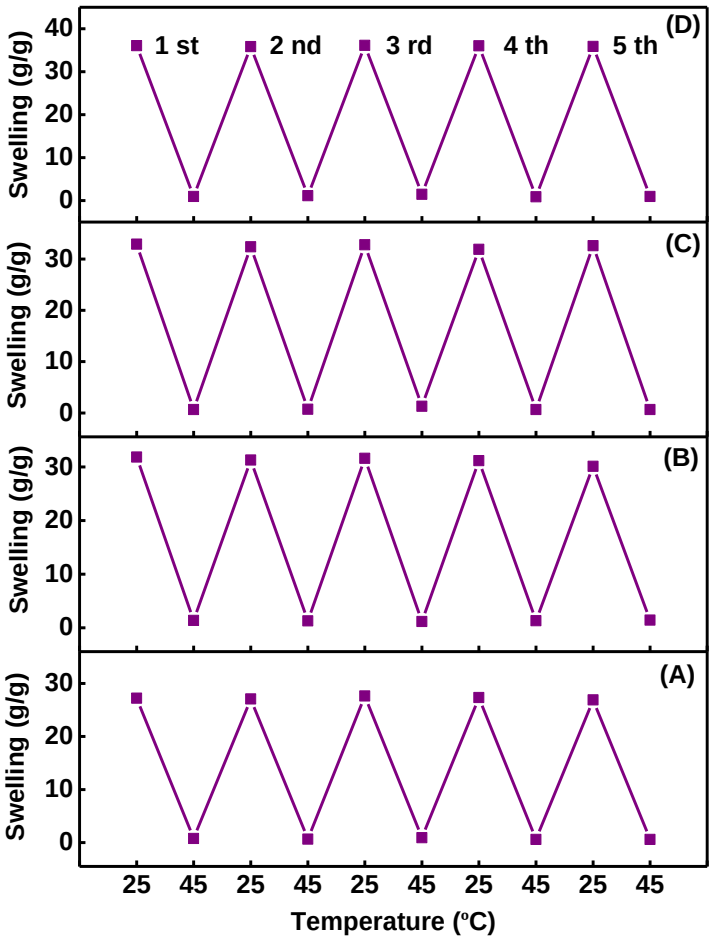

Fig. S9 Swelling/deswelling cyclic tests at 25/45 ºC for (A) L_1NP, (B) L_2NP, (C) L_3NP, and (D) L_4NP.

Table S1 Summary of mechanical properties of the reported nanocomposite hydrogels.

NC hydrogel	Inorganic nanoparticle content (wt%)	Elongation at break (%)	Tensile strength (kPa)	Tensile modulus (kPa)	Toughness (MJ/m^3)	Ref.
Clay/PNIPAM	0.6	1424	41	1.5		[1]
	1.8	1112	69	4.0		
	2.9	857	109	9.9		
Clay/PNIPAM	0.6	1308	27	0.84		[2]
	1.8	1112	69	3.8		
	2.9	1035	88	7.6		
	4.0	998	152	15.2		
	5.1	1031	305	26.1		
GO/PNIPAM /clay	10	628±13	460± 60	1860±680	2.06± 0.24	[3]
	11.7	741±90	950±170	3810±620	4.81± 0.98	
	14.5	691±78	970±50	9690±760	5.60± 0.93	
RGO/PNIPAM /clay	10	703±142	340±90	1000±40	1.92±0.74	[3]
	11.7	659±127	690±40	2520±80	3.50±0.76	
	14.5	594±12	460±70	3460±560	2.47±0.37	
GO/PNIPAM	0.25	1500	180	14.8		[4]
	0.41	1600/860	330/173			
Clay/PNIPAM	6.4		350	50	1.2	[5]
	9.3		650	150	2.8	
	11.0		880	250	3.2	
	12.0		950	330	3.3	
GO/clay /PNIPAM	5.2		156	10	0.66	[6]
	5.3		178	13	0.63	
	5.4		183	18	0.66	
	5.8		220	19.7	0.7	
RGO/clay /PNIPAM	5.2		89	15	0.35	[6]
	5.3		96	19.6	0.39	
	5.4		112	23.3	0.41	
	5.8		125	44	0.41	
Mg-Al LDH /PAM	0.8	2355	29.3	<100	0.69	[7]
	1.6	4068	43.2	<100	1.99	
	2.3	4361	45.8	<100	2.25	
Zn-Al LDH /PAM	1.1	3800	21	36.4	0.64	[8]
	2.1	>4936	>67.0	39.5	1.70	

References

[1] K. Haraguchi and T. Takehisa, *Adv. Mater.*, 2002, **14**, 1120.

[2] K. Haraguchi, T. Takehisa and S. Fan, *Macromolecules*, 2002, **35**, 10162.

[3] C. Teng, J. L. Qiao, J. F. Wang, L. Jiang, and Y. Zhu, *ACS Nano*, 2016, **10**, 413.

[4] Z. C. Zhu, Y. Li, H. Xu, X. Peng, Y.-N. Chen, C. Shang, Q. Zhang, J. Q. Liu and H. L. Wang, *ACS Appl. Mater. Interfaces*, 2016, **8**, 15637.

[5] K. Haraguchi and H. J. Li, *Macromolecules* 2006, **39**, 1898-1905

[6]. E. Z. Zhang, T. Wang, C. X. Lian, W. X. Sun, X. X. Liu and Z. Tong, *Carbon*, 2013**, 62**, 117-126.

[7] Z. Hu and G. Chen, *Adv. Mater.*, 2014, **26**, 5950.

[8] L. Wu, Z. Hu, G. Chen and Z. Li, *Soft Matter,* 2015, **11**, 9038.