Support Information

Oligosaccharide toughened polyacrylamide hydrogel for high sensitivity strain sensor

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Table S1. Composition ratio of COS/PAM@KCl/CNT hydrogel

Sample	Water (mL)	AM (g)	MBAA (g)	APS (g)	KCl (g)	COS (g)	CNT (g)	PVP (g)
PAM	10	3	0.0034	0.02	0	0	0	0
PAM@CNT$_{0.25wt\%}$	10	3	0.0034	0.02	0	0	0.0075	0.015
COS/PAM@KCl	10	3	0.0034	0.02	1.49	0.3	0	0
COS/PAM@KCl/CNT$_{0.15wt\%}$	10	3	0.0034	0.02	1.49	0.3	0.005	0.01
COS/PAM@KCl/CNT$_{0.25wt\%}$	10	3	0.0034	0.02	1.49	0.3	0.0075	0.015
COS/PAM@KCl/CNT$_{0.5wt\%}$	10	3	0.0034	0.02	1.49	0.3	0.015	0.03
COS/PAM@KCl/CNT$_{0.75wt\%}$	10	3	0.0034	0.02	1.49	0.3	0.0225	0.045

Table S2. Mechanical properties of different hydrogels

Sample	Strain (%)	Stress (kPa)	Toughness (kJ·m^{-2})	Modulus (kPa)
PAM	340.82±4.67	559.16±20.03	153.69±6.37	273.78±30.53
COS/PAM	1084.44±84.28	753.07±81.88	606.57±8.94	500.59±58.64
PAM@CNT$_{0.25wt\%}$	431.06±2.34	517.46±35.91	102.41±10.4	117.03±24.11
COS/PAM@KCl	1469.65±42.72	886.31±10.80	902.01±31.4	311.87±3.18
COS/PAM@KCl/CNT$_{0.15wt\%}$	1652.53±20.01	920.00±11.99	923.23±16.9	260.29±13.78
COS/PAM@KCl/CNT$_{0.25wt\%}$	1990.35±42.09	1264.23±1.78	1546.44±2.4	358.43±18.15
COS/PAM@KCl/CNT$_{0.5wt\%}$	1851.85±21.08	1201.46±11.67	1368.88±56	332.55±47.95
COS/PAM@KCl/CNT$_{0.75wt\%}$	1764.17±53.62	1130.36±40.73	1072.76±16	250.99±25.14

Table S3. Ionic conductivity of different hydrogels

Sample	Ionic conductivity (S/m)
PAM	0.13494 ± 0.01382
COS/PAM	0.18387 ± 0.01724
COS/PAM@KCl	8.03096 ± 0.34356
COS/PAM@KCl/CNT$_{0.15wt\%}$	13.8725 ± 0.73073
COS/PAM@KCl/CNT$_{0.25wt\%}$	15.30928 ± 0.26784
COS/PAM@KCl/CNT$_{0.5wt\%}$	14.02918 ± 0.46685
COS/PAM@KCl/CNT$_{0.75wt\%}$	12.85798 ± 0.12654

Table S4. Adhesive strength of the hydrogel on different substrates

Substrates	Shear strength (kPa)
Glass	303.25±16.34
PMMA	254.93±2.29
Wood	375.77±20.64
Metal	111.33±8.34
Paper	143.07±7.45

Table S5. GF versus strain for COS/PAM@KCl/CNT hydrogels at various CNT loadings.

Stress	COS/ PAM@KCl	COS/PAM@K Cl/CNT$_{0.15wt\%}$	COS/PAM@K Cl/CNT$_{0.25wt\%}$	COS/PAM@K Cl/CNT$_{0.5wt\%}$	COS/PAM@KCl/ CNT$_{0.75wt\%}$
25%	0.80	2.92	5.20	4.60	3.40
50%	0.70	3.60	5.30	4.00	4.40
75%	0.70	3.70	5.10	4.30	4.13
100%	1.10	3.80	6.00	4.85	4.20
200%	0.93	3.35	4.40	4.12	3.20
300%	0.97	3.42	4.40	4.10	3.00
400%	1.00	3.57	4.40	4.10	3.50
500%	1.20	3.80	4.76	4.32	3.90

[*] GF values in Table S5 represent the instantaneous sensitivity at the given strain.

Table S6. Comparison of mechanical performance of the published work.

| Hydrogel	Stress (kPa)	Strain (%)	Modulus (kPa)	GF	Ref.
PPAVC-BA	147.74	1750	140	4.43	[1]
PAA@CS-Al/Gly	196	960	37.3	4.64	[2]
Gelatin$_{0.5}$/PAM/LiCl1.0	150	618.03	106.33	3.71	[3]
PTSL	60	756	7	2.52	[4]
PVA/P(AM-co-AA)-Fe^{3+}	2100	590	400	2.30	[6]
PANI/PVA/CMC -P(AM-co-AA)-	838	330	80	2.94	[7]
PVA-B-PPy	150	400	302	2.48	[8]
PAGDP-Ag	200	699	105.77	3.98	[9]
PLTAV	470	1300	88.13	1.33	[12]
PCGB	151	1694	2.8	5.7	[13]
PSBMA-BCN	12.6	520	5.8	2.2	[14]
ICH	311.83	35	-	2.78	[15]
COS/PAM@KCl/CNT$_{0.25wt\%}$	**1264**	**1990**	**358**	**6.25**	**This work**

Table S7. Comparison of the GF values under different strains of the published work.

| Hydrogel	0-100%	100-200%	200%-300%	400%-600%	Ref.
PPAVC-BA	1.15	2.53	-	4.43	[1]
PAA@CS-Al/Gly	1.84	2.72	-	4.63	[2]
Gelatin$_{0.5}$/PAM/LiCl1.0	0.87	2.18	-	3.71	[3]
PTSL	2.52	2.52	2.52	2.52	[4]
PAM/SA-Gly-KCl$_{1M}$	1.17	2.65	3.49	-	[5]
PVA/P(AM-co-AA)-Fe^{3+}	1.7	1.9	2.3	-	[6]
PANI/PVA/CMC -P(AM-co-AA)-	3.77	2.94	-	-	[7]
PVA-B-PPy	0.98	0.98	-	5.7	[8]
PAGDP-Ag	1.08	-	1.91	3.98	[9]
PVA/AA-SBMA	2.601	2.87	3.75	-	[11]
PCGB	0.98	0.98	-	5.7	[13]
PSBMA-BCN	2.601	2.87	3.75	-	[14]
ICH	2.78	-	-	-	[15]
COS/PAM@KCl/CNT$_{0.25wt\%}$	**6.26**	**3.65**	**3.65**	**6.25**	**This work**

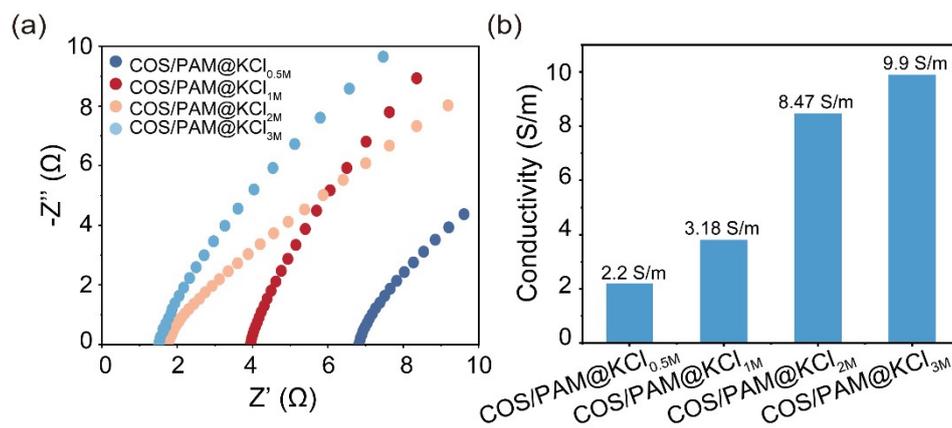[*] GF values in Table S7 represent the average over the corresponding strain range.
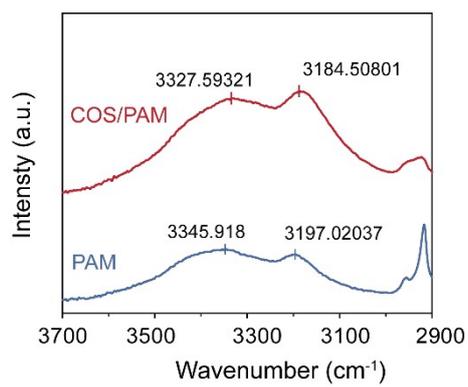
Figure S1. FTIR spectra of PAM and COS/PAM hydrogels
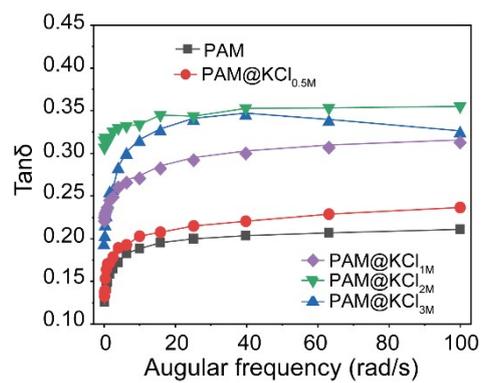
Figure S2. Loss tangent (tanδ) values at different KCl contents
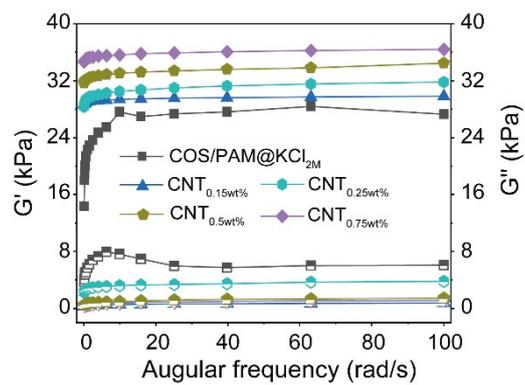
Figure S3. Storage modulus (G') and loss modulus (G") at different CNT contents (G',

filled and G", open).

Figure S4. Ionic conductivity characterization of COS/PAM hydrogels with different

KCl contents; (a) Nyquist impedance plots; (b) Ionic conductivity.

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