Electronic Supplementary Material (ESI) for Materials Advances.

SUPPORTING INFORMATION

Scalable and robust silica aerogel materials from ambient pressure drying

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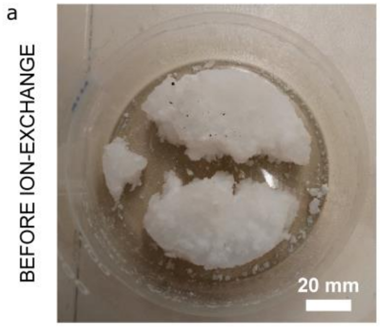
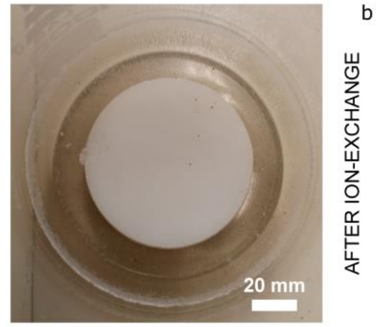


ELEMENT	WEIGHT %	ATOMIC %
C K	20.44	29.41
O K	45.74	49.40
Na K	2.78	2.09
Al K	0.00	0.00
Si K	31.04	19.10
Cl K	0.00	0.00
Totals	100.00	

ELEMENT	WEIGHT %	ATOMIC %
C K	32.31	43.37
O K	41.09	41.41
Na K	0.00	0.00
Al K	0.00	0.00
Si K	26.21	15.05
Cl K	0.38	0.17
Totals	100.00	



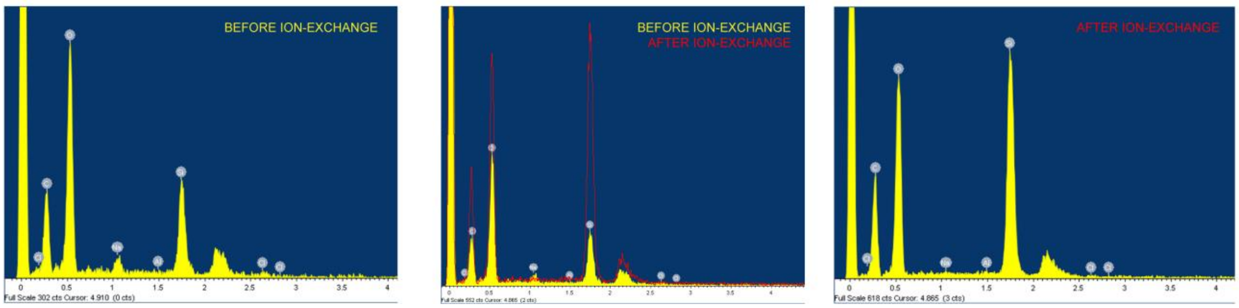


Figure S1. a) and b) Element mapping (Energy Dispersive Spectroscopy- EDS) analysis for aerogel samples including waterglass before and after ion-exchange procedure, alongside optical images showing macroscopic morphology of aerogels for both cases.

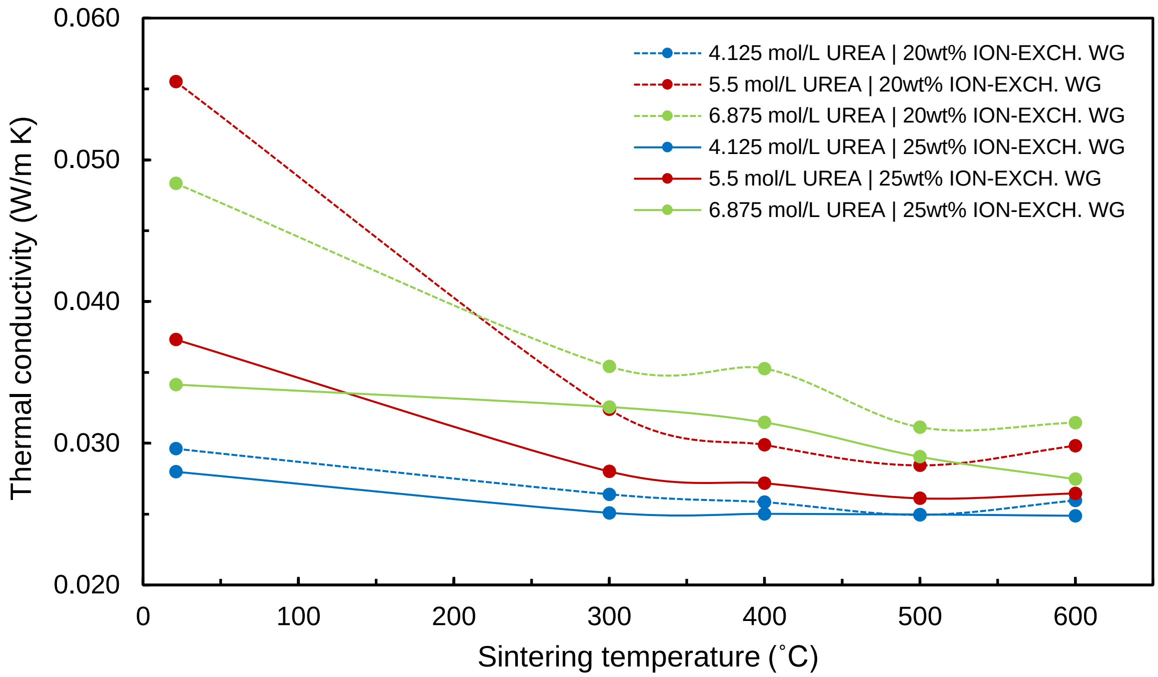


Figure S2. Thermal conductivity vs sintering temperature for aerogel samples with 1:1 SDS/CTAB ratio and different urea molar ratio and ion-exchange waterglass weight percentage respectively.

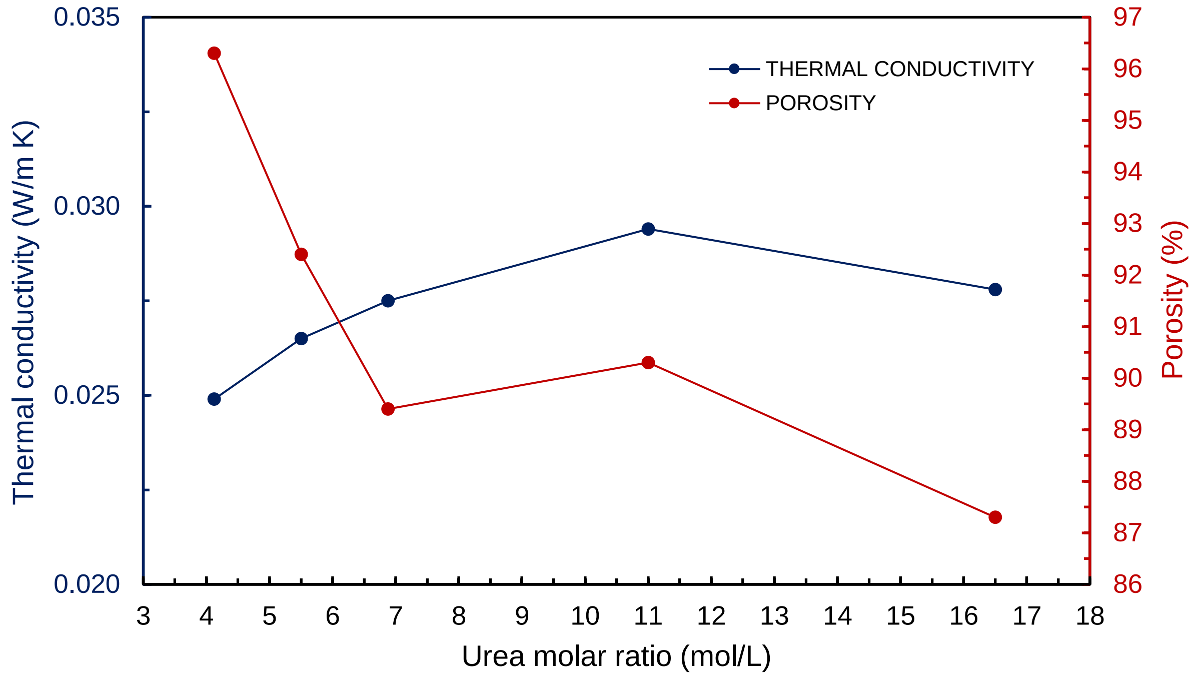


Figure S3. Thermal conductivity and porosity vs urea molar ratio for aerogel samples with 1:1 SDS/CTAB ratio and 25% weight ion-exchange waterglass respectively.

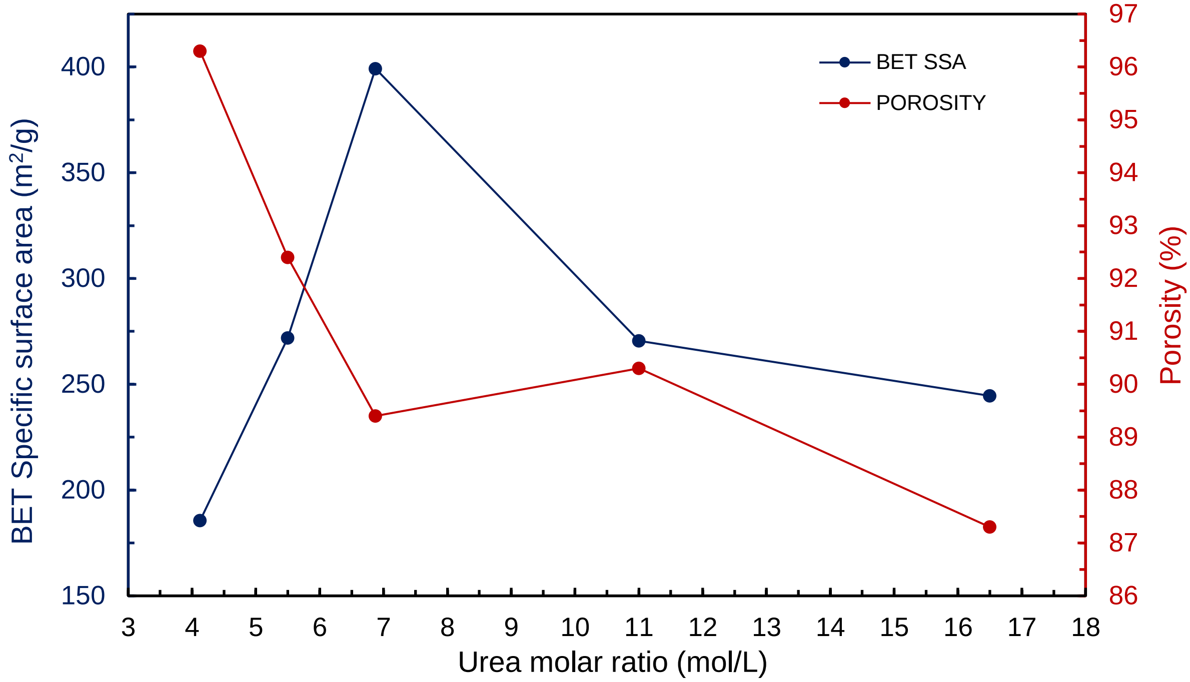
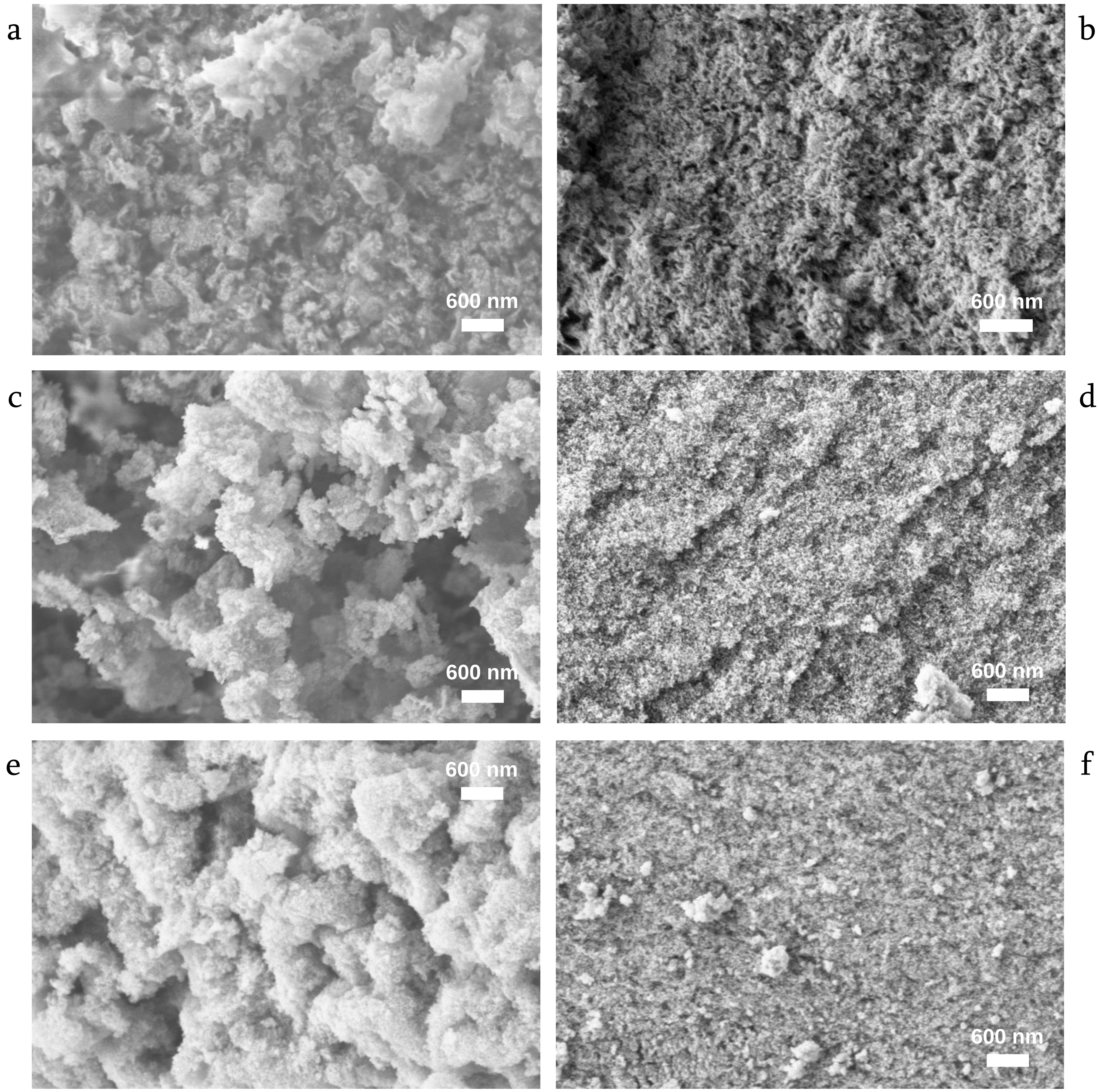


Figure S4. BET specific surface area and porosity vs urea molar ratio for aerogel samples with 1:1 SDS/CTAB ratio and 25% weight ion-exchange waterglass.



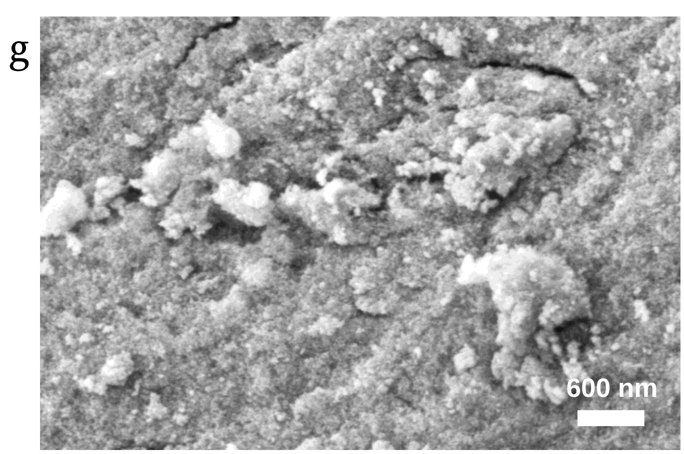


Figure S5. SEM image showing microstructure of aerogel sample featuring a) 1:1 SDS/CTAB ratio, 25wt% ion-exchange waterglass and 4.125 mol/L of urea | b) 1:1 SDS/CTAB ratio, 25wt% ion-exchange waterglass and 6.875 mol/L of urea | c) 1:2 SDS/CTAB ratio, 25wt% ion-exchange waterglass and 6.875 mol/L of urea | d) 2:1 SDS/CTAB ratio, 25wt% ion-exchange waterglass and 6.875 mol/L of urea | e) 1:3 SDS/CTAB ratio, 25wt% ion-exchange waterglass and 6.875 mol/L of urea | f) 3:1 SDS/CTAB ratio, 25wt% ion-exchange waterglass and 6.875 mol/L of urea and | g) CTAB only, 25wt% ion-exchange waterglass and 6.875 mol/L of urea. All samples have been sintered to 600°C.

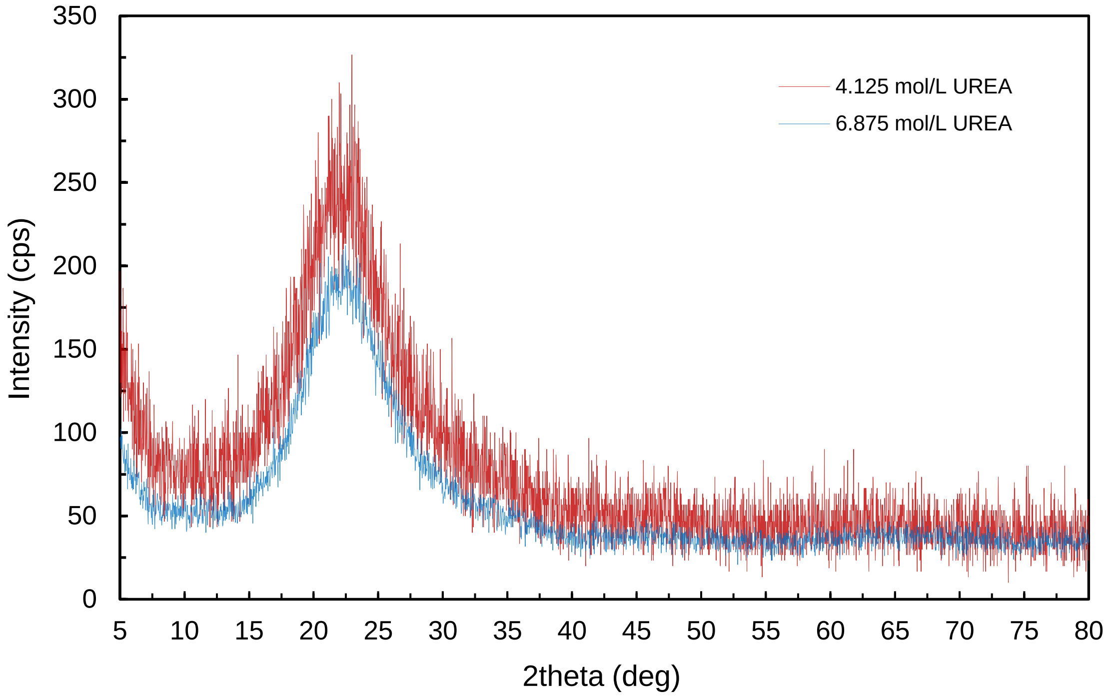


Figure S6. X-ray diffraction (XRD) spectra for aerogel samples with 1:1 SDS/CTAB ratio and 25% weight ion-exchange waterglass, including 4.125 and 6.875 mol/L of urea respectively. Both specimens feature an amorphous nature as suggested by the broad peak observed near 22° as shown, while the small difference between both patterns can be attributed to a dissimilar structural evolution of Si and C prior to the formation of SiC during condensation, due to gradual reaction between both C and Si respectively.

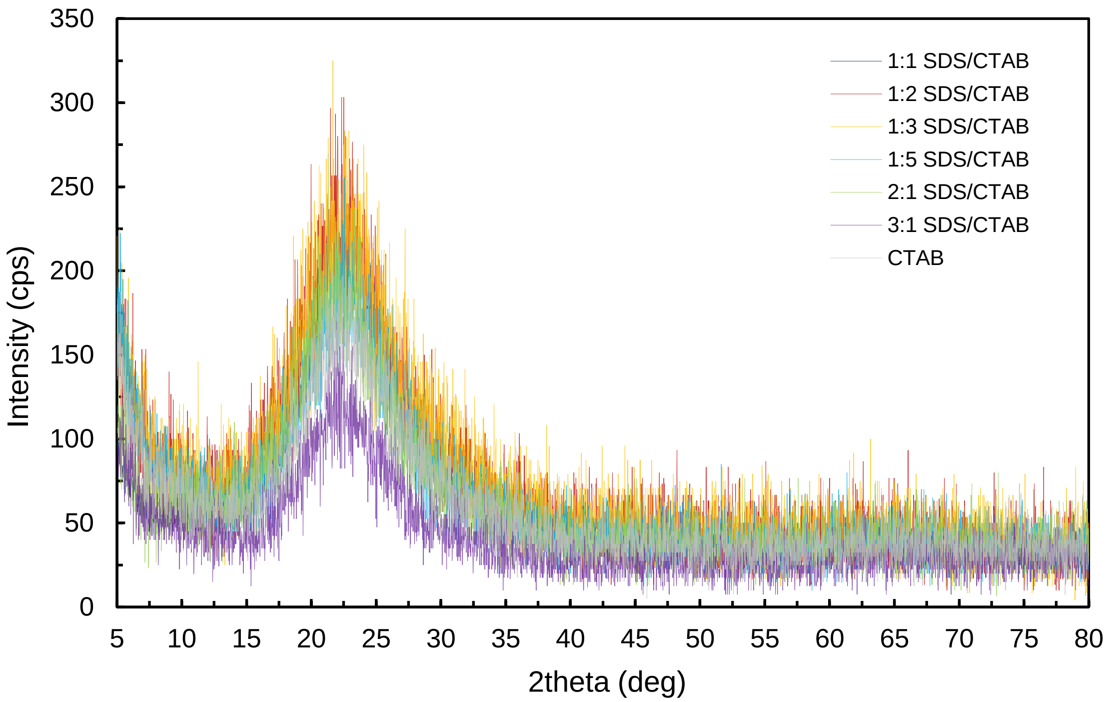


Figure S7. X-ray diffraction (XRD) spectra for aerogel samples with 6.875 mol/L of urea and 25% weight ion-exchange waterglass, including different SDS/CTAB molar ratios.

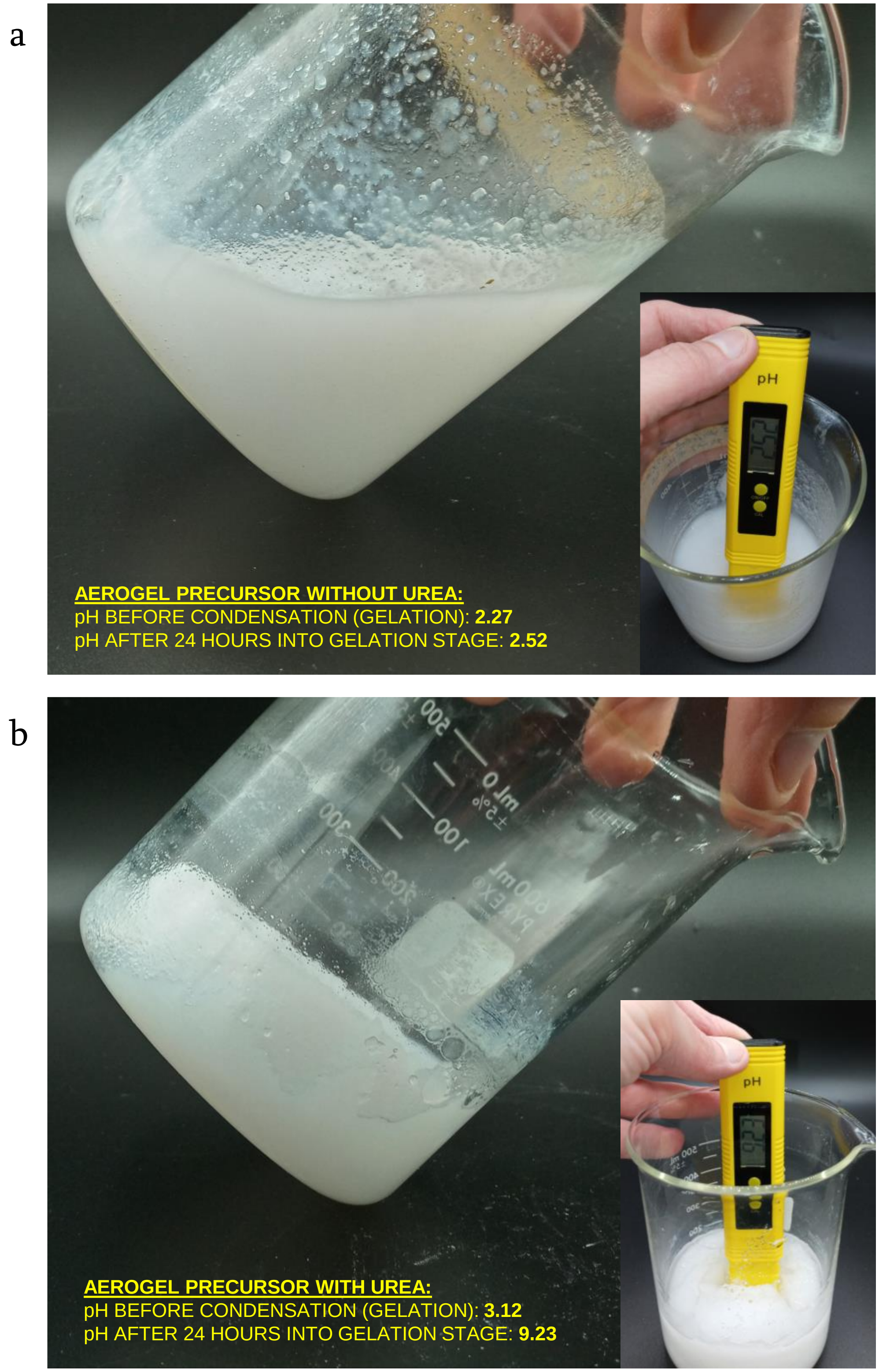
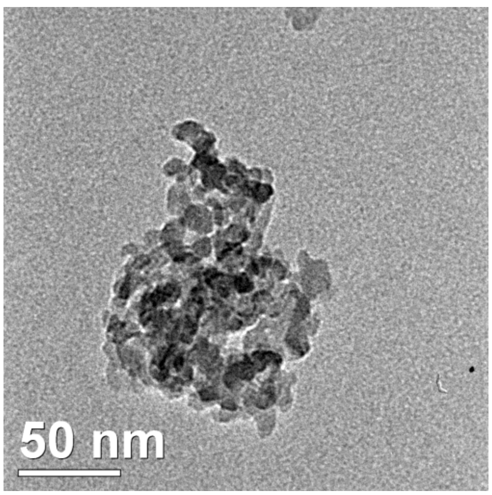


Figure S8. Optical image of aerogel precursor without (a) and with (b) urea after 24 hours into gelation stage. Inset images include pH measurement of the precursor.

a

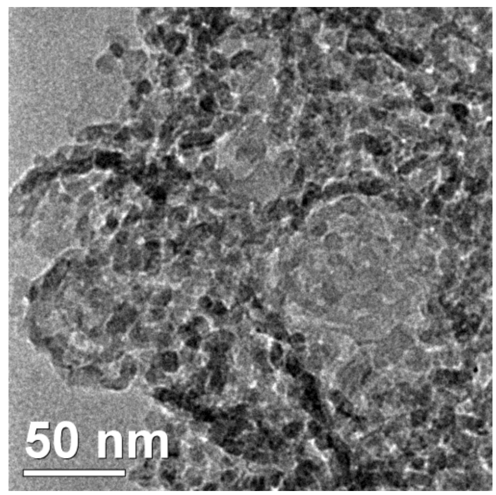
NON-ION-EXCHANGE WATERGLASS



Label	Area	Mean	Min	Max	Angle	Length
P1	2.541	101.113	43.299	251	-12.265	10.83
P2	2.064	94.862	52.82	134.064	-12.2	8.709
P3	1.641	61.092	9.333	154.8	88.091	6.906
P4	2.17	33.706	0	68	92.862	9.214
P5	2.117	79.974	21.826	134.789	103.325	8.984
P6	1.482	117.729	67.951	167.963	-109.799	6.113
P7	1.641	142.843	77.2	227.778	57.381	6.829
P8	2.276	101.734	69.619	178.476	-1.364	9.665
P9	2.964	124.106	88.364	221	-5.194	12.705
P10	2.064	181.93	112.84	245.544	103.671	8.76
P11	1.8	132.932	104.587	188.851	-68.839	7.648
P12	2.117	86	26	140	0	8.972
P13	2.223	163.466	124.004	223.795	14.036	9.486
P14	2.488	124.884	58.97	223.577	-17.65	10.623
P15	1.852	54.43	25.508	120.799	-142.125	7.869
Mean	2.096	106.72	58.821	178.696	5.995	8.888
SD	0.387	40.63	38.185	53.289	74.829	1.71
Min	1.482	33.706	0	68	-142.125	6.113
Max	2.964	181.93	124.004	251	103.671	12.705

b

ION-EXCHANGE WATERGLASS



Label	Area	Mean	Min	Max	Angle	Length
P1	1.801	69.259	16.875	142	-8.881	7.567
P2	1.856	42.324	10	96	0	7.71
P3	1.801	52.4	20.375	112.844	20.136	7.466
P4	2.511	60.775	32.852	87.339	-43.21	10.579
P5	1.965	50.269	8.016	135	-115.115	8.257
P6	2.02	82.388	47.259	165	38.157	8.32
P7	1.583	36.432	0	79	-96.116	6.579
P8	1.747	86.942	10.484	205.742	176.309	7.258
P9	1.365	129.867	54	184.667	48.366	5.627
P10	2.511	91.889	41.173	163.507	168.44	10.493
P11	1.638	123.115	56	185.095	51.953	6.824
P12	2.238	70.018	32.45	125	-8.531	9.45
P13	2.184	116.451	68.775	164.527	-169.563	9.028
P14	1.638	84.019	50.737	133.206	-75.964	6.743
P15	1.529	149.501	94.667	242.481	2.121	6.313
Mean	1.892	83.043	36.244	148.094	-0.793	7.881
SD	0.345	33.938	26.252	45.605	94.635	1.477
Min	1.365	36.432	0	79	-169.563	5.627
Max	2.511	149.501	94.667	242.481	176.309	10.579

Figure S9. TEM images of silica aerogel powder (sintered to 600 °C) synthesized without (a) and with (b) ion-exchange waterglass. The results in the table correspond to Particle Size Analysis using image analysis software.

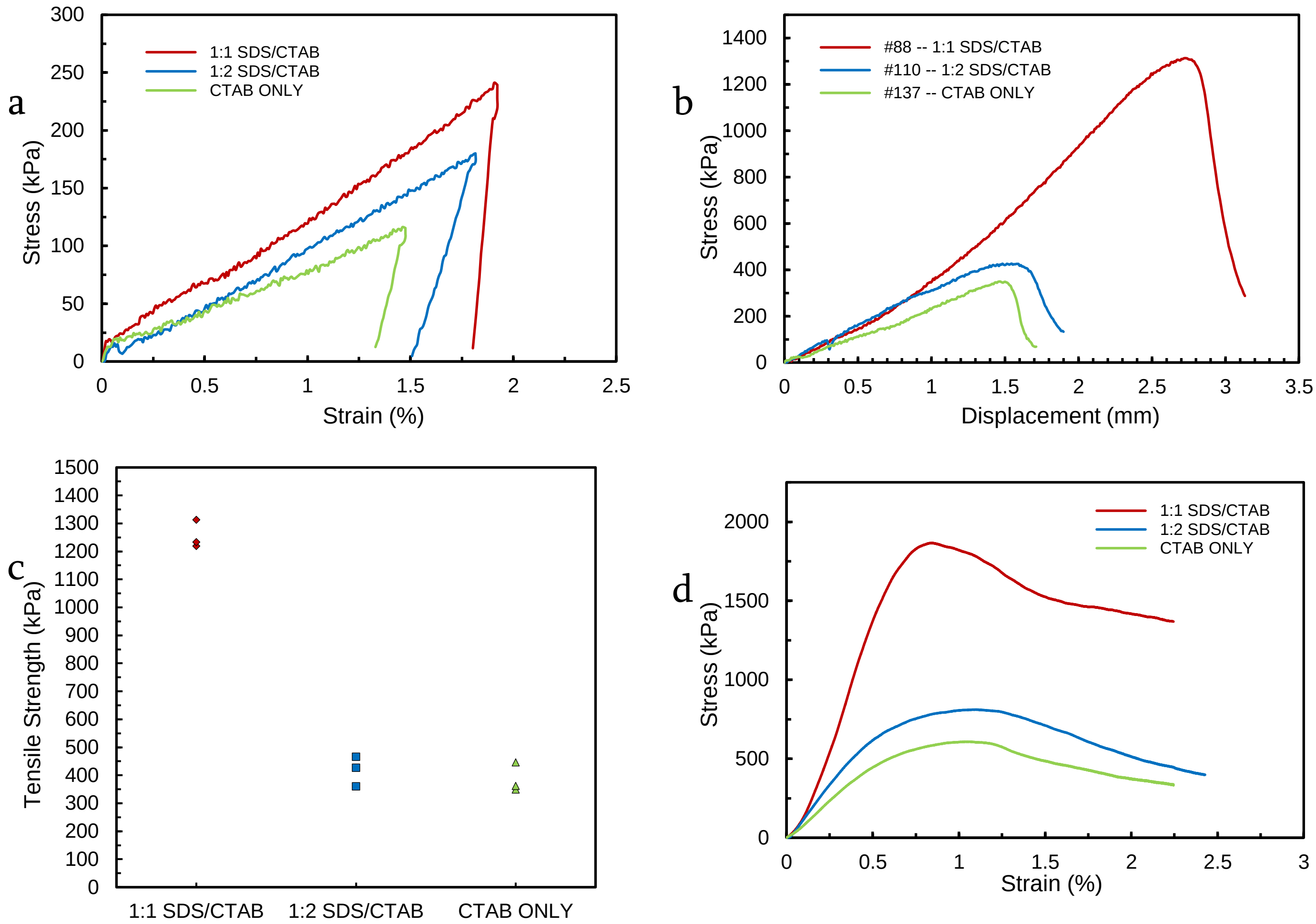


Figure S10. (a) Strain-stress plot for tensile test to low strain rate for elastic modulus calculation; (b) Strain-stress plot for tensile test to low strain rate for tensile strength calculation; (c) Tensile strength comparison for cellulose-fiber-based materials using three different precursors; and (d) Strain-stress plot for flexural (bending) tests for flexural strength and flexural modulus calculations.

Table S1. Properties of aerogel specimens with 6.875 mol/L of urea and 25% weight ion-exchange waterglass, (including different SDS/CTAB molar ratios)

CO-SURFACTANT RATIO	k *(W/ m · K)*	BET SURF. AREA *(m²/g)*	BJH DESORPTION AVG. PORE WIDTH *(nm)*	AVERAGE PARTICLE SIZE *(nm)*	POROSITY *(%)*
1:1	0.0275	399.23	6.642	15.029	89.4
1:2	0.0234	412.84	13.678	14.534	97.4
2:1	0.0336	271.96	17.980	22.062	85.0
1:3	0.0242	498.03	9.449	12.048	98.3
3:1	0.0380	331.38	12.731	18.106	82.7
1:5	0.0263	507.56	18,922	11.821	92.5
CTAB ONLY	0.0353	541.56	10.303	11.079	84.4

Table S2. Properties of cellulose fiber/silica aerogel composite specimens following mechanical properties tests (uniaxial compression, tensile, and flexural tests).

AEROGEL PRECURSOR	THICKNESS *(mm)*	wt% AEROGEL *(%)*	k *($W\cdot m^{-1}\cdot K^{-1}$)*	UNIAXIAL COMPRESSION TEST		TENSILE TEST		FLEXURAL TEST	
				MAX. COMPRESSIVE STRESS (AT 50% STRAIN) *(kPa)*	ELASTIC MODULUS (COMPRESSIVE) *(MPa)*	ULTIMATE STRENGTH (TENSILE) *(kPa)*	ELASTIC MODULUS (TENSILE) *(MPa)*	ULTIMATE STRENGTH (FLEXURAL) *(kPa)*	FLEXURAL MODULUS *(MPa)*
1:1 SDS/CTAB	3.1	~ 49	0.0451	9821.66	6.02	1313.0	12.17	1866.6	113.3
1:2 SDS/CTAB	3.4	~ 55	0.0365	11079.28	13.51	465.6	10.03	811.2	57.9
CTAB ONLY	2.7	~ 44	0.0324	10432.98	8.59	445.7	7.58	608.6	39.2
1:2 SDS/CTAB (MONOLITHIC)	4.5	100	--	1405 (BEFORE FRACTURING)	10.84	--	--	--	--