

# Supporting Information

## Composition–Structure–Solubility Relationships in Borosilicate Glasses: Towards a Rational Design of Bioactive Glasses with Controlled Dissolution Behavior

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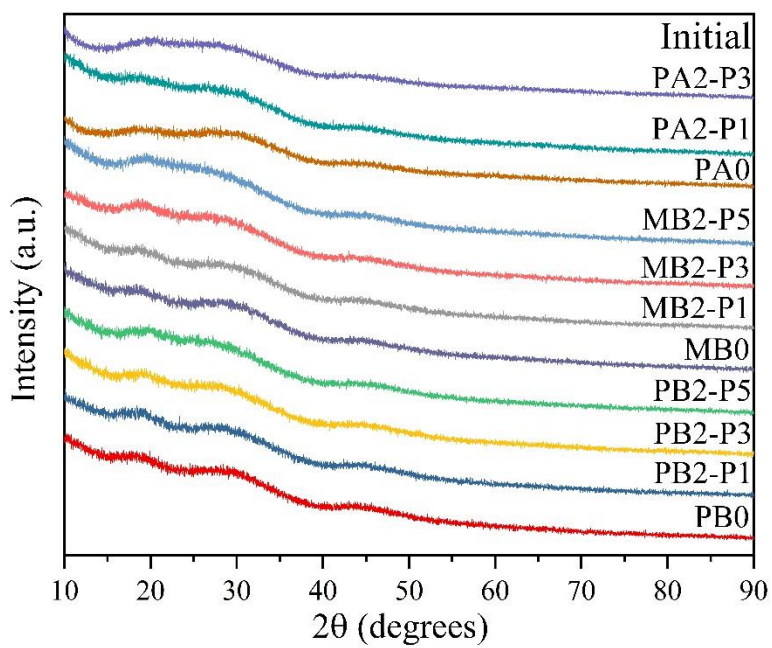
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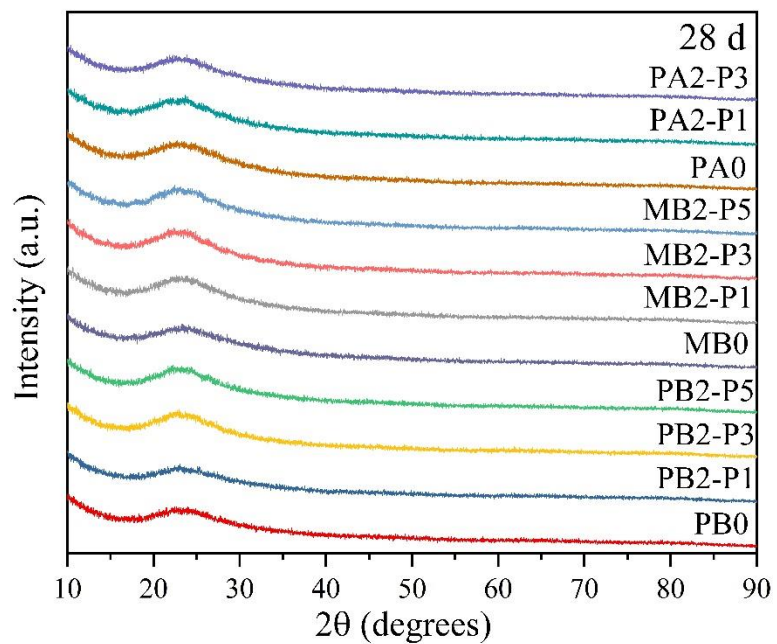
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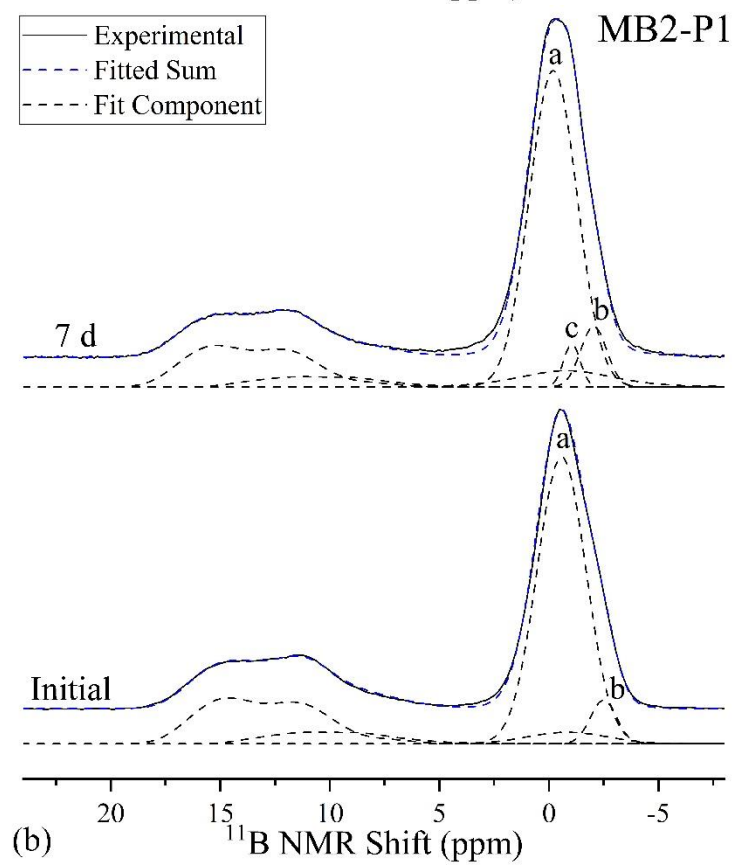
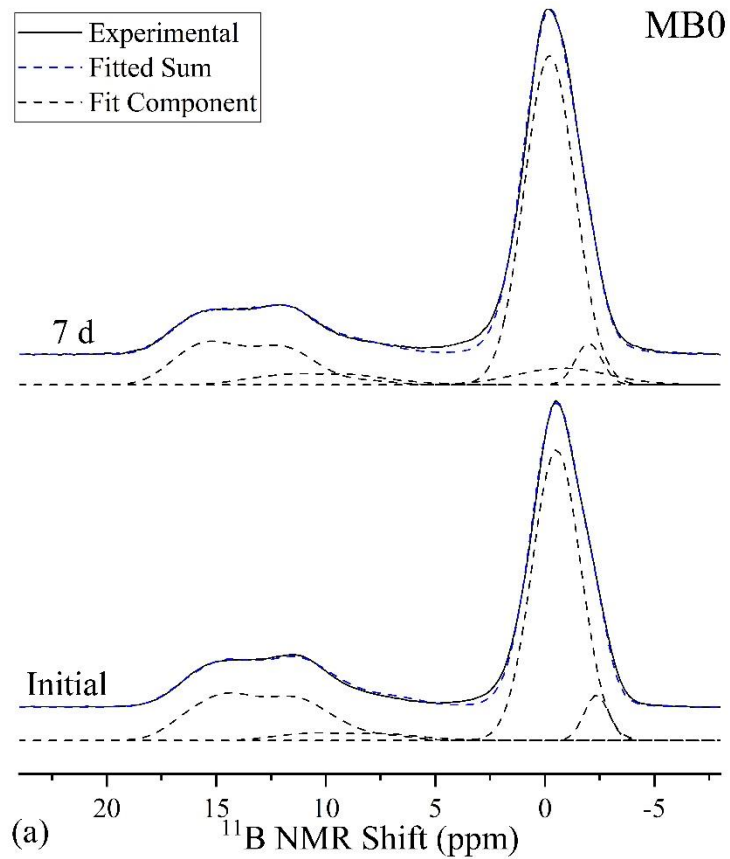
**Figure S1.** Images of the as-synthesized samples from series PB2, displaying the transparent nature of  $P_2O_5$ -containing glasses in our study.

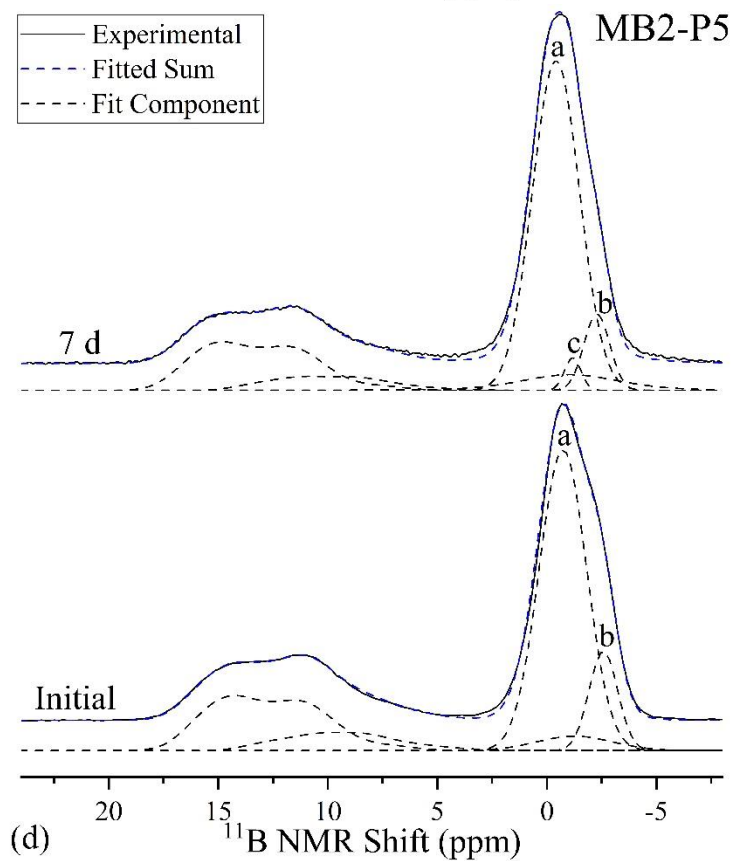
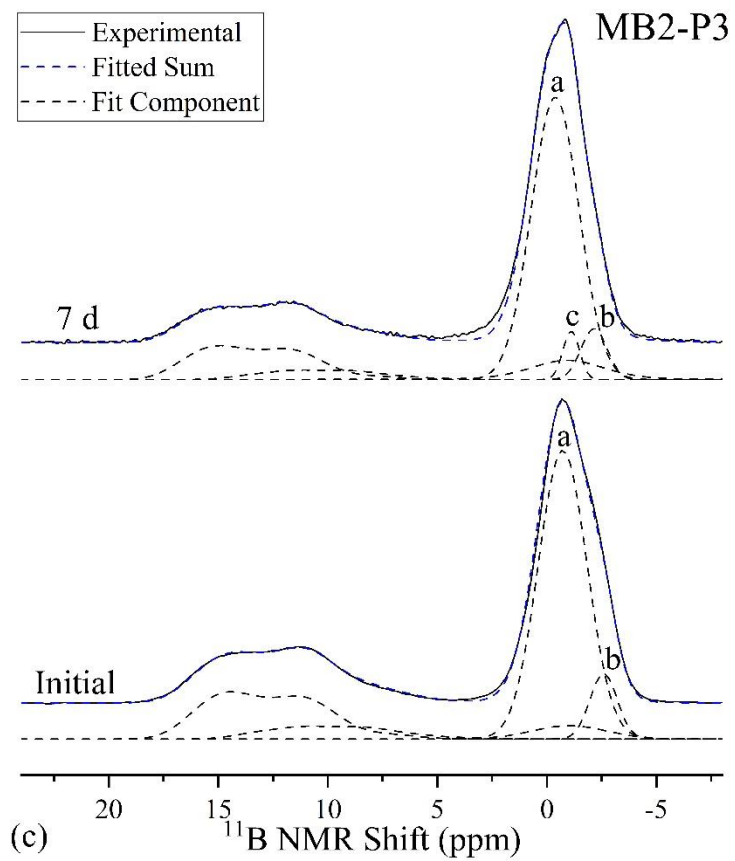


**Figure S2.** XRD patterns of as-synthesized glasses.

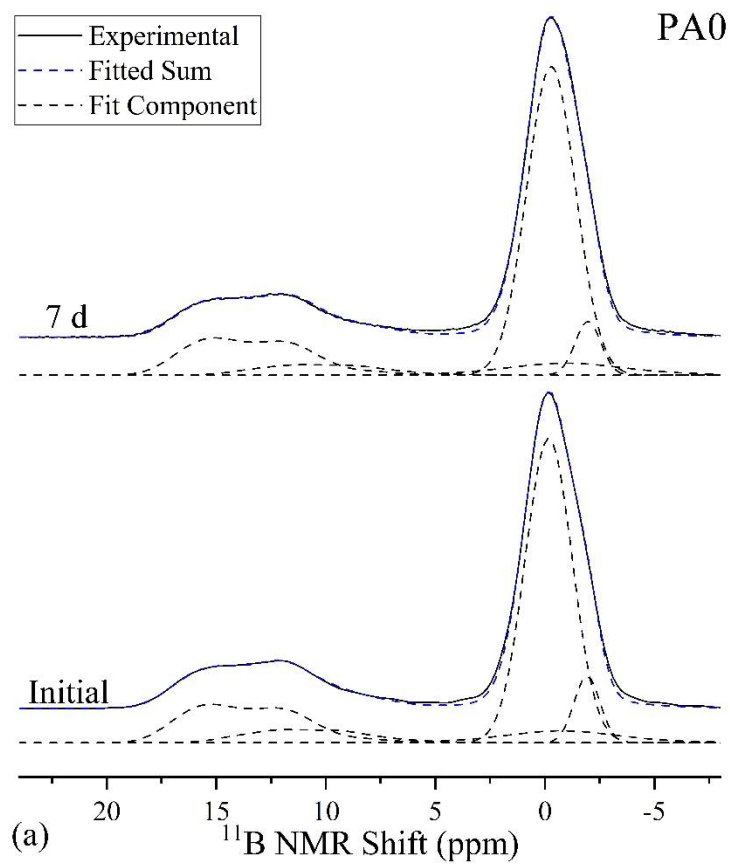


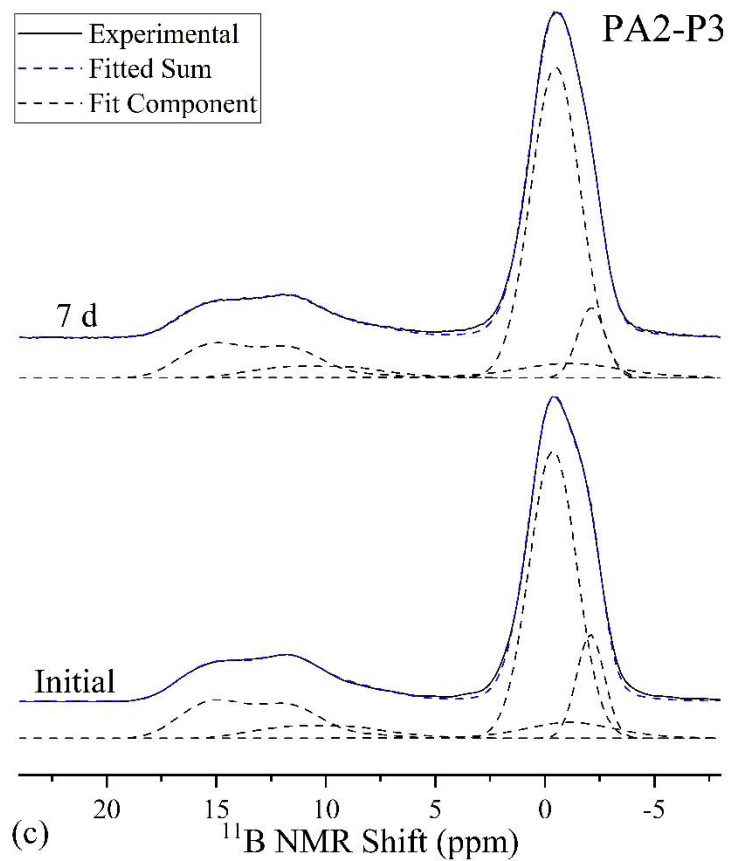
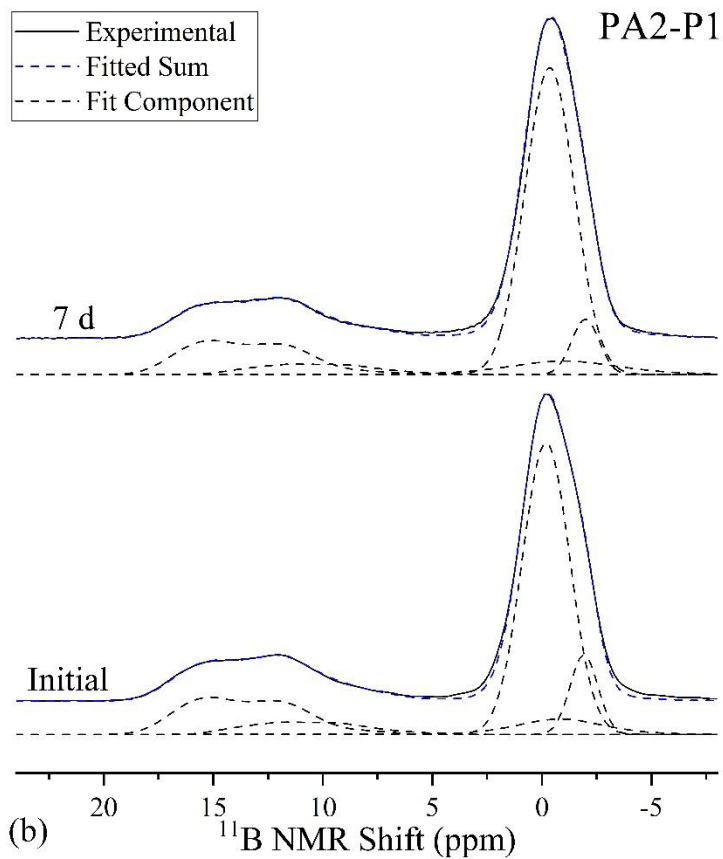
**Figure S3.** XRD patterns of glass powders recovered from 28 d degradation experiments.





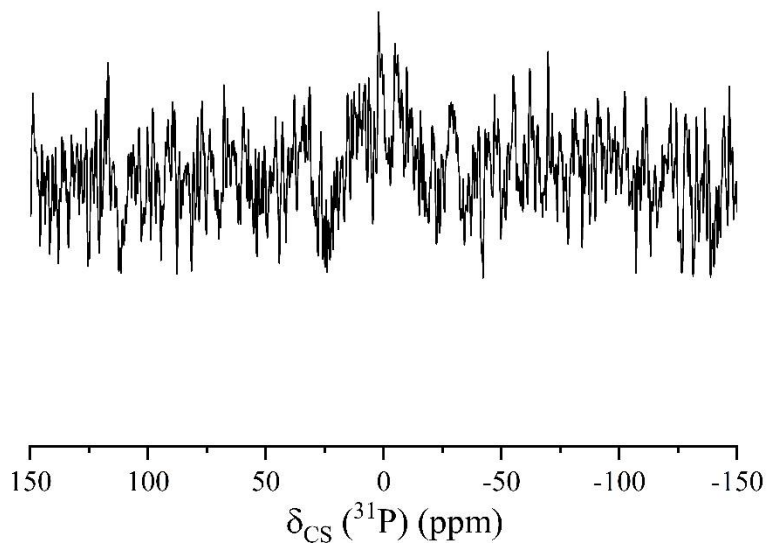
**Figure S4.**  $^{11}\text{B}$  MAS NMR spectra and subsequent lineshape fitting of the as-synthesized (a) MB0, (b) MB2-P1, (c) MB2-P3, and (d) MB2-P5 glasses as compared to analogous glass powders recovered from 7 d degradation experiments in Tris- $\text{HNO}_3$  solutions.





**Figure S5.**  $^{11}\text{B}$  MAS NMR spectra and subsequent lineshape fitting of the as-synthesized (a) PA0, (b) PA2-P1, and (c) PA2-P3 glasses as compared to analogous glass powders recovered from 7 d degradation experiments in Tris- $\text{HNO}_3$  solutions.

PB2-P5 7d



**Figure S6.**  $^{31}\text{P}$  MAS NMR spectra of the PB2-P5 sample recovered from 7-day degradation experiments in Tris- $\text{HNO}_3$  solutions, indicating the likely absence of phosphate species in this sample.



**Table S1.** Average concentration (ppm), averaged normalized loss ( $\times 10^{-2}$ ; mol/m<sup>2</sup>), and pH as a function of time (h) for all glasses in simulated body solutions. The reported errors are calculated 1 $\sigma$  standard deviation for duplicate samples.

<b>PB0 – Tris-HNO<sub>3</sub></b>		<b>Concentration, ppm</b>								<b>Normalized Loss (<math>\times 10^{-2}</math>), mol/m<sup>2</sup></b>							
<b>Time (h)</b>	<b>pH</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>
1	7.39 $\pm$ 0.02	14.4	$\pm$ 1.6	--	--	8.1	$\pm$ 0.7	5.3	$\pm$ 0.7	25.1	$\pm$ 2.8	--	--	23.6	$\pm$ 2.3	8.3	$\pm$ 1.1
6	7.50 $\pm$ 0.01	75.3	$\pm$ 5.4	--	--	37.9	$\pm$ 2.1	16.5	$\pm$ 1.8	131.0	$\pm$ 9.4	--	--	115.8	$\pm$ 6.5	26.1	$\pm$ 2.8
12	7.46 $\pm$ 0.03	117.2	$\pm$ 10.4	--	--	59.2	$\pm$ 6.3	26.0	$\pm$ 2.0	204.0	$\pm$ 18.1	--	--	181.5	$\pm$ 19.4	41.2	$\pm$ 3.2
24	7.50 $\pm$ 0.00	143.4	$\pm$ 1.6	--	--	74.9	$\pm$ 0.7	32.5	$\pm$ 1.8	249.5	$\pm$ 2.7	--	--	229.8	$\pm$ 2.1	51.5	$\pm$ 2.9
72	7.69 $\pm$ 0.01	175.8	$\pm$ 6.9	--	--	91.3	$\pm$ 2.5	43.2	$\pm$ 1.3	305.8	$\pm$ 12.0	--	--	280.2	$\pm$ 7.6	68.4	$\pm$ 2.0
168	7.5 $\pm$ 0.01	213.0	$\pm$ 10.0	--	--	111.0	$\pm$ 3.2	63.4	$\pm$ 1.4	370.5	$\pm$ 17.4	--	--	341.0	$\pm$ 9.9	100.3	$\pm$ 2.2
336	7.56 $\pm$ 0.00	233.4	$\pm$ 4.3	--	--	119.7	$\pm$ 1.4	62.1	$\pm$ 0.8	406.1	$\pm$ 7.6	--	--	367.9	$\pm$ 4.4	98.3	$\pm$ 1.3
672	7.67 $\pm$ 0.01	219.8	$\pm$ 1.3	--	--	118.1	$\pm$ 0.7	61.0	$\pm$ 0.2	382.5	$\pm$ 2.3	--	--	359.8	$\pm$ 2.1	96.5	$\pm$ 0.4
<b>PB2-P1 – Tris-HNO<sub>3</sub></b>		<b>Concentration, ppm</b>								<b>Normalized Loss (<math>\times 10^{-2}</math>), mol/m<sup>2</sup></b>							
<b>Time (h)</b>	<b>pH</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>
1	7.39 $\pm$ 0.01	13.0	$\pm$ 2.8	<0.5	--	7.5	$\pm$ 1.3	4.7	$\pm$ 1.1	22.9	$\pm$ 5.0	--	--	22.0	$\pm$ 4.0	7.5	$\pm$ 1.8
6	7.48 $\pm$ 0.01	71.9	$\pm$ 11.5	3.1	$\pm$ 0.5	36.0	$\pm$ 5.7	15.0	$\pm$ 2.4	126.3	$\pm$ 20.1	100.0	$\pm$ 17.2	110.8	$\pm$ 17.6	24.0	$\pm$ 3.8
12	7.43 $\pm$ 0.01	119.7	$\pm$ 11.8	5.7	$\pm$ 0.5	60.6	$\pm$ 4.2	24.6	$\pm$ 2.7	210.4	$\pm$ 20.8	183.0	$\pm$ 16.4	187.4	$\pm$ 13.1	39.3	$\pm$ 4.3
24	7.58 $\pm$ 0.01	158.1	$\pm$ 8.1	7.9	$\pm$ 0.3	81.4	$\pm$ 4.7	33.7	$\pm$ 2.4	277.9	$\pm$ 14.3	254.0	$\pm$ 10.1	252.2	$\pm$ 14.7	53.9	$\pm$ 3.8
72	7.68 $\pm$ 0.01	201.6	$\pm$ 3.8	9.9	$\pm$ 0.3	103.1	$\pm$ 2.2	44.5	$\pm$ 2.4	354.2	$\pm$ 6.7	318.8	$\pm$ 10.3	319.8	$\pm$ 6.8	71.2	$\pm$ 3.8
168	7.47 $\pm$ 0.02	218.7	$\pm$ 12.1	11.2	$\pm$ 0.5	112.8	$\pm$ 5.5	55.7	$\pm$ 4.8	384.3	$\pm$ 21.3	362.3	$\pm$ 16.1	350.2	$\pm$ 17.2	89.1	$\pm$ 7.7
336	7.45 $\pm$ 0.01	238.1	$\pm$ 2.6	12.1	$\pm$ 0.0	122.6	$\pm$ 0.8	64.3	$\pm$ 0.1	418.4	$\pm$ 4.5	390.1	$\pm$ 1.0	380.6	$\pm$ 2.6	102.7	$\pm$ 0.1
672	7.66 $\pm$ 0.01	219.8	$\pm$ 3.3	11.7	$\pm$ 0.1	116.8	$\pm$ 1.9	61.1	$\pm$ 0.9	386.4	$\pm$ 5.7	378.8	$\pm$ 1.7	359.3	$\pm$ 5.9	97.7	$\pm$ 1.4
<b>PB2-P3 – Tris-HNO<sub>3</sub></b>		<b>Concentration, ppm</b>								<b>Normalized Loss (<math>\times 10^{-2}</math>), mol/m<sup>2</sup></b>							
<b>Time (h)</b>	<b>pH</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>
1	7.37 $\pm$ 0.02	8.0	$\pm$ 0.5	1.0	$\pm$ 0.0	5.0	$\pm$ 0.3	2.7	$\pm$ 0.1	14.3	$\pm$ 0.9	10.3	$\pm$ 0.4	14.8	$\pm$ 0.9	4.5	$\pm$ 0.2
6	7.46 $\pm$ 0.00	60.8	$\pm$ 4.6	8.9	$\pm$ 0.8	31.6	$\pm$ 2.1	13.7	$\pm$ 0.5	109.1	$\pm$ 8.2	96.2	$\pm$ 9.0	99.2	$\pm$ 6.6	22.3	$\pm$ 0.9
12	7.39 $\pm$ 0.01	109.3	$\pm$ 3.1	16.5	$\pm$ 0.9	56.0	$\pm$ 1.5	23.8	$\pm$ 0.7	196.1	$\pm$ 5.6	178.1	$\pm$ 9.7	176.8	$\pm$ 4.8	38.9	$\pm$ 1.2
24	7.53 $\pm$ 0.01	149.6	$\pm$ 3.2	22.4	$\pm$ 0.8	76.9	$\pm$ 2.6	30.6	$\pm$ 1.7	268.3	$\pm$ 5.8	241.4	$\pm$ 8.7	243.1	$\pm$ 8.1	49.9	$\pm$ 2.8
72	7.64 $\pm$ 0.01	212.0	$\pm$ 16.0	31.7	$\pm$ 2.4	109.0	$\pm$ 7.6	43.2	$\pm$ 4.9	380.3	$\pm$ 28.7	341.6	$\pm$ 25.3	345.1	$\pm$ 24.1	70.4	$\pm$ 8.0
168	7.45 $\pm$ 0.00	221.6	$\pm$ 1.9	35.0	$\pm$ 0.1	114.8	$\pm$ 0.6	59.3	$\pm$ 1.8	397.6	$\pm$ 3.3	377.2	$\pm$ 1.0	363.7	$\pm$ 1.9	96.7	$\pm$ 3.0
336	7.50 $\pm$ 0.01	222.2	$\pm$ 1.2	36.3	$\pm$ 1.0	116.6	$\pm$ 0.6	64.5	$\pm$ 1.3	398.6	$\pm$ 2.2	390.2	$\pm$ 10.3	369.2	$\pm$ 1.8	105.2	$\pm$ 2.1
672	7.60 $\pm$ 0.00	212.9	$\pm$ 3.6	35.1	$\pm$ 1.6	114.1	$\pm$ 2.1	63.2	$\pm$ 0.9	381.9	$\pm$ 6.4	377.3	$\pm$ 17.4	358.1	$\pm$ 6.5	103.1	$\pm$ 1.4

<b>PB2-P5 – Tris-HNO<sub>3</sub></b>		<b>Concentration, ppm</b>								<b>Normalized Loss (<math>\times 10^{-2}</math>), mol/m<sup>2</sup></b>							
<b>Time (h)</b>	<b>pH</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>
1	7.36±0.01	7.6	±0.5	2.0	±0.3	4.9	±0.4	2.2	±0.4	13.9	±0.9	12.8	±1.7	14.7	±1.2	3.6	±0.6
6	7.45±0.00	59.1	±3.5	15.7	±1.2	31.4	±2.0	13.2	±1.7	108.2	±6.5	101.1	±7.8	100.6	±6.6	21.9	±2.8
12	7.35±0.00	105.4	±13.4	27.9	±4.1	54.7	±6.8	21.1	±4.3	193.0	±24.5	180.0	±26.2	176.2	±22.2	35.2	±7.2
24	7.5±0.01	152.8	±0.5	41.1	±0.8	80.9	±0.2	32.6	±0.8	279.9	±1.0	265.4	±5.1	261.1	±0.5	54.3	±1.3
72	7.64±0.01	209.3	±3.5	57.2	±1.2	110.4	±2.2	44.4	±5.6	383.2	±6.3	369.5	±7.6	357.1	±7.2	74.0	±9.3
168	7.4±0.01	210.6	±4.9	57.2	±0.2	111.0	±2.7	57.5	±0.7	385.7	±9.0	369.5	±1.1	358.9	±8.7	95.7	±1.2
336	7.45±0.01	210.3	±0.5	58.7	±0.1	113.3	±0.5	67.0	±0.1	385.1	±0.9	379.2	±0.9	366.6	±1.5	111.5	±0.2
672	7.54±0.01	203.0	±3.0	58.0	±0.5	111.7	±1.8	66.4	±0.5	371.7	±5.5	374.4	±3.5	357.8	±5.8	110.6	±0.9
<b>MB0 – Tris-HCl</b>		<b>Concentration, ppm</b>								<b>Normalized Loss (<math>\times 10^{-2}</math>), mol/m<sup>2</sup></b>							
<b>Time (h)</b>	<b>pH</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>
1	7.41±0.00	4.8	±0.2	--	--	4.3	±0.0	1.3	±0.0	8.4	±0.3	--	--	8.4	±0.0	1.8	±0.1
6	7.49±0.00	35.4	±2.1	--	--	16.2	±0.9	9.3	±0.5	61.5	±3.6	--	--	52.5	±3.2	13.3	±0.7
12	7.48±0.01	58.6	±1.4	--	--	25.9	±0.7	17.4	±0.1	102.0	±2.4	--	--	88.4	±2.5	24.8	±0.1
24	7.64±0.00	84.9	±1.3	--	--	36.5	±0.2	27.9	±4.2	147.7	±2.2	--	--	127.7	±0.9	39.7	±5.9
72	7.64±0.01	132.7	±8.7	--	--	57.0	±3.3	44.0	±5.0	230.9	±15.1	--	--	203.5	±12.1	62.6	±7.2
168	7.58±0.01	162.1	±2.6	--	--	70.9	±0.9	52.6	±3.0	282.0	±4.5	--	--	254.8	±3.3	74.9	±4.3
336	7.64±0.01	206.7	±0.6	--	--	87.9	±0.8	61.1	±0.0	359.7	±1.0	--	--	317.9	±2.8	87.1	±0.0
672	7.75±0.02	205.3	±1.6	--	--	90.7	±0.8	60.9	±1.3	357.2	±2.8	--	--	330.3	±3.1	86.7	±1.8
<b>MB2-P1 – Tris-HCl</b>		<b>Concentration, ppm</b>								<b>Normalized Loss (<math>\times 10^{-2}</math>), mol/m<sup>2</sup></b>							
<b>Time (h)</b>	<b>pH</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>
1	7.43±0.02	5.2	±0.2	<0.5	--	4.2	±0.1	1.4	±0.1	9.2	±0.3	--	--	8.3	±0.2	2.0	±0.1
6	7.49±0.00	44.4	±1.4	1.8	±0.0	19.2	±0.3	11.1	±0.5	77.9	±2.4	56.8	±0.7	64.2	±1.3	16.0	±0.7
12	7.48±0.01	58.1	±2.0	2.4	±0.1	24.7	±0.6	13.8	±0.4	102.1	±3.5	76.9	±2.6	84.8	±2.4	19.9	±0.6
24	7.58±0.01	94.0	±1.9	4.3	±0.0	40.6	±0.1	25.8	±0.4	165.2	±3.4	138.9	±0.6	144.1	±0.4	37.0	±0.6
72	7.64±0.01	161.2	±8.7	7.7	±0.3	67.1	±4.1	46.2	±5.2	283.3	±15.3	250.1	±11.1	243.4	±15.3	66.5	±7.4
168	7.54±0.02	196.1	±2.9	9.7	±0.0	82.1	±0.6	55.4	±0.9	344.7	±5.1	311.9	±0.5	299.5	±2.3	79.7	±1.3
336	7.64±0.01	232.2	±4.3	11.3	±0.4	97.0	±1.8	61.6	±0.3	408.1	±7.5	365.0	±12.5	355.0	±6.6	88.7	±0.5
672	7.74±0.01	221.9	±0.7	12.0	±0.1	97.7	±0.0	61.9	±0.5	389.9	±1.3	388.8	±1.7	359.6	±0.1	89.0	±0.7

<b>MB2-P3 – Tris-HCl</b>		<b>Concentration, ppm</b>								<b>Normalized Loss (<math>\times 10^{-2}</math>), mol/m<sup>2</sup></b>							
<b>Time (h)</b>	<b>pH</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>
1	7.42±0.00	1.7	±0.1	<0.5	--	2.8	±0.1	0.7	±0.1	3.1	±0.2	--	--	2.9	±0.4	1.1	±0.1
6	7.46±0.02	27.3	±0.7	3.9	±0.1	12.8	±0.2	8.8	±0.1	48.9	±1.3	42.2	±1.0	41.3	±0.8	13.0	±0.1
12	7.46±0.01	46.5	±2.4	6.8	±0.4	20.3	±1.0	14.9	±0.2	83.4	±4.3	73.4	±4.4	69.9	±3.8	21.8	±0.2
24	7.61±0.01	74.0	±10	10.9	±1.8	31.3	±4.2	20.1	±2.7	132.8	±18.0	117.6	±19.0	111.6	±16.1	29.5	±4.0
72	7.57±0.02	152.5	±9.7	23.9	±2.1	64.8	±5.0	40.7	±5.9	273.5	±17.5	256.8	±22.3	239.6	±19.2	59.8	±8.6
168	7.48±0.03	208.8	±1.5	32.6	±0.6	86.7	±0.7	54.3	±2.6	374.4	±2.6	351.1	±6.2	323.2	±2.8	79.8	±3.7
336	7.61±0.03	228.6	±2.6	35.1	±0.9	94.9	±0.6	62.0	±0.5	410.1	±4.7	377.3	±9.6	354.3	±2.3	91.0	±0.7
672	7.70±0.01	210.1	±1.7	36.3	±0.6	93.5	±0.7	62.0	±0.4	376.8	±3.0	390.5	±6.5	351.3	±2.6	91.0	±0.6
<b>MB2-P5 – Tris-HCl</b>		<b>Concentration, ppm</b>								<b>Normalized Loss (<math>\times 10^{-2}</math>), mol/m<sup>2</sup></b>							
<b>Time (h)</b>	<b>pH</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>
1	7.42±0.00	<0.5	--	<0.5	--	2.1	±0.0	0.3	±0.0	--	--	--	--	0.3	±0.0	0.4	±0.0
6	7.47±0.01	16.3	±0.6	4.2	±0.0	8.5	±0.2	6.2	±0.8	29.8	±1.2	27.0	±0.3	25.3	±0.9	9.4	±1.2
12	7.46±0.01	27.1	±6.3	7.0	±1.7	12.6	±2.6	8.4	±3.3	49.7	±11.5	45.2	±10.8	41.5	±10.0	12.6	±5.0
24	7.66±0.02	53.1	±0.4	14.2	±0.0	24.2	±0.1	17.7	±0.1	97.2	±0.7	91.4	±0.1	86.3	±0.3	26.5	±0.2
72	7.55±0.02	130.3	±5.5	34.9	±1.1	56.3	±1.8	38.6	±3.2	238.6	±10.1	225.2	±7.3	211.6	±7.0	57.8	±4.8
168	7.37±0.02	183.9	±1.4	47.9	±0.6	78.2	±0.5	51.8	±0.3	336.9	±2.6	309.0	±3.9	296.6	±1.9	77.6	±0.5
336	7.57±0.04	215.5	±2.4	56.3	±0.0	91.4	±1.2	61.0	±1.1	394.8	±4.5	363.4	±0.3	348.3	±4.5	91.4	±1.7
672	7.66±0.01	199.8	±3.7	57.4	±0.7	90.8	±1.9	64.5	±0.9	365.9	±6.8	370.6	±4.7	347.9	±7.3	96.7	±1.3
<b>MB0 – Tris-HNO<sub>3</sub></b>		<b>Concentration, ppm</b>								<b>Normalized Loss (<math>\times 10^{-2}</math>), mol/m<sup>2</sup></b>							
<b>Time (h)</b>	<b>pH</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>
1	7.40±0.01	4.7	±0.3	--	--	2.9	±0.1	1.3	±0.1	8.2	±0.4	--	--	9.3	±0.3	1.8	±0.1
6	7.49±0.01	42.2	±1.8	--	--	17.9	±0.9	11.6	±0.5	73.4	±3.2	--	--	64.6	±3.5	16.5	±0.7
12	7.41±0.01	68.1	±4.4	--	--	30.1	±2.2	18.7	±2.6	118.4	±7.7	--	--	110.0	±8.0	26.6	±3.7
24	7.65±0.01	91.2	±4.0	--	--	39.5	±2.1	27.6	±1.4	158.7	±7.0	--	--	144.9	±7.9	39.3	±2.1
72	7.59±0.01	138.0	±4.9	--	--	60.2	±2.3	40.9	±2.4	240.0	±8.6	--	--	221.4	±8.3	58.3	±3.4
168	7.64±0.03	165.1	±2.1	--	--	72.4	±1.2	57.1	±0.9	287.3	±3.6	--	--	266.5	±4.5	81.4	±1.3
336	7.63±0.01	195.1	±1.1	--	--	85.0	±0.3	59.3	±0.4	339.5	±1.9	--	--	313.1	±1.1	84.4	±0.5
672	7.68±0.01	207.3	±1.7	--	--	93.5	±1.0	60.4	±0.4	360.6	±2.9	--	--	340.6	±3.9	86.0	±0.6

<b>MB2-P1 – Tris-HNO<sub>3</sub></b>		<b>Concentration, ppm</b>								<b>Normalized Loss (<math>\times 10^{-2}</math>), mol/m<sup>2</sup></b>							
<b>Time (h)</b>	<b>pH</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>
1	7.41±0.00	5.3	±0.3	<0.5	--	3.0	±0.1	1.3	±0.0	9.3	±0.5	--	--	9.9	±0.4	1.9	±0.1
6	7.48±0.01	46.9	±1.2	1.9	±0.2	19.5	±0.6	11.4	±0.7	82.4	±2.1	60.6	±4.8	71.4	±2.4	16.4	±1.0
12	7.40±0.01	74.4	±1.2	3.2	±0.2	31.5	±0.6	17.4	±0.4	130.8	±2.1	104.4	±6.9	116.1	±2.3	25.0	±0.6
24	7.51±0.03	100.1	±7.9	4.7	±0.6	43.2	±5.2	25.3	±3.9	175.8	±13.9	152.9	±19.3	159.8	±19.4	36.5	±5.6
72	7.63±0.01	158.9	±3.2	7.6	±0.3	68.0	±1.2	38.1	±2.7	279.3	±5.6	244.5	±9.7	252.7	±4.6	54.8	±3.9
168	7.47±0.04	196.8	±3.9	10.4	±0.1	85.6	±1.9	61.3	±2.5	346.0	±6.9	336.4	±3.5	318.4	±7.0	88.1	±3.6
336	7.61±0.03	221.6	±0.8	11.2	±0.0	94.5	±0.9	59.4	±0.3	389.5	±1.4	360.5	±0.3	351.8	±3.5	85.5	±0.4
672	7.67±0.01	224.2	±0.1	11.8	±0.0	99.6	±0.2	61.5	±0.0	394.1	±0.1	381.5	±0.4	366.9	±0.8	88.5	±0.0
<b>MB2-P3 – Tris-HNO<sub>3</sub></b>		<b>Concentration, ppm</b>								<b>Normalized Loss (<math>\times 10^{-2}</math>), mol/m<sup>2</sup></b>							
<b>Time (h)</b>	<b>pH</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>
1	7.40±0.01	2.6	±0.1	<0.5	--	2.1	±0.0	1.0	±0.1	4.6	±0.2	--	--	6.3	±0.2	1.5	±0.2
6	7.47±0.00	35.2	±1.7	5.3	±0.4	15.5	±0.6	12.0	±0.9	63.2	±3.0	56.6	±4.6	57.7	±2.2	17.6	±1.3
12	7.40±0.00	64.2	±1.0	9.4	±0.1	28.1	±0.5	19.0	±0.7	115.1	±1.7	100.7	±0.8	105.5	±1.8	27.8	±1.0
24	7.56±0.00	93.0	±2.4	14.3	±0.8	41.0	±0.7	26.4	±1.5	166.8	±4.3	153.8	±8.7	154.8	±2.5	38.8	±2.2
72	7.70±0.01	143.5	±1.7	24.1	±0.3	66.1	±1.0	38.6	±1.9	257.3	±3.1	259.5	±2.7	246.6	±3.9	56.7	±2.8
168	7.65±0.02	207.1	±4.5	33.8	±0.7	89.3	±2.0	62.1	±0.8	371.4	±8.0	363.7	±7.1	338.9	±7.5	91.2	±1.2
336	7.55±0.02	225.8	±5.9	36.0	±0.3	97.6	±1.1	62.5	±1.3	405.0	±10.5	387.4	±3.0	370.9	±4.0	91.8	±1.9
672	7.62±0.01	211.0	±2.1	35.3	±0.5	94.3	±0.9	61.2	±0.1	378.4	±3.9	380.0	±5.5	354.2	±3.3	89.8	±0.1
<b>MB2-P5 – Tris-HNO<sub>3</sub></b>		<b>Concentration, ppm</b>								<b>Normalized Loss (<math>\times 10^{-2}</math>), mol/m<sup>2</sup></b>							
<b>Time (h)</b>	<b>pH</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>	<b>Na</b>	<b>Na-error</b>	<b>P</b>	<b>P-error</b>	<b>B</b>	<b>B-error</b>	<b>Si</b>	<b>Si-error</b>
1	7.41±0.01	<0.5	--	<0.5	--	1.2	±0.1	0.4	±0.0	--	--	--	--	3.3	±0.2	0.6	±0.0
6	7.46±0.00	22.8	±0.5	5.7	±0.1	10.6	±0.1	8.9	±0.5	41.8	±0.9	36.9	±0.4	39.9	±0.4	13.4	±0.7
12	7.38±0.01	43.1	±0.1	11.3	±0.1	19.9	±0.1	15.5	±0.8	79.0	±0.2	72.7	±0.6	76.0	±0.3	23.3	±1.3
24	7.50±0.01	66.8	±5.9	17.7	±1.7	30.5	±2.3	24.9	±2.6	122.3	±10.9	114.3	±11.3	117.1	±8.9	37.4	±3.9
72	7.67±0.00	135.7	±5.5	35.0	±1.5	60.3	±2.1	39.7	±4.0	248.6	±10.1	226.2	±10.0	233.5	±8.1	59.5	±6.0
168	7.60±0.01	179.1	±3.7	50.4	±1.2	79.3	±1.8	60.3	±0.1	328.0	±6.7	325.6	±7.4	307.2	±6.9	90.4	±0.1
336	7.54±0.01	216.5	±0.1	57.7	±0.0	94.1	±0.1	61.0	±2.1	396.6	±0.2	372.9	±0.0	364.8	±0.5	91.5	±3.2
672	7.58±0.01	199.1	±3.4	55.5	±0.6	90.9	±1.5	62.8	±0.4	364.7	±6.3	358.3	±3.6	348.2	±5.9	94.1	±0.6

PA0 – Tris-HNO <sub>3</sub>		Concentration, ppm								Normalized Loss ( $\times 10^{-2}$ ), mol/m <sup>2</sup>							
Time (h)	pH	Na	Na-error	P	P-error	B	B-error	Si	Si-error	Na	Na-error	P	P-error	B	B-error	Si	Si-error
1	7.37±0.00	1.2	±0.2	--	--	1.4	±0.1	0.4	±0.1	2.1	±0.3	--	--	4.6	±0.7	0.6	±0.1
6	7.48±0.00	24.0	±1.4	--	--	9.7	±0.3	8.5	±1.0	41.7	±2.5	--	--	43.1	±1.4	11.1	±1.3
12	7.39±0.01	41.3	±3.5	--	--	16.1	±0.7	14.5	±2.4	71.8	±6.2	--	--	72.8	±3.2	18.8	±3.1
24	7.50±0.00	56.1	±2.9	--	--	22.0	±0.5	17.9	±2.1	97.6	±5.1	--	--	100.0	±2.4	23.1	±2.7
72	7.69±0.00	112.7	±0.3	--	--	42.1	±0.3	35.4	±0.5	196.1	±0.6	--	--	193.0	±1.2	45.9	±0.7
168	7.51±0.01	155.6	±5.5	--	--	57.3	±2.1	50.5	±2.8	270.8	±9.5	--	--	263.0	±9.6	65.4	±3.6
336	7.69±0.03	198.0	±8.2	--	--	70.5	±2.6	58.7	±2.5	344.5	±14.3	--	--	324.2	±11.8	76.0	±3.3
672	7.69±0.01	215.8	±0.6	--	--	79.0	±0.2	59.2	±0.4	375.5	±1.1	--	--	358.9	±0.8	76.7	±0.5
PA2-P1 – Tris-HNO <sub>3</sub>		Concentration, ppm								Normalized Loss ( $\times 10^{-2}$ ), mol/m <sup>2</sup>							
Time (h)	pH	Na	Na-error	P	P-error	B	B-error	Si	Si-error	Na	Na-error	P	P-error	B	B-error	Si	Si-error
1	7.47±0.02	0.9	±0.2	<0.5	--	1.2	±0.1	0.4	±0.1	1.6	±0.4	--	--	3.7	±0.3	0.6	±0.1
6	7.48±0.01	17.4	±2	<0.5	--	7.3	±0.8	7.0	±0.8	30.6	±3.5	--	--	32.4	±3.8	9.1	±1.1
12	7.40±0.01	37.4	±1.1	1.5	±0.0	14.5	±0.5	15.9	±0.5	65.7	±1.9	48.3	±0.2	66.1	±2.4	20.8	±0.6
24	7.47±0.01	56.2	±2.8	2.4	±0.2	21.8	±2.2	23.2	±3.9	98.7	±4.9	76.9	±7.9	100.1	±10.5	30.4	±5.1
72	7.68±0.02	108.4	±5	5.1	±0.3	41.3	±2.4	41.4	±3.5	190.6	±8.7	164.0	±11.0	191.0	±11.1	54.2	±4.6
168	7.57±0.03	154.3	±5.4	7.6	±0.1	55.7	±1.9	52.1	±3.1	271.2	±9.4	246.3	±2.9	258.3	±8.7	68.2	±4.1
336	7.66±0.01	205.9	±4.3	10.4	±0.1	73.3	±0.8	60.6	±0.6	361.8	±7.5	335.2	±3.5	340.7	±3.9	79.2	±0.8
672	7.68±0.02	211.6	±1.9	11.5	±0.0	78.1	±0.8	60.4	±1.6	371.9	±3.3	370.3	±0.9	358.2	±3.8	79.0	±2.1
PA2-P3 – Tris-HNO <sub>3</sub>		Concentration, ppm								Normalized Loss ( $\times 10^{-2}$ ), mol/m <sup>2</sup>							
Time (h)	pH	Na	Na-error	P	P-error	B	B-error	Si	Si-error	Na	Na-error	P	P-error	B	B-error	Si	Si-error
1	7.47±0.01	<0.5	--	<0.5	--	0.6	±0.0	<0.2	--	--	--	--	--	1.0	±0.1	--	--
6	7.46±0.01	10.5	±3.2	1.4	±0.5	4.9	±1.0	5.6	±2.1	18.7	±5.7	15.1	±5.2	21.7	±4.6	7.5	±2.8
12	7.39±0.01	23.6	±0.2	3.5	±0.0	9.7	±0.2	11.1	±0.4	42.3	±0.3	37.5	±0.2	44.5	±0.9	14.8	±0.5
24	7.53±0.00	36.7	±3.4	5.7	±0.4	14.9	±0.9	19.1	±0.8	65.9	±6.0	61.4	±4.5	69.1	±4.5	25.5	±1.1
72	7.68±0.02	90.8	±1.1	13.8	±0.2	33.3	±0.3	38.7	±3.8	162.8	±2.0	148.5	±1.8	156.9	±1.4	51.6	±5.0
168	7.54±0.01	145.9	±2.2	23.5	±0.9	53.0	±1.3	54.3	±2.2	261.7	±3.9	252.5	±9.6	250.7	±6.4	72.4	±2.9
336	7.65±0.01	207.1	±0.9	33.1	±0.1	72.0	±0.3	63.2	±0.3	371.4	±1.6	356.2	±1.1	341.6	±1.2	84.4	±0.4
672	7.64±0.01	214.7	±1.2	37.2	±1.5	79.6	±0.6	64.6	±0.2	385.1	±2.1	400.4	±16.3	372.6	±2.7	86.2	±0.3

**Table S2.** Fitting parameters of  $^{11}\text{B}$  MAS NMR in the studied glasses, including fraction of each species  $f$  ( $\pm 1.0\%$ ), isotropic chemical shift,  $\delta_{\text{CS}}^{\text{iso}}$  ( $\pm 0.5$  ppm), quadrupolar coupling constant,  $C_Q$  ( $\pm 0.2$  MHz),  $\eta_Q$  ( $\pm 0.05$ ), and overall  $N_4$  fractions ( $\pm 1\%$ ).

Sample ID	B(III) Ring				B(III) Non-Ring				B(IV)-a		B(IV)-b		B(IV)-c		$N_4$
	$f$ (%)	$\delta_{\text{CS}}^{\text{iso}}$ (ppm)	$C_Q$ (MHz)	$\eta_Q$	$f$ (%)	$\delta_{\text{CS}}^{\text{iso}}$ (ppm)	$C_Q$ (MHz)	$\eta_Q$	$f$ (%)	$\delta_{\text{CS}}^{\text{iso}}$ (ppm)	$f$ (%)	$\delta_{\text{CS}}^{\text{iso}}$ (ppm)	$f$ (%)	$\delta_{\text{CS}}^{\text{iso}}$ (ppm)	
<b>PB0 Initial</b>	28.1	18.3	2.6	0.3	8.0	15.6	2.6	0.5	58.6	0.1	5.1	-1.9	--	--	63.7
<b>PB0 1 d</b>	27.6	18.3	2.6	0.3	6.9	14.9	2.6	0.5	61.2	-0.1	4.0	-2.1	--	--	65.2
<b>PB0 7d</b>	21.8	18.3	2.6	0.3	6.2	15.2	2.6	0.5	63.9	-0.2	5.4	-2.1	2.7	-1.1	72.0
<b>PB2-P1 Initial</b>	29.4	18.2	2.6	0.3	6.9	14.9	2.6	0.5	57.6	0.0	5.8	-2.0	--	--	63.4
<b>PB2-P1 1 d</b>	26.0	18.3	2.6	0.3	6.5	14.9	2.6	0.5	62.6	-0.1	4.7	-2.0	--	--	67.3
<b>PB2-P1 7d</b>	17.6	18.0	2.6	0.3	4.1	15.0	2.6	0.5	66.1	-0.4	5.3	-2.2	7.0	-1.1	78.3
<b>PB2-P3 Initial</b>	30.6	18.0	2.6	0.3	7.4	14.8	2.6	0.5	54.2	-0.1	7.6	-2.0	--	--	61.8
<b>PB2-P3 1 d</b>	28.3	18.0	2.6	0.3	7.0	14.6	2.6	0.5	58.6	-0.2	5.9	-2.1	--	--	64.5
<b>PB2-P3 7d</b>	6.2	17.7	2.6	0.3	1.1	14.6	2.6	0.5	62.0	-0.6	7.5	-2.4	23.3	-1.2	92.7
<b>PB2-P5 Initial</b>	31.7	17.8	2.6	0.3	9.7	14.6	2.6	0.5	49.5	-0.2	9.0	-2.1	--	--	58.5
<b>PB2-P5 1 d</b>	30.8	17.9	2.6	0.3	8.5	14.4	2.5	0.5	53.2	-0.3	7.3	-2.2	--	--	60.5
<b>PB2-P5 7d</b>	7.5	17.5	2.6	0.3	1.2	14.6	2.6	0.5	64.5	-0.7	5.2	-2.4	21.6	-1.1	91.3
<b>MB0 Initial</b>	25.1	17.7	2.6	0.3	5.9	14.6	2.5	0.5	62.4	-0.5	6.6	-2.4	--	--	67.2
<b>MB0 1 d</b>	24.7	18.3	2.6	0.3	5.8	14.4	2.6	0.5	63.9	-0.1	5.6	-2.0	--	--	69.5
<b>MB0 7d</b>	21.5	18.2	2.6	0.3	5.7	14.9	2.6	0.5	68.3	-0.2	4.5	-2.0	--	--	72.8
<b>MB2-P1 Initial</b>	25.8	17.6	2.6	0.3	6.7	14.6	2.6	0.5	62.4	-0.6	5.1	-2.5	--	--	67.5
<b>MB2-P1 1 d</b>	25.0	18.1	2.6	0.3	6.1	15.1	2.6	0.5	63.3	-0.2	5.3	-2.1	--	--	68.6
<b>MB2-P1 7d</b>	21.0	18.1	2.6	0.3	5.3	15.1	2.6	0.5	63.9	-0.2	6.7	-2.1	3.1	-1.1	73.7
<b>MB2-P3 Initial</b>	25.5	17.4	2.6	0.3	7.3	14.8	2.6	0.5	59.6	-0.7	7.6	-2.6	--	--	67.2
<b>MB2-P3 1 d</b>	24.6	17.9	2.6	0.3	6.5	14.6	2.6	0.5	61.2	-0.3	7.6	-2.2	--	--	68.7
<b>MB2-P3 7d</b>	19.5	17.9	2.6	0.3	5.6	14.9	2.6	0.5	64.6	-0.4	6.4	-2.2	3.9	-1.1	74.9
<b>MB2-P5 Initial</b>	26.1	17.3	2.6	0.3	8.4	14.1	2.5	0.5	54.6	-0.7	10.9	-2.6	--	--	65.5
<b>MB2-P5 1 d</b>	27.2	17.8	2.6	0.3	7.9	14.5	2.5	0.5	55.6	-0.3	9.1	-2.2	--	--	64.7
<b>MB2-P5 7d</b>	22.7	17.8	2.6	0.3	6.7	14.6	2.6	0.5	60.8	-0.4	7.7	-2.3	2.1	-1.2	70.6

Table S2 (cont.).

Sample ID	B(III) Ring				B(III) Non-Ring				B(IV)-a		B(IV)-b		B(IV)-c		$N_4$
	$f$ (%)	$\delta_{CS}^{iso}$ (ppm)	$C_Q$ (MHz)	$\eta_Q$	$f$ (%)	$\delta_{CS}^{iso}$ (ppm)	$C_Q$ (MHz)	$\eta_Q$	$f$ (%)	$\delta_{CS}^{iso}$ (ppm)	$f$ (%)	$\delta_{CS}^{iso}$ (ppm)	$f$ (%)	$\delta_{CS}^{iso}$ (ppm)	
<b>PA0 Initial</b>	21.2	18.2	2.6	0.3	7.3	15.5	2.6	0.5	63.6	-0.2	7.7	-1.9	--	--	71.3
<b>PA0 1 d</b>	21.5	18.1	2.6	0.3	5.8	15.2	2.6	0.5	66.0	-0.3	6.4	-2.1	--	--	72.4
<b>PA0 7d</b>	20.2	18.1	2.6	0.3	5.7	14.9	2.6	0.5	67.9	-0.3	6.2	-2.0	--	--	74.2
<b>PA2-P1 Initial</b>	20.7	18.2	2.6	0.3	7.0	15.4	2.6	0.5	62.1	-0.2	10.0	-1.9	--	--	72.2
<b>PA2-P1 1 d</b>	21.3	18.0	2.6	0.3	5.6	14.8	2.6	0.5	64.5	-0.3	8.3	-2.1	--	--	72.8
<b>PA2-P1 7d</b>	18.5	18.1	2.6	0.3	5.7	15.0	2.6	0.5	68.8	-0.4	7.0	-2.0	--	--	75.8
<b>PA2-P3 Initial</b>	20.7	17.9	2.6	0.3	6.9	14.8	2.6	0.5	59.6	-0.4	12.6	-2.1	--	--	72.2
<b>PA2-P3 1 d</b>	20.8	17.8	2.6	0.3	6.3	14.7	2.6	0.5	61.8	-0.4	11.0	-2.2	--	--	72.7
<b>PA2-P3 7d</b>	18.3	17.9	2.6	0.3	6.2	14.9	2.6	0.5	67.0	-0.5	8.5	-2.1	--	--	75.5

**Table S3.** Fitting parameters of  $^{31}\text{P}$  MAS NMR in selected as-synthesized and dissolved glasses, including species designations, fraction of each species  $f$  ( $\pm 1.0\%$ ), isotropic chemical shift,  $\delta_{\text{CS}}^{\text{iso}}$  ( $\pm 0.2$  ppm), and FWHM ( $\pm 0.1$  ppm). Average number of B next nearest neighbors around P and total average P NNN coordination are also displayed.

Sample ID		$^{31}\text{P}$ MAS NMR					
		PB2-P5 Initial	PB2-P5 1 d	MB2-P5 Initial	MB2-P5 3d	PA2-P3 Initial	PA2-P3 7 d
$\text{P}^0$	$f$ (%)	0.0	0.0	1.2	1.1	4.7	4.0
	$\delta_{\text{CS}}^{\text{iso}}$ (ppm)	--	--	15.6	15.6	15.3	15.3
	FWHM (ppm)	--	--	4.9	4.9	4.5	4.5
$\text{P}^1_{1\text{B}}$	$f$ (%)	4.7	8.5	14.5	12.5	21.1	22.6
	$\delta_{\text{CS}}^{\text{iso}}$ (ppm)	6.1	5.8	6.2	6.2	5.8	5.8
	FWHM (ppm)	4.0	4.6	3.9	3.9	4.6	4.6
$\text{P}^1_{1\text{P-a}}$	$f$ (%)	33.2	20.2	36.6	32.5	40.6	37.3
	$\delta_{\text{CS}}^{\text{iso}}$ (ppm)	2.6	2.9	2.9	2.9	2.9	2.9
	FWHM (ppm)	5.8	4.5	4.6	4.4	4.6	4.4
$\text{P}^2_{2\text{B}}$	$f$ (%)	12.1	18.0	14.1	16.7	12.2	12.3
	$\delta_{\text{CS}}^{\text{iso}}$ (ppm)	-2.1	-0.9	-0.9	-0.9	-0.3	-0.3
	FWHM (ppm)	5.1	5.0	5.0	5.0	5.0	5.0
$\text{P}^2_{1\text{B,1P}}$	$f$ (%)	36.1	35.4	23.8	24.8	14.4	15.3
	$\delta_{\text{CS}}^{\text{iso}}$ (ppm)	-6.3	-5.9	-5.8	-5.8	-5.8	-5.8
	FWHM (ppm)	6.4	6.5	6.4	6.4	6.5	6.5
$\text{P}^3_{2\text{B,1P}}$	$f$ (%)	12.4	13.6	9.8	10.9	7.1	6.5
	$\delta_{\text{CS}}^{\text{iso}}$ (ppm)	-11.7	-11.7	-10.9	-10.9	-10.9	-10.9
	FWHM (ppm)	6.4	6.5	6.5	6.5	6.5	6.5
$\text{P}^2_{2\text{P}}$	$f$ (%)	1.4	3.4	0.0	1.7	0.0	1.3
	$\delta_{\text{CS}}^{\text{iso}}$ (ppm)	-18.7	-18.7	--	-18.7	--	-18.7
	FWHM (ppm)	5.9	5.9	--	5.9	--	5.9
$\text{P}^1_{1\text{P-b}}$	$f$ (%)	0.0	0.9	0.0	0.0	0.0	0.8
	$\delta_{\text{CS}}^{\text{iso}}$ (ppm)	--	2.5	--	--	--	2.8
	FWHM (ppm)	--	0.9	--	--	--	0.8
$\langle m_{\text{B}}(\text{P}) \rangle$ Av. # of B neighbors per P		0.90	1.07	0.86	0.92	0.74	0.76
$\langle n(\text{P}) \rangle$		1.74	1.84	1.56	1.64	1.36	1.38



**Table S4.** Fitting parameters of  $^{29}\text{Si}$  MAS NMR in selected glasses recovered from dissolution experiments, including species designations, fractions of each species  $f$  ( $\pm 1.0\%$ ), isotropic chemical shift,  $\delta_{\text{CS}}^{\text{iso}}$  ( $\pm 0.2$  ppm), FWHM ( $\pm 0.1$  ppm), and total average Si NNN coordination ( $\langle n_{\text{Si}} \rangle$ ).

Sample ID	$\text{Si}^4$			$\text{Si}^3$			$\text{Si}^2$			$\langle n(\text{Si}) \rangle$
	$f$ (%)	$\delta_{\text{CS}}^{\text{iso}}$ (ppm)	FWHM (ppm)	$f$ (%)	$\delta_{\text{CS}}^{\text{iso}}$ (ppm)	FWHM (ppm)	$f$ (%)	$\delta_{\text{CS}}^{\text{iso}}$ (ppm)	FWHM (ppm)	
<b>PB2-P5 14 d</b>	66.2	-112.1	8.6	26.8	-103.2	7.7	7.0	-96.2	7.7	3.59
<b>MB0 14 d</b>	58.2	-111.0	8.8	28.7	-102.5	7.7	13.1	-95.9	7.7	3.45
<b>MB2-P5 14 d</b>	72.2	-112.1	8.8	22.9	-104.4	7.7	4.9	-97.8	7.6	3.67