

## **Unveiling the Mechanisms Behind Surface Degradation of Dental Resin Composites in Simulated Oral Environments**

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## Hardness of Composites in Acid and Artificial Saliva Treatment

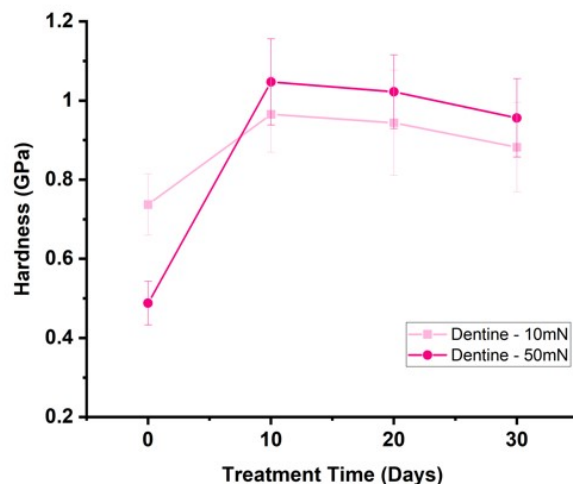


Figure S1. Average hardness values for UC-1 composite after 0, 10, 20, and 30 days of acid treatment.

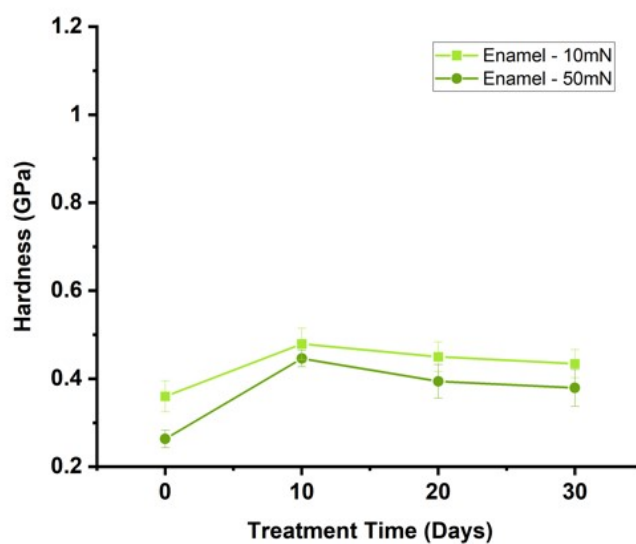


Figure S2. Average hardness values for AC-1 composite after 0, 10, 20 and 30 days of acid treatment.

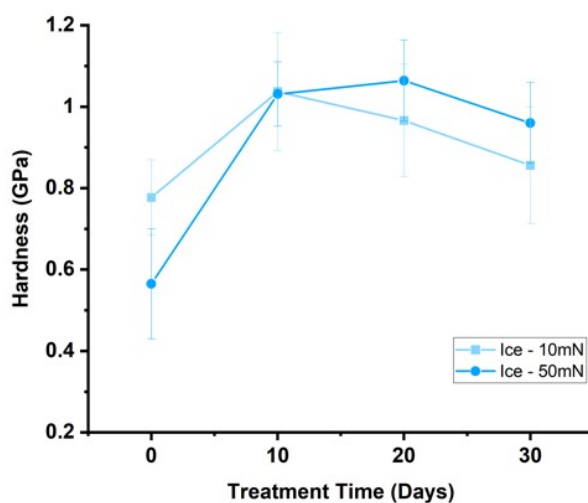


Figure S3. Average hardness values for UC-2 after 0, 10, 20 and 30 days of acid treatment.

## Hardness of Composites in Artificial Saliva Immersion

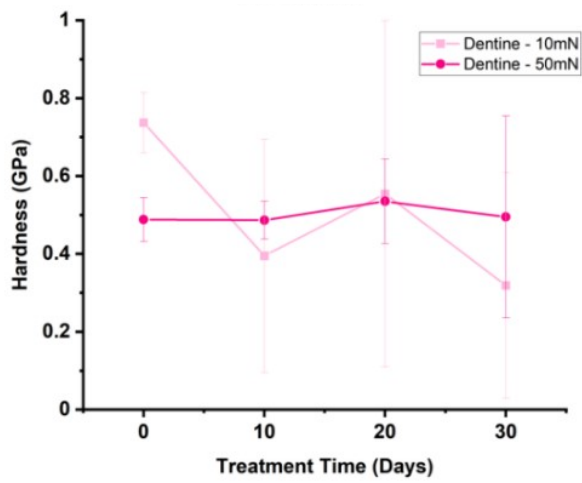


Figure S4. Average hardness for UC-1 after 0, 10, 20 and 30 days of immersion in Artificial saliva.

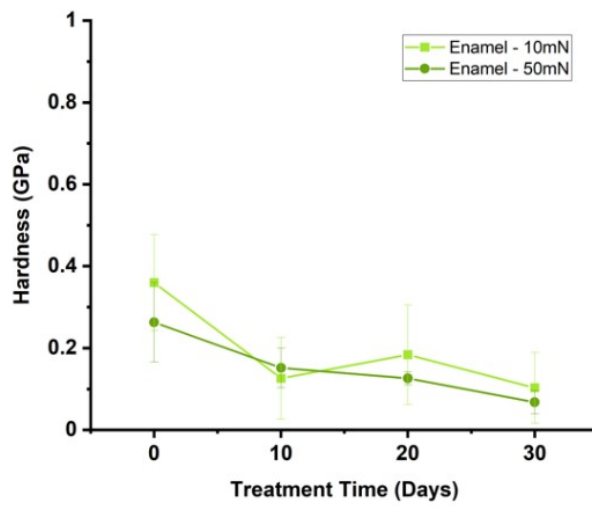


Figure S5. Average hardness for AC-1 after 0, 10, 20 and 30 days of immersion in Artificial saliva.

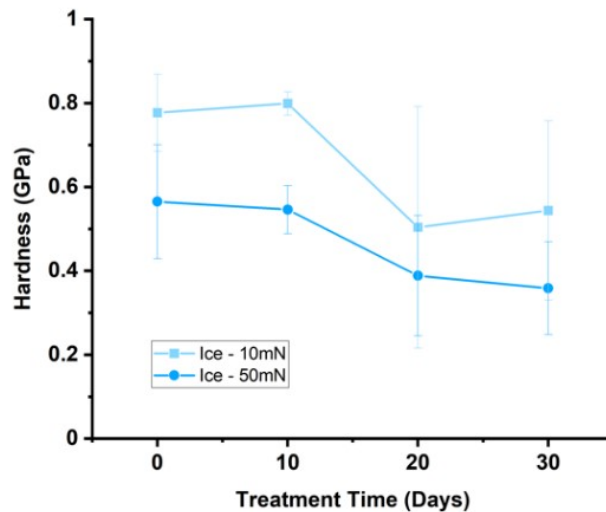


Figure S6. Average hardness for UC-2 after 0, 10, 20 and 30 days of immersion in Artificial saliva.

### Hardness of Composites in Distilled Water Immersion

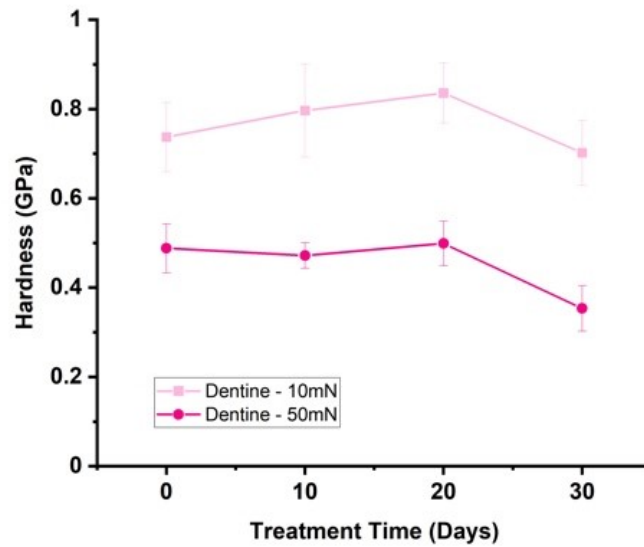


Figure S7. Average hardness for UC-1 after 0, 10, 20 and 30 days of immersion in distilled water.

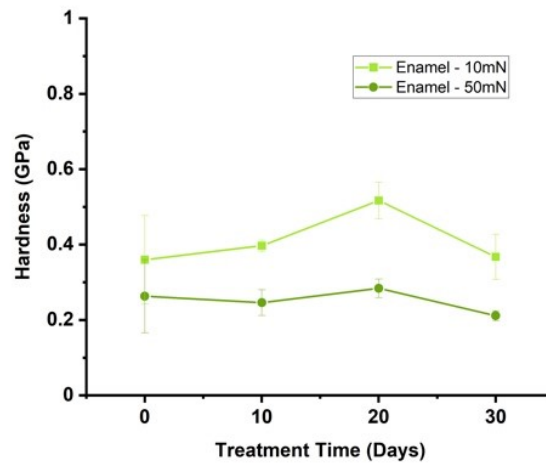


Figure S8. Average hardness for AC-1 after 0, 10, 20 and 30 days of immersion in distilled water.

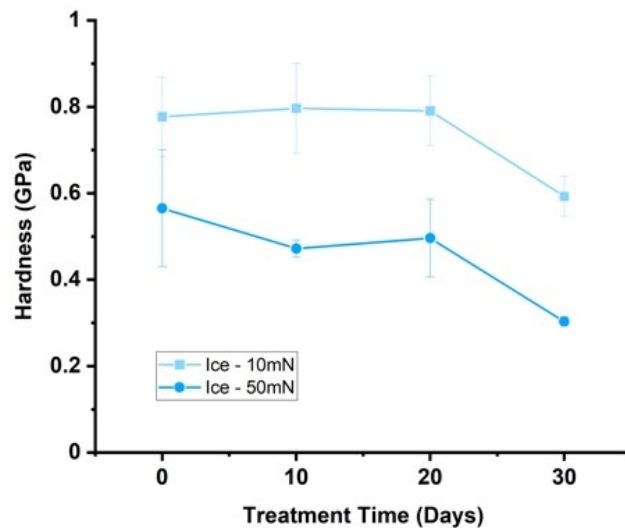
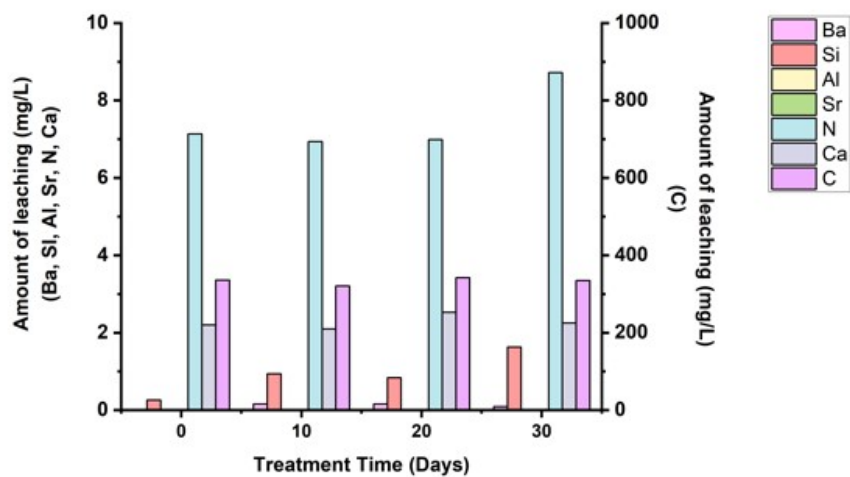
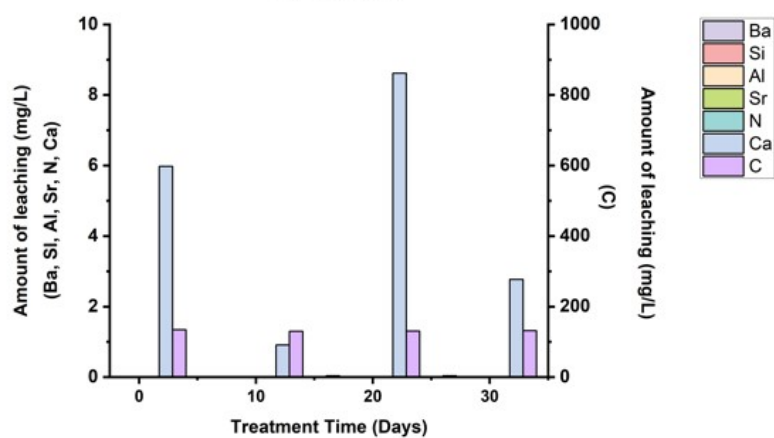


Figure S9. Average hardness for UC-2 after 0, 10, 20 and 30 days of immersion in distilled water.

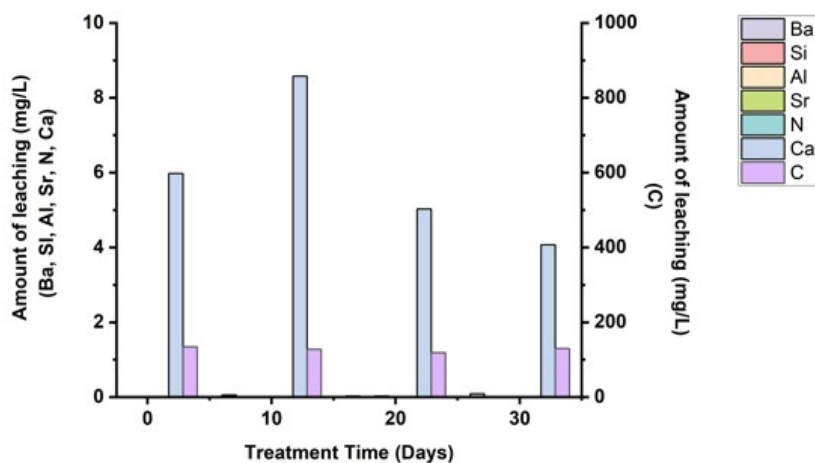
### Variation in Elements in Leachate



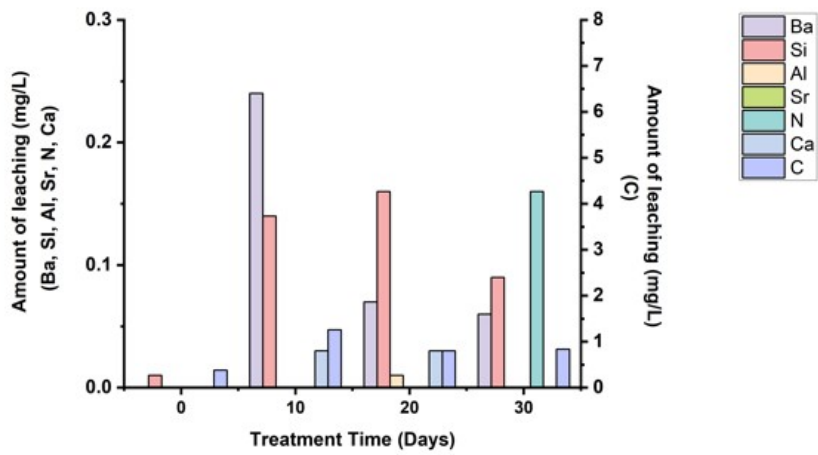
Figures S10. Elements leaching from UC-1 composite after immersion in artificial saliva.



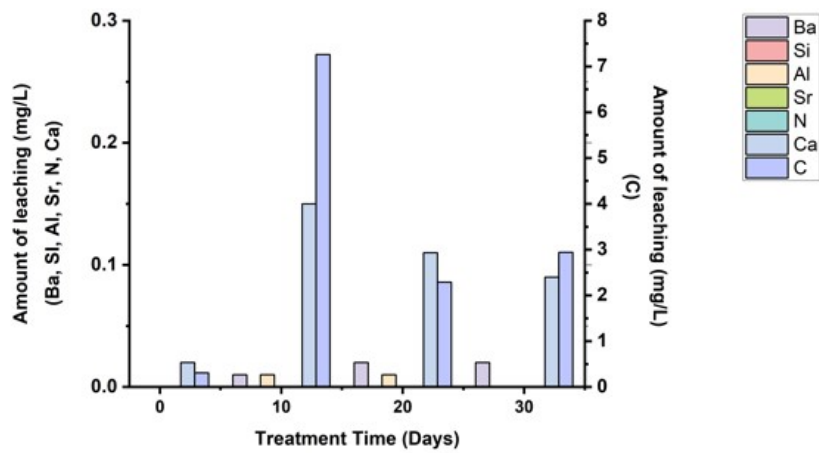
Figures S11. Elements leaching from AC-1 composite after immersion in artificial saliva.



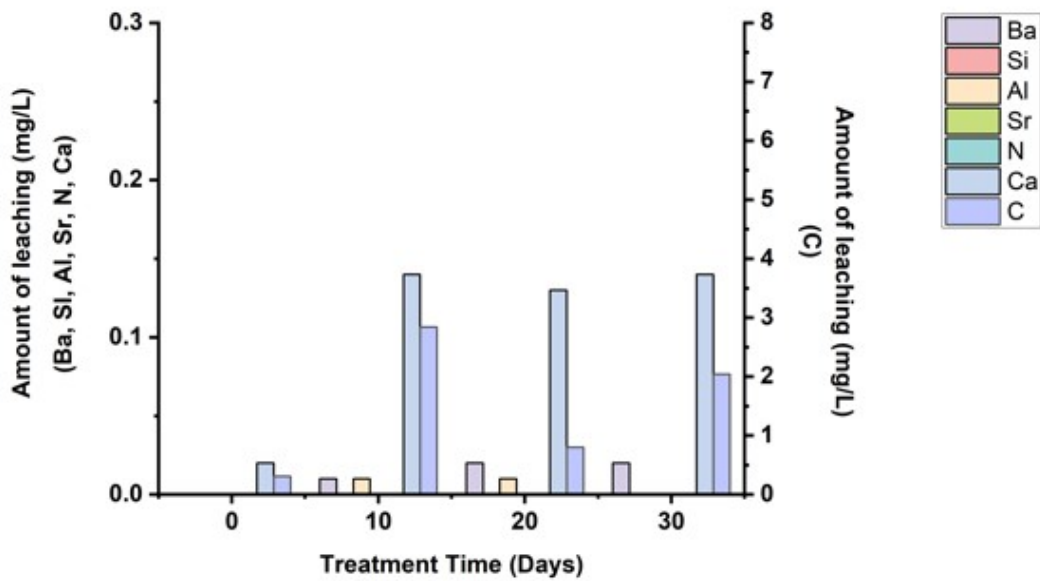
Figures S12. Elements leaching from UC-2 composite after immersion in artificial saliva.



Figures S13. Elements leaching from UC-1 composite after immersion in distilled water.



Figures S14. Elements leaching from AC-1 composite after immersion in distilled water.



Figures S15. Elements leaching from UC-2 composite after immersion in distilled water.

**Table S1:** ICP results upon the surface of UC-1 across the three treatment conditions at 0, 10, 20 and 30 days.

Treatment Element	Artificial Saliva				Water			
	0 days	10 days	20 days	30 days	0 days	10 days	20 days	30 days
Al	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.00
Ba	0.02	0.16	0.16	0.09	0.00	0.24	0.07	0.06
Ca	5.98	1.89	7.69	3.42	0.02	0.18	0.11	0.13
Cu	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00
K	1101	1055	1159	1101	0.11	0.52	0.18	0.35
Mg	0.05	0.08	0.07	0.07	0.01	0.03	0.02	0.02
Na	336	321	342	335	0.38	1.26	0.80	0.84
P	220	210	253	225	0.00	0.03	0.03	0.00
S	15.8	17.1	16.0	16.4	0.03	0.19	0.07	0.03
Si	0.26	0.94	0.84	1.63	0.01	0.14	0.16	0.09
Sr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C	135	124	130	128	0.31	3.29	0.40	1.42
N	6.67	6.68	6.79	7.09	0.04	0.15	0.02	0.14
F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl	714	694	699	872	0.00	0.00	0.00	0.16

**Table S2.** ICP results upon the surface of AC-2 across the three treatment conditions at 0, 10, 20 and 30 days.

Treatment Element	Artificial Saliva				Water			
	0 days	10 days	20 days	30 days	0 days	10 days	20 days	30 days
Al	0.00	0.01	0.02	0.00	0.00	0.01	0.01	0.00
Ba	0.02	0.02	0.04	0.04	0.00	0.01	0.02	0.02
Ca	5.98	0.91	8.62	2.77	0.02	0.15	0.11	0.09
Cu	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00
K	1101	1117	1148	1117	0.11	1.09	0.11	0.18
Mg	0.05	0.07	0.07	0.07	0.01	0.02	0.02	0.02
Na	336	342	339	340	0.38	1.21	0.88	0.85
P	220	221	242	230	0.00	0.09	0.03	0.02
S	15.8	16.9	16.6	16.4	0.03	0.35	0.03	0.06
Si	0.26	1.48	1.00	2.12	0.01	0.10	0.13	0.14
Sr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C	135	130	131	132	0.31	7.26	2.29	2.94
N	6.67	6.89	6.60	7.37	0.04	0.19	0.11	0.12
F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl	714	694	706	874	0.00	0.00	0.00	0.07

**Table S3.** ICP results upon the surface of IC-2 across the three treatment conditions at 0, 10, 20 and 30 days.

Treatment	Artificial Saliva				Water			
	Element	0 days	10 days	20 days	30 days	0 days	10 days	20 days
Al	0.00	0.00	0.03	0.01	0.00	0.01	0.01	0.00
Ba	0.02	0.06	0.03	0.09	0.00	0.01	0.02	0.02
Ca	5.98	8.58	5.03	4.07	0.02	0.14	0.13	0.14
Cu	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
K	1101	1086	1124	1108	0.11	0.65	0.19	0.27
Mg	0.05	0.10	0.07	0.11	0.01	0.02	0.02	0.02
Na	336	332	331	337	0.38	1.33	0.80	0.83
P	220	219	249	231	0.00	0.08	0.05	0.01
S	15.8	17.4	16.4	15.9	0.03	0.25	0.04	0.01
Si	0.26	0.53	1.10	2.07	0.01	0.13	0.08	0.08
Sr	0.00	0.09	0.02	0.02	0.00	0.05	0.02	0.02
C	135	128	119	130	0.31	2.84	0.80	2.04
N	6.67	6.61	6.67	7.07	0.04	0.14	0.07	0.12
F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl	714	691	702	866	0.00	0.00	0.00	0.09

### Surface Chemistry Changes

**Table S4.** XPS results upon the surface of UC-1 across the three treatment conditions at 0, 10 and 30 days.

Treatment	Control	Hydrochloric Acid		Artificial Saliva		Distilled Water	
	0 days	10 days	30 days	10 days	30 days	10 days	30 days
Ba	1.863	0.496	0.281	0.811	0.688	1.104	0.844
Si	17.91	16.19	6.60	10.25	11.81	17.36	18.24
Al	2.609	1.227	0.000	1.592	1.862	2.082	2.344
Sr					0.000		0.000
O	75.05	72.26	76.90	79.55	71.97	73.93	72.49
K				0.811	0.000		0.000
Na	0.000		0.597	0.250	0.805		0.000
N	1.260	6.686	11.267	2.871	4.478	1.738	2.663
Ca	0.745	0.783	3.580	6.538	4.898	0.344	0.563
P	0.000		0.772	3.433	3.489	0.000	0.000

**Table S5:** XPS results upon the surface of AC-1 across the three treatment conditions at 0, 10 and 30 days.

Treatment	Control	Acid Treatment		Artificial Saliva		Distilled Water	
	0 days	10 days	30 days	10 days	30 days	10 days	30 days



<b>Ba</b>					0.000	0.148	0.000
<b>Si</b>	18.75	9.66	4.40	5.76	5.15	16.29	19.05
<b>Al</b>	0.000	0.453			0.000	2.366	0.000
<b>Sr</b>					0.000	0.549	0.000
<b>O</b>	76.59	78.26	78.66	73.01	70.46	75.31	77.69
<b>K</b>					0.000		0.000
<b>Na</b>			0.975		0.739		0.000
<b>N</b>	2.013	6.943	8.717	3.513	9.748	1.943	3.262
<b>Ca</b>	0.905	2.868	3.694	11.475	8.290	1.542	0.000
<b>Cl</b>			0.768		0.000		0.000
<b>P</b>			1.891	6.233	5.613		0.000

**Table S6.** XPS results upon the surface of UC-2 across the three treatment conditions at 0, 10 and 30 days.

<b>Treatment</b>	<b>Control</b>	<b>Acid Treatment</b>		<b>Artificial Saliva</b>		<b>Distilled Water</b>	
<b>Element</b>	0 days	10 days	30 days	10 days	30 days	10 days	30 days
<b>Ba</b>					0.101		0.000
<b>Si</b>	18.00	14.34	4.45	14.45	6.70	17.78	17.85
<b>Al</b>	3.943	1.084	0.000	2.864	1.536		2.493
<b>Sr</b>	1.840		0.067	0.761	0.362		0.401
<b>O</b>	90.71	74.05	75.68	71.80	69.07	79.04	74.67
<b>K</b>				1.287	0.000		0.000
<b>Na</b>	0.000		0.334		0.377		0.190
<b>N</b>	1.950	8.101	5.901	3.752	4.348	2.854	3.485
<b>Ca</b>	0.811	0.387	7.793	1.214	10.668	0.327	0.908
<b>Cl</b>		0.310			0.000		0.000
<b>P</b>	0.000		4.453	0.236	6.842		0.000

### Nano-mechanical properties

**Table S7.** Average hardness values of hydrochloric acid-treated dental composites over 0, 10, 20 and 30 days.

Dental Composite	Treatment Time (Days)							
	0	$\sigma$	10	$\sigma$	20	$\sigma$	30	$\sigma$
UC-1 (10 mN)	0.737	0.078	0.965	0.096	0.944	0.133	0.882	0.114
UC-1 (50 mN)	0.488	0.592	1.047	0.109	1.022	0.094	0.956	0.099
AC-1 (10 mN)	0.360	0.036	0.479	0.036	0.450	0.034	0.434	0.032
AC-1 (50 mN)	0.263	0.020	0.446	0.020	0.394	0.039	0.379	0.042
UC-2 (10 mN)	0.777	0.092	1.037	0.146	0.966	0.138	0.856	0.144
UC-2 (50 mN)	0.565	0.136	1.031	0.080	1.064	0.108	0.960	0.099

**Table S8.** Average hardness values of dental composites immersed in Artificial saliva over 0, 10, 20 and 30 days.

Dental Composite	Treatment Time (Days)							
	0	$\sigma$	10	$\sigma$	20	$\sigma$	30	$\sigma$
UC-1 (10 mN)	0.737	0.078	0.395	0.300	0.554	0.445	0.319	0.398
UC-1 (50 mN)	0.488	0.056	0.487	0.487	0.535	0.109	0.495	0.259
AC-1 (10 mN)	0.360	0.118	0.127	0.117	0.184	0.121	0.103	0.086
AC-1 (50 mN)	0.263	0.097	0.151	0.048	0.126	0.016	0.068	0.029
UC-2 (10 mN)	0.777	0.092	0.799	0.029	0.504	0.362	0.545	0.214
UC-2 (50 mN)	0.565	0.136	0.547	0.057	0.389	0.143	0.359	0.111

**Table S9.** Average hardness values of dental composites immersed in Artificial saliva over 0, 10, 20 and 30 days.

Dental Composites	Treatment Time (Days)							
	0	$\sigma$	10	$\sigma$	20	$\sigma$	30	$\sigma$
UC-1 (10 mN)	0.737	0.078	0.797	0.104	0.836	0.067	0.702	0.073
UC-1 (50 mN)	0.488	0.056	0.472	0.029	0.500	0.051	0.353	0.051
AC-1 (10 mN)	0.360	0.118	0.398	0.015	0.517	0.049	0.368	0.069
AC-1 (50 mN)	0.263	0.097	0.246	0.034	0.285	0.024	0.211	0.014
UC-2 (10 mN)	0.777	0.092	0.797	0.104	0.790	0.080	0.593	0.047
UC-2 (50 mN)	0.565	0.136	0.472	0.029	0.496	0.090	0.303	0.011