Electronic Supplementary Material (ESI) for RSC Advances.

Supporting Information

Hierarchical Alginate Biopolymer Papers Produced via Lanthanide Ions Coordination

Shunli Liu,[a] Jun Ling,[b] Kewen Li,[a] Fang Yao,[a] Olayinka Oderinde,[a] Zhihong Zhang,*[c] Guodong Fu *[c]

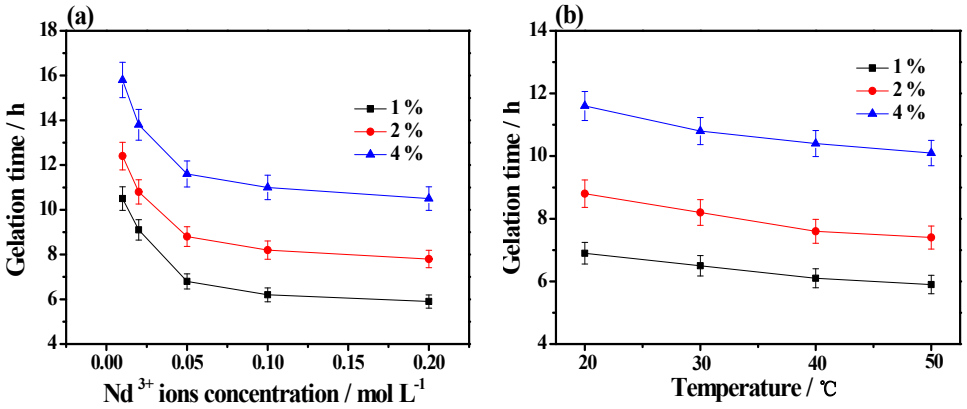

Fig. S1 Effect of (a) Nd^{3+} ion concentrations (0.01, 0.02, 0.05, 0.1, and 0.2 M) and (b) temperature on gelation time.

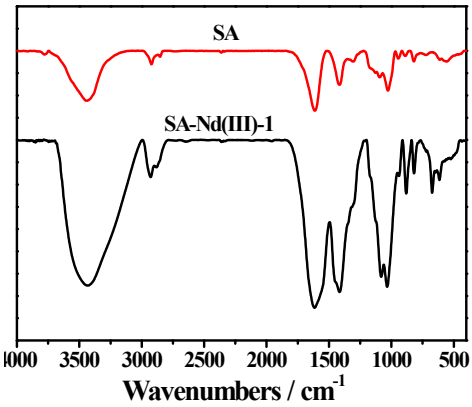

Fig. S2 FTIR spectral analysis of SA biopolymers and SA-Nd(III)-1 paper.

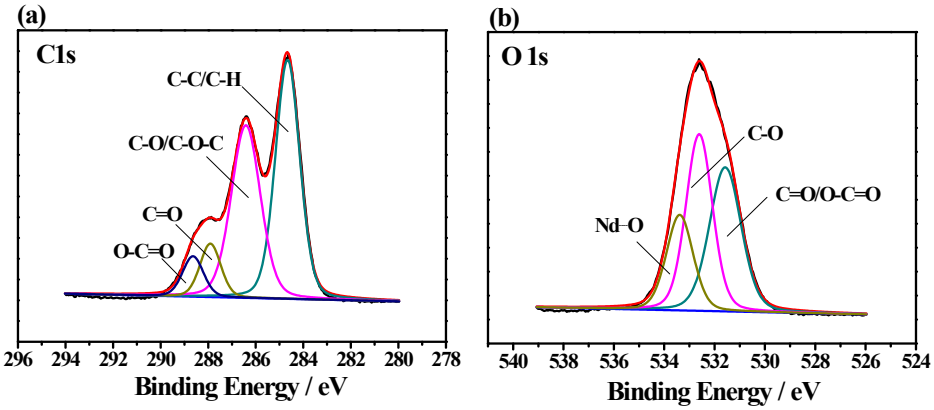

Fig. S3 XPS spectra of (a) core-level C*1s* and (b) core-level O*1s* of the layered SA-Nd(III)-1 paper.

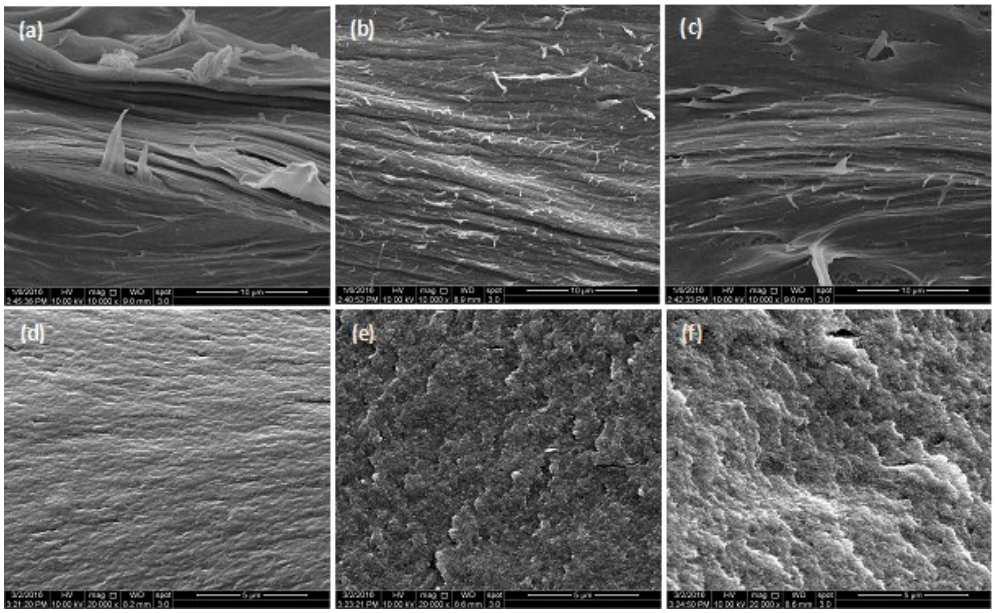

Figure S4. Comparison of the cross-sectional morphology and structure of the (a) SA-Gd(III), (b) SA-Ce(III), (c) SA-Yb(III), (d) SA-Ca(II), (e) SA-Fe(III), and (f) SA-Al(III) papers (SA concentrations was 2 wt %).

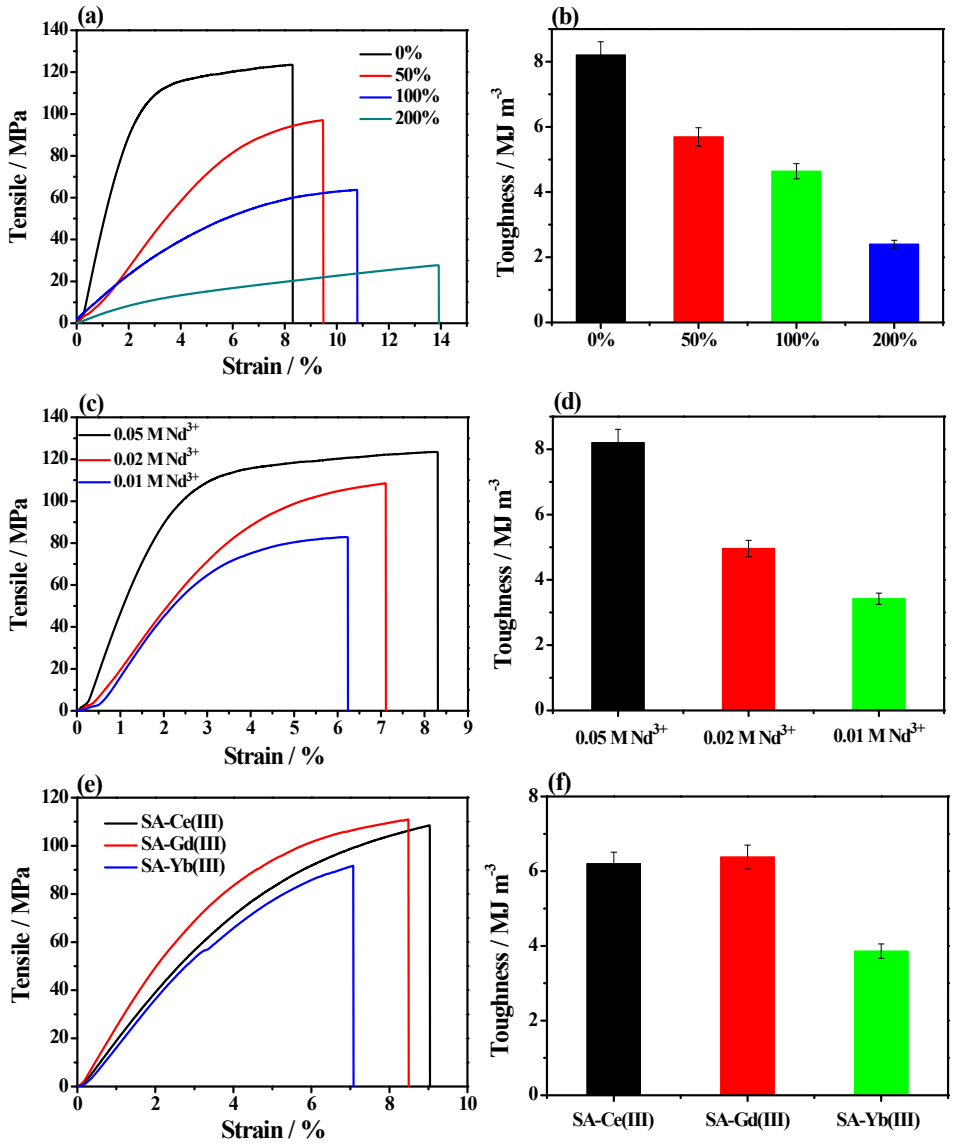

Fig. S5 (a-b) Typical strain-stress curves and toughness of layered SA-Nd(III)-1 papers with different water contents. (c-d) Typical strain-stress curves and toughness of layered SA-Nd(III) papers which formed under different Nd^{3+} ions concentrations. (e-f) Typical strain-stress curves and toughness of layered SA-Ce(III), SA-Gd(III) and SA-Yb(III) papers (SA, 2 wt%).

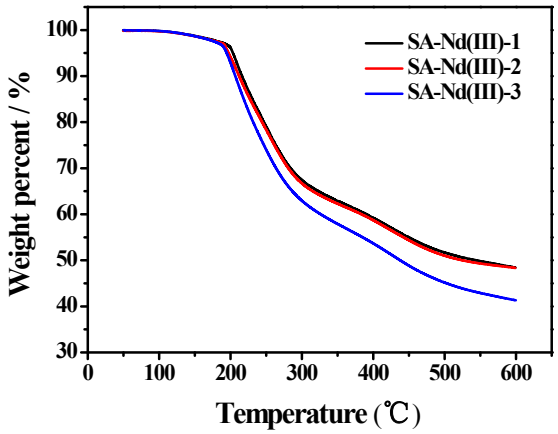

Fig. S6 TGA curves of SA-Nd(III)-1, SA-Nd(III)-2, SA-Nd(III)-3 layered papers. The curves were obtained under atmosphere of nitrogen with a temperature rising rate of 10℃·min^{-1}

Table S1. Atomic % of the SA-Nd(III)-2 paper before ([a]) and after ([b]) dipping in sodium chloride solution.

Samples	C (%)	N (%)	Nd (%)	Na (%)
[a]SA-Nd(III)-2	51.0	44.87	3.92	0.21
[b]SA-Nd(III)-2	51.23	44.64	3.90	0.23

Table S2. The tensile strength and young's modulus of Alginate-based materials.

Samples	tensile strength/MPa	Young's modulus/GPa	Ref.
SA/GO	69.32	3.8	[33]
Al/GO	113	4.18	[34]
SA-rGO	122	4.46	[38]
GO/SA	2.33	-	[39]
Alginate film	14	0.2	[40]
Alginate-Based Nanofibrous	7	0.03	[41]
Alginate-based film	2.9	0.07	[42]
Alginate/pectin films	75.7	-	[43]
SA-Nd(III)	124.2	5.25	This work

Table S3. Solvent uptake rate of the SA-Nd(III) hydrogel in various solvent.

Solvent uptake rate / %	**SA-Nd(III) papers**	
	25℃[a]	90℃[b]
Water	12.82[c]	18.34
Ethanol	6.19	7.67
THF	4.42	5.58
DMF	3.07	4.15
DMSO	4.63	5.88
EDTA	d	d

[a] The sample was soaked in solvent at 25℃ for 24 h. [b] The sample was soaked in solvent at 25℃ for three days, 90℃ for 4 h in a sealed vessel. [c] The calculation formula of the solvent uptake rate: $(W_{wet} - W_{dry})/W_{dry} \times 100\%$. [d] The sample was dissolved in this solvent.