

Author	Zirconia material	Surface treatment	Method of Artificial aging	Cement type	Test method	Bond Strength/ MPa	Bond Strength/ MPa (after aging)
1.Bottino et al <sup>(37)</sup> 2005	In Ceram Zirconia (CEREC In-Lab, VITA)	Airborne particles abrasion (APA) with 110- $\mu$ m Al <sub>2</sub> O <sub>3</sub>	Water Storage (H <sub>2</sub> O ST ) 7 days	Panavia F	MTBS	-	15.1
2.Amaral et al <sup>(11)</sup> 2006	In Ceram Zirconia (VITA)	APA (110 $\mu$ m Al <sub>2</sub> O <sub>3</sub> )	-	Panavia F	MTBS	20.5	-
3.Tsuo et al <sup>(38)</sup> 2006	Zirconia ceramic, (Ohtsuka)	Alumina sand-blasting  *50 $\mu$ m **75 $\mu$ m ***100 $\mu$ m ****150 $\mu$ m	5,000 thermo cycles (TC)	Linkmax HV	SBS	*20.1 **21.5 ***23.0 ****19.6	*4.3 **3.7 ***0 ****0
4.Kumbuloglu et al <sup>(39)</sup> 2006	Zirconium oxide (DCS)	APA (50- $\mu$ m Al <sub>2</sub> O <sub>3</sub> )	H <sub>2</sub> O ST 7 days  TC 2000	*Panavia F **RelyX Unicem	SBS	-	*17.7 16.3 **17.5 19.5
5.Yang B et al <sup>(40)</sup> 2007	Cercon, DeguDent	APA (50 $\mu$ m Al <sub>2</sub> O <sub>3</sub> )	3 days H <sub>2</sub> O ST	Panavia F2.0	TBS	-	40.1
6.Aboushelib et al <sup>(41)</sup> 2007	Cercon Base;- Dentsply	APA (110- $\mu$ m Al <sub>2</sub> O <sub>3</sub> )	1 week H <sub>2</sub> O ST 2 weeks 3 weeks 1 month	*Panavia F 2.0 **RelyX ARC ***Bistite II DC	MTBS	*33.4 **23.3 ***31.3	*33.9 34.2 34.4 32.5 **19.2 16.2 13.6 2.6 ***25.9 22.6 18.3 14.4

7.Valandro L F et al <sup>(42)</sup> 2008	In-Ceram Zirconia®, Vita	APA( 110-µm Al2O3 )	-	Panavia F	*MTBS **SBS	*21.9 **17.2	-
8.Aboushelib et al <sup>(43)</sup> 2009	Procera Zirconia	APA( 50 mm Al2O3)  -APA + silane	-	*Panavia 21 **RelyX ARC	MTBS	*28.8 **_ *31.5 **13.7	-
9.Cavalcanti AN et al <sup>(44)</sup> 2009	Cercon, Degu-Dent	APA( 53 µm Al2O3)	-	*Panavia F2.0 **Calibra	MSBS	*22.3 **24.3	-
10.Tashkandi E <sup>(45)</sup> 2009	LAVA, 3M-ESPE	Sandblasted (120 µm Al2O3)	-	Multilink	MSBS	20.87	-
11.Oyague et al <sup>(46)</sup> 2009	Zirconia (Cercon)	Sandblasting 125 Al2O3)	24h  6 months	*Clearfil Esthetic Cement **Rely x unicem ***Calibra	MTBS	*18.63 **11.44 ***10.84	*11.82 **13.16 ***_
12.Aboushelib et al <sup>(47)</sup> 2010	Lava zirconia, 3M ESPE	APA( 50-µm Al2O3)	*T C **4weeks H2O ST **26 weeks H2O ST	Panavia F 2.0	MTBS	35.9	*34.7 **28.7 ***27.4
13.Qeblawi et al <sup>(48)</sup> 2010	Y-TZP (ZirCAD, Ivoclar Vivaden)	APA(50-µm Al2O3) + *Acid etched/silanated **Silanated ***Zirconia primer	H2O ST 90 days, and TC	Multilink Auto-mix	SBS	15.7 *17.1 **22.9 ***20.8	**24.34 ***21.18
14.Attia A et al <sup>(49)</sup> 2011	(e.maxZirCAD, Ivoclar)	APA (110 Al2O3) + *universal primer + universal primer + ultrasonic cleaning	30 days TC	MultiLinkAutomix	TBS	*42.5 **44.1	*27.8 **38.8
15.Foxton et al <sup>(50)</sup> 2011	Procera Zircon, Nobel Biocare	APA( 53-µm Al2O3)	H2O ST 6months	*Variolink **NAC-100	SBS	*19 **19.6	(8.3)  (15.3)

16. Shimoe S et al <sup>(51)</sup> 2012	Cercon Base, Dentsply	*APA(50 µm Al2O3) **APA(70 µm Al2O3) ***placed in a furnace at 500°C, heated to 1,200°C at a rate of 50°C/min, and then held at 1,200°C for 10 min	20,000 TC	Gradia  -Estenia C&B	SBS	*24.6 **23 ***19.7  *13.7 **13.6 ***6.3	(22.4) (21.5) (6.9)  12.4 13.9 3.1
17. Komine F et al <sup>(52)</sup> 2012	Katana, Noritake	APA( 50-µm 70 µm Al2O3) *0.05 MPa **0.1 MPa ***0.2 MPa ****0.4 MPa *****0.6 MPa	20,000 TC	Estenia C&B	SBS	*7.3 **12.8 ***13.2 ****14.2 *****14.2	*(9.9) **(14.3) ***17.4 ****17.6 *****16.7
18. Abu-Eittah MR <sup>(53)</sup> 2012	ICE ZirkonZ-irkon- Zahn	Sandblast ( 50 µm Al2O3)	21 days H2O ST + 5000TC	Rely X Unicem	SBS	-	8.4
19. de Castro et al <sup>(54)</sup> 2012	Zirconia (YZ-In Ceram YZ, VITA)	APA( 50 µm Al2O3)	no storage 60 days H2O ST TC 10,000	*RelyX ARC **RelyX U100 ***Panavia F	MTBS	*8.9 **10.2  ***13	*5.8 *1.9 **7.0 **9.9 ***6.9 ***14.8
20. Jevnikar P et al <sup>(55)</sup> 2012	TZ-3YB-E Zirconia (Tosoh)	APA( 110 µm Al2O3)	24 h H2O ST 12,000 TC	*Rely X Unicem **FUJI plus	SBS	*10.15 **8.95	*10.16  **3.27
21. Usumez A et al <sup>(56)</sup> 2013	ICE ZirkonZ-irkon- Zahn	APA (110 µm Al2O3)	-	Clearfil Esthetic Cement	SBS	4.26	-
22. Zandparsa R et al <sup>(57)</sup> 2014	Zirconia, 3M ESPE	APA (50 µm, Al2O3)	500 TC	Panavia F2.0	SBS	-	14.23
23. Reddy S M et al <sup>(58)</sup> 2014	(Incoris ZI, Sirona	APA (50 µm Al2O3 )	-	Multilink Speed	SBS	6.71	-

24.Subaş M G et al <sup>(59)</sup> 2014	VITA In-Ceram YZ for inLab®; VITA	APA( 110-µm Al2 O3 )	-	*RelyX U100 **Clearfil Es-thetic Cement ***Panavia F2.0	SBS	*3 **3.47 ***4	-
25.MurthyV et al <sup>(60)</sup> 2014	Cortis-YZ, Sirona	*Sandblasted (110 µm Al2O3 ) Sandblasted with 250 µm Al2O3 )	-	Resin cement	SBS	10.8 10.7	-
26.Ishii R et al <sup>(61)</sup> 2015	IPS e.maxZirCAD, Ivoclar	APA( 50-µm Al2O3)	*10,000 TC **30,000TC	Multilink Automix	SBS	16.4	*(15.7) **(13)
27.Komine F et al <sup>(52)</sup> 2015	Katana, Noritake	APA(50-µm Al2O3) *0.1 MPa **0.2 MPa **0.4 MPa ****0.6 MPa	20,000 TC	Estenia Opaque Primer -Estenia C&B Opaque modifier- Estenia C&B Gingival	SBS	*11.7 **18.4 ***19.1 ****19.9	*12.1 **19.7 ***18.8 ****18.7
28.Anand S et al <sup>(63)</sup> 2015	AmannGirrbach, German)	Sandblasted (150 µm Al2O3)		Variolink II	MSBS	10.12	-
29.Liu L et al <sup>(64)</sup> 2015	Everest ZS,KAVO	APA(110-µm Al2O3)	TC	CLEARFIL SA Cement	SBS	12.03	12.16
30.Zanjani VA et al <sup>(65)</sup> 2015	Y-TZP, Zirkon-Zahn	APA(50-µm Al2O3)	-	Panavia F2.0	MSBS	37.3	-
31.Yi et al. <sup>(66)</sup> 2015	Lava(3M-Espe	APA(110-µm Al2O3)	T C	Self-adhesive resin cement	SBS	-	10.56
32.Sciasci et al. <sup>(67)</sup> 2015	Lava(3MEspe)	*APA(50-µm Al2O3) +Silane **APA(120-µm Al2O3) +Silane	10 000 TC	RelyX ARC RelyX U100 Panavia F	SBS		* 7.7 * 11.5 * 10.8 ** 8.4 ** 10.8 ** 10.8
33.Nishigawa G et al <sup>(68)</sup> 2016	Lava, 3M ESPE	APA(50-µm Al2O3) *ultrasonic cleaning **without ultrasonic cleaning	-	Panavia F 2.0	SBS	*9.67 **13.11	-

34.Mahmoodi N et al <sup>(69)</sup> 2016	ICE Zirkon Translucent, Zirkonzahn,	Sandblasted 50- $\mu$ m Al2O3)	3000 TC	*Panavia F2.0(-zirconia primer (Monobond Plus) **Clearfil SA Luting	MTBS	-	*8 **-(debonded)
35.Vicente M et al <sup>(70)</sup> 2016	Cercon1, DeguDent,	APA(25- $\mu$ m Al2O3)	50.000 TC	Clearfil SA Cement	SBS	8.1	7.2
36.Akay C, et al <sup>(71)</sup> 2016	(ICE Zirkon; Zirkonzahn	APA(50- $\mu$ m Al2O3)	-	*Variolink II ** Panavia SA	SBS	*9.18 **33.78	-
Mean Bond Strength/MPa						17.4	15.2

**Table 1:** Airborne-particle abrasion studies n=36.

Author	Zirconia material	Surface treatment	Method of Artificial aging	Cement type	Test method	Bond Strength/MPa	Bond Strength/MPa(after aging)
1.Qeblawi et al <sup>(48)</sup> 2010	Y-TZP (ZirCAD, Ivoclar Vivadent	600-grit silicon carbide paper wet gridding ;+*Acid etched/silanated **Silanated ***Zirconia primer	90 days H2O ST and TC	Multilink Automix	SBS	11.6 *22.2 **17.2 ***25.5	***24.38
2.Komine F et al <sup>(52)</sup> 2012	Katana, Noritake	600-grit silicon carbide abrasive paper wet-ground	20,000 TC	Estenia C&B	SBS	5	6.9
3.Abu-Eittah MR <sup>(53)</sup> 2012	ICE ZirkonZirkon- Zahn	Wet ground with 600 grit diamond disc	21 days H2O ST then 5000TC	Rely X Unicem	SBS	-	4.4
4.Komine F et al <sup>(62)</sup> 2015	Katana, Noritake	*600-grit silicon carbide abrasive paper wet grinding **1500-grit silicon carbide abrasive paper wet grinding	20,000 TC	Estenia Opaque Primer -Estenia C&B Opaque modifier- Estenia C&B Gingival	SBS	*8.3 **4.2	*9.5 **6.4
Mean bond strength/MPa						13.4	8.6

**Table 2:** Grinding with disks and diamond rotary instruments n=4.

Author	Zirconia material	Surface treatment	Method of Artificial aging	Cement type	Test method	Bond Strength/MPa	Bond Strength/MPa(after aging)
1.Aboushelib et al <sup>(41)</sup> 2007	Cercon Base; Dentsply	Heat-induced maturation and SIE (HIM/SIE).	*1 week H2O ST **2 weeks ***3 weeks ****1 month	Panavia F 2.0	MTBS	49.8	*55.8 **54.2 ***55.9 ****52.2
2.Aboushelib et al <sup>(78)</sup> 2008	Procera Zirconia (Nobel Biocare)	SIE + *3-Acryloyloxypropyltrimethoxysilane **3-Isocyanatopropyltriethoxysilane ***Styrylethyltrimethoxysilane ****3-Methacryloyloxypropyltrimethoxysilane *****3-(N-Allylamino)propyltrimethoxysilane	-	Panavia F 2.0	MTBS	*31.2 **32.4 ***28 ****40.6 *****32.6	-
3.Abouslib et al <sup>(79)</sup> 2009	Procera Zirconia (Nobel Biocare)	SIE + * 3-Acryloyloxypropyltrimethoxysilane **3-Isocyanatopropyltriethoxysilane ***3-Styrylethyltrimethoxysilane **** 3-Methacryloyloxypropyltrimethoxysilane	90 days H2O ST	Panavia F2.0	MTBS	*31 **32 ***28 ****41	*15 **18 ***18 ****17
4.Aboushelib et al <sup>(47)</sup> 2010	Lava zirconia, 3M ESPE	SIE	*TC **4 weeks H2O ST ***26 week H2O ST	Panavia F 2.0	MTBS	51.9	
5.Anand S et al <sup>(63)</sup> 2015	AmannGirrbach, Germany)	*Sandblasting+ SIE **Sandblasting+ SIE +HF acid etching	-	Variolink II	MSBS	*29.24 **31.23	*53.4 **52.5 ***51.9
Mean Bond Strength/MPa						32.8	40.3

**Table 3:** Selective infiltration etching (SIE) n=4

Author	Zirconia material	Surface treatment	Method of Artificial aging	Cement type	Test method	Bond Strength/MPa	Bond Strength/MPa(after aging)
1.Derand et al <sup>(80)</sup> , 2005	ProceraZirkon (Nobel Biocare)	*Low fusing porcelain pearls **Lfpp + silane	-	Variolink II	SBS	*11.3 **18.4	-
Mean Bond Strength/MPa						14.8	-

**Table 4:** Coatings of low melting temperature porcelain micropearls n=1.

Author	Zirconia material	Surface treatment	Method of Artificial aging	Cement type	Test method	Bond Strength/MPa	Bond Strength/MPa(after aging)
1.Aboushelib <sup>(81)</sup> 2012	Lava zirconia, 3M ESPE	7-12µm zirconia particles sprayed on unsintered zirconia disks by fusion sputtering	6 months H2O ST	Rely X unicem	MTBS	42.5	37.9
Mean Bond Strength/MPa						42.5	37.9

**Table 5:** Fusion sputtering n=1.

Author	Zirconia material	Surface treatment	Method of Artificial aging	Cement type	Test method	Bond Strength/MPa	Bond Strength/MPa(after aging)
1.XIE H et al <sup>(83)</sup> 2013	Everest ZS, KAVO	*Dipped in 100°C H2SO4/(NH4)2SO4 solution and kept for 30 min **Etched with 100°C HF/HNO3 for 30 Min ***Etched with 100°C H2SO4/HF/HNO3 for 30 min	40 days H2O ST	Bis-GMA-based resin cement	SBS	*9.56 **9.80 ***8.73	*(13.15) **(13.48) ***10.04
2.Zandparsa R et al <sup>(57)</sup> 2014							
Zirconia, 3M ESPE							
Piranha solution 7:1; Piranha acid etching solution at 7:1 concentration mixture of sulfuric acid (H2SO4) and hydrogen peroxide (H2O2) was applied for 2 minutes. Then the specimens were rinsed with distilled water and air dried.							
500 TC							
Panavia F2.0							
SBS							2.61
3.Reddy S M et al <sup>(58)</sup> 2014	(Incoris ZI, Sirona)	Hydrofluoric acid 4.5 % etching for 3 min.	-	Multilink Speed	SBS	3.88	-
4-Murthy V et al <sup>(60)</sup> 2014	Cortis-YZ, Sirona	HF acid (9.6 %) treatment 30 sec.	-	-	SBS	12.6	-

5.Komine F et al <sup>(62)</sup> 2015	Katana, Noritake	9.5% hydrofluoric acid gel for 1 min	20,000 TC	Estenia Opaque Primer -Estenia C&B Opaque modifier-  Estenia C&B Gingival	SBS	0.1	0.1
6.Anand S et al <sup>(63)</sup> 2015	AmannGirrbach, Germany)	Sandblasting+HF acid etching(9.6%) for 60 sec.	-	Variolink II	MSBS	11.04	-
7.Akay C, et al <sup>(71)</sup> 2016	(ICE Zirkon; Zirkonzahn	*Hot chemical etching solution composed of 800 ml methanol, 200 ml HCl, and 2 g ferric chloride and that was heated to 100°C or 10 minutes.  **Hot chemical etching solution for 30 minutes.	-	Variolink II  Panavia SA	SBS	*30.94 *46.71  **35.69 **31.31	-
Mean Bond Strength/MPa						18.2	7.8

**Table 6:** Chemical treatment (Hot acid) n= 7.

Author	Zirconia material	Surface treatment	Method of Artificial aging	Cement type	Test method	Bond Strength/MPa	Bond Strength/MPa(after aging)
1.Cavalcanti AN et al <sup>(44)</sup> 2009	Cercon, DeguDent	Er:YAG Laser 2.94 µm 5 sec Power 200 mJ	-	*Panavia F2.0 **Calibra	MSBS	*15.8 **3	-
2.Foxton et al <sup>(50)</sup> 2011	Procera Zircon, Nobel Biocare	Er:YAG laser 2.94-µm wavelength 5 seconds 200 mJ.	H2O ST  6months	*Variolink  **NAC-100	SBS	*13.3 **15	(7.6)  (9.2)
3.Akin H et al <sup>(97)</sup> 2012	ICE ZirkonZirkon- Zahn	Er:YAG laser Wave length of 2.94 µm at 150 mJ, 10 Hz, 1 W, 20 sec.	-	NX3	SBS	3.2	-
4.Usumez A et al <sup>(56)</sup> 2013	ICE ZirkonZirkon- Zahn	Nd:YAG λ 1,064 nm  P; 60 sec. 200 mJ/pulse, *laser pulse duration (180 µs)  **Nd:YAG laser pulse duration (320 µs)	-	Clearfil Es-thetic Cement	SBS	*6.99  **8.17	-



5.Subaş M G et al <sup>(59)</sup> 2014	VITA In-Ceram YZ for in Lab®; VITA	Er: YAG laser: wavelength of 2,940 nm energy, 400 mJ; pulse rate,10 Hz power,4 W 15 sec	-	*RelyX U100  **Clearfil Esthetic Cement  ***Panavia F2.0	SBS	*1.76  **2.79  ***2.48	-
6.MurthyV et al <sup>(60)</sup> 2014	Cortis-YZ, Sirona	CO2 laser wavelength of 10.6 mm, power setting of 3 w	-	-	SBS	18.12	-
7.Kasraei S et al <sup>(61)</sup> 2014	CeramillZi; AmannGirrbach	CO2 Laser $\lambda$ 10,6 $\mu$ , pulse repetition 100 Hz, pulse duration 160 10 sec.	-	Panavia F 2.0	SBS	12.12	-
8.Kasraei S et al <sup>(99)</sup> 2014 CeramillZi; AmannGirrbach CO2 Laser $\lambda$ 10.6 $\mu$ m, with a pulse repetition of 100 Hz, pulse duration of 160 ms, output energy of 3W 10 sec. Er:YAG laser $\lambda$ 2,940 nm, pulse duration of 50 $\mu$ s output power of 2 W, 10 sec. - Panavia F2.0 SBS						12.12  8.65	-

<p>9.Liu L et al (64) 2015</p>	<p>Everest ZS,KAVO</p>	<p>Nd:YAG laser  <math>\lambda=1,064</math> nm;  * 100 mJ, 10 Hz for 30 s  ** 100 mJ, 10 Hz for 60 s  *** 100 mJ, 10 Hz for 90 s  **** 100 mJ, 20 Hz for 30 s  ***** 100 mJ, 20 Hz for 60 s  ***** 100 mJ, 20 Hz for 90 s  ***** 100 mJ, 30 Hz for 30 s  ***** 100 mJ, 30 Hz for 60 s  *****100 mJ, 30 Hz for 90 s</p>	<p>TC</p>	<p>CLEARFIL SA Cement</p>	<p>SBS</p>	<p>*4.1  **4.5  ***4.4  ****5  *****4.4  *****4.6  *****5.4  *****6.3  *****5.8</p>	<p>*3.7  **3.9  ***4.4  ****4.5  ****4.5  *****4.2  *****5.2  *****5.7  *****5.4</p>
<p>10.Gomes A L et al<sup>(100)</sup> 2015</p>	<p>Cercon®, DeguDent</p>	<p>Er:YAG  2,940 nm wave-length.  pulse repetition was set at 10 Hz and energy intensity was set at 200 mJ</p>	<p>TC</p>	<p>*BiFix SE  **Clearfil SA</p>	<p>MSBS</p>	<p>*5.7  **6.9</p>	<p>*1.8  **0</p>
<p>11.Zanjani VA et al<sup>(65)</sup> 2015</p>	<p>Y-TZP, Zirkon- Zahn</p>	<p>*CO2 laser  1060-nm wave-length  50 sec.  4W  **Er;Cr:YSGG  2780-nm wavelength  pulse duration of 140 ls, 50 sec  at 3W  ***Er;Cr:YSGG at 2W</p>	<p>-</p>	<p>Panavia F2.0</p>	<p>MSBS</p>	<p>*29  **2***7.5  21.9</p>	<p>-</p>

12.Vicente M et al <sup>(70)</sup> 2016	Cercon1, DeguDent,	Femtosecond laser irradiation  1 kHz trains of pulses centered at 800 nm, with an energy of 4.0mj and a duration of 40 fs at step 20 (FS20).  Femtosecond laser irradiation at step 40 (FS40)	TC	Clearfil SA Cement	SBS	10.8 10.7	8.5 7.7
13.Mahmoodi N et a <sup>(69)</sup> 2016	ICE Zirkon Translucent, Zirconzahn,	Nd:YAG laser Output power 2 W  Frequency 20 Hz  Exposure time 2 min	3000 TC	*Panavia F2.0(zirconia primer (Monobond Plus)  **Clearfil SA Luting	MTBS	-	*_ (debonded)  **_
Mean Bond Strength/MPa						8.6	4.4

**Table 7:** Effect of lasers n= 13

Author	Zirconia material	Surface treatment	Method of Artificial aging	Cement type	Test method	Bond Strength/ MPa	Bond Strength/ MPa(after aging)
1.Tsuo et al <sup>(38)</sup> 2006	Zirconia ceramic, Ohtsuka	Silane coupling agent	10,000 TC	Linkmax HV	SBS	31.2	0
2.Atsu et al <sup>(104)</sup> 2006	Zirconium oxide (Cercon, Degussa Dental)	APA(125- μm Al2O3) + silanized with a silane coupling agent  (Clearfil Porcelain Bond Activator)	-	Panavia F	SBS	16.5	-
3.Aboushelib et al <sup>(43)</sup> 2009	Procera Zirconia	*Silane  **APA + silane	-	Panavia 21  RelyX  ARC	MTBS	*26  *_  **31.5  **13.7	-
4.Heikkinen et al <sup>(105)</sup> 2009	Procera Zirconia (Nobel Biocare)	Silicatization  (Rocatec) + *ZA were silanized with the acrylate silane.**ZM was silanized with a methacrylate silane	1000 TC  3000TC  8000 TC  15000 TC	RelyX ARC	SBS	*23  **16.8	*20.8 **10.2 *13.5 **6.9 *4.7 **4.4 *4.7 **2.7

5.Matinlinna AndLassila <sup>(106)</sup> 2011	Procera All Zircon	Tribochemical silica coating + * 3-methacryloxypropyltri- methoxysilane ** 3-Acryloxypropyltri- methoxysilane *** Strylethyltrimethoxysi- lane **** 3-Isocyanatopropyl- triethoxysilane ***** 3-Glycidoxypropyltri- methoxysilane	6000TC	RelyXUnicem	SBS	*10.3 **11.7 ***10.3 ****6.8 *****7.8	*13.6 **16 ***14.9 ****8.5 *****17.6
6.Lung et al <sup>(107)</sup> 2012	Lava (3M-Espe)	Silicatization (Rocatec) + silane *3M ESPE Sil **3Acryloxypropyltri- methoxysilane ***2-Hydroxyethyl meth- acrylate ****Itaconic acid *****Oleic acid	30-Day wa- ter storage Thermocy- cling	Rely X Unicem	SBS	*12.9 **13.5 ***11.4 ****10.7 *****9.6	*12.1 6.7 **14.6 14.5 ***7.9 6.7 ****10.8 5.9 *****7.4 5.5
Mean Bond Strength/MPa						15.5	8.8

**Table 8:** Silane coupling agents n= 6

Author	Zirconia material	Surface treatment	Method of Artificial aging	Cement type	Test method	Bond Strength/ MPa	Bond Strength/ MPa(after aging)
1.Piascik J R al <sup>(109)</sup> 2011	ZirCAD, Ivoclar-Viva- dent	Fluorination(rough) Fluorination (polished)	-	Rely-X Unicem	SBS	32.7 26.3	-
2.Piascik JR et al 2011 <sup>(110)</sup>	LAVA, 3M ESPE	APA+ fluorinated in a pla- nar, inductively coupled 13.56 MHz radiofrequen- cy plasma reactor at 800 W with a dc bias of 300 V  *20SEC *2Min *5Min	-	RelyXUnicem,	SBS	22.9 31.5 33.7	-
3.Piascik et al <sup>(108)</sup> 2012	Lava (3M-Espe)	Plasma fluorination	-	RelyXUnicem	SBS	37.3	-
Mean Bond Strength/MPa						30.7	-

**Table 9:** Plasma oxyfluoride n=3.

Author	Zirconia material	Surface treatment	Method of Artificial aging	Cement type	Test method	Bond Strength/ MPa	Bond Strength/ MPa(after aging)
1.Bottino et al <sup>(37)</sup> 2005	In Ceram Zirconia (CEREC In-Lab, VITA)	*Rocatec system, tribochemical silica coating  **CoJet system, tribochemical silica coating	H2O ST 7 days	Panavia F	MTBS	-	*23  **26.8
2.Atsu et al <sup>(104)</sup> 2006	zirconiumoxide(Cercon,De-gussa Dental)	APA(125- μm Al2O3)+ Tribochemical silica coating	-	Panavia F	SBS	22.9	-
3.Luthy et al <sup>(115)</sup> 2006	ZrO2-TZP (Cercon Smart)	Tribochemical silica coating	H2O ST2 day  - TC	-KetacCem  *Nexus **Rely X Unicem -***Superbond C&B -****Panavia21 *****Panavia F	SBS	6.5 7.3 *22.8 **39.2 ***44.5 ****52.4 *****63.4	1.4 2.5 *18.9 **36.7 ***29.4 ****55.7 *****73.8
4.Kumbuloglu et al <sup>(39)</sup> 2006	Zirconium oxide (DCS)	APA( 50-μm (Al2O3) + Tribochemical silica coating	H2O ST7 days   2000TC	*Panavia F  **RelyXUnicem	SBS	-	*18 18 **20.9 20.1
5.Amaral et al <sup>(11)</sup> 2006	InCeram Zirconia (VITA)	Tribochemical silica coating  *Rocatec  **CoJet	-	Panavia F	MTBS	*24.6 **26.7	-
6.Valandro L F et al <sup>(116)</sup> 2007	In Ceram Zirconia (VITA)	Tribochemical silica coating	*Dry  **150 day H2O ST  ***150d&CT  ***300 D st  ****300 d&TC	Panavia F	MTBS	*26.4	**6.5  ***6.2  ****3.4 4.3
7.Valandro L F et al <sup>(42)</sup> 2008	In-Ceram Zirconia®, Vita	Tribochemical silica coating system  * Rocatec-Plus then silanized. tribochemical silica coating **CoJet	-	Panavia F	MTBS  SBS  MTBS  SBS	*26.1 *27.2  **26.1 **21.7	-

8.Oyague et al <sup>(46)</sup> 2009	Zirconia (Cercon)	Tribochemical silica coating	H2O ST 6 months	*Clearfil Esthetic Cement **Rely x unicem	MTBS	*18.9   **8.8	*15.36   **6.07
9.Qeblawi et al <sup>(48)</sup> 2010	Y-TZP (ZirCAD, Ivoclar Vivadent)	Tribochemical silica coating + silane	-	Multilink Automix	SBS	30.9	-
10.Lin J et al <sup>(117)</sup> 2010	ZrO <sub>2</sub> , Nikkato,	Tribochemical treatment), + silane coupling agent (Clear- fil ceramic primer	-	*Maxcem **Smartcem *** Rely X Unicem ****Breeze ***** Biscem ***** Set/SE ***** Clearfil SA luting/	SBS	*31.94 **15.32 ***42.47 ****50.91 *****46.39 *****36.48 *****37.05	-
11-Attia et al <sup>(49)</sup> 2011	Zirconia (e.max ZirCAD, Ivoclar Vivadent)	Tribochemical silica coating	3 days No TC  30 days TC	Multilink Auto- mix	TBS	38.3	16.5
12-de Cas- tro et al <sup>(54)</sup> 2012	Zirconia (YZ-In Ceram YZ, VITA)	Tribochemical silica coating + Rely X Ceramic Primer )	ST 60 days 10,000TC	*RelyX ARC **RelyX U100 ***Panavia F	MTBS	*13.9   **6       ***9.7	*10.4 *12.9 **10.4 **7.2 ***10.3 ***9.2

13-XIE H et al <sup>(83)</sup> 2013	Everest ZS,KA-VO	Tribochemical sandblasting with 30- $\mu$ m CoJet followed by silane coupling agent, Porcelain Primer	40 days H2O ST	Bis-GMA-based composite resin cement	SBS	12.46	12.89
14-Perdigão J et al <sup>(118)</sup> 2013	IPS e.max-ZirCAD (IPS, Ivoclar	silicatization with CoJet sand	24 hourH2O ST	RelyXUnicem	MTBS	13.1	7.7
15-Chen C et al <sup>(119)</sup> 2013	KaVo Everest® ZS-Ronde	Tribochemically sandblasted with 30 $\mu$ mCoJet sands + silane (Porcelain Primer	-	Choice2	SBS	14.5	-
16-Subaş M G et al <sup>(59)</sup> 2014	VITA In-Ceram YZ for inLab®; VITA	silicatization with CoJet sand	-	*RelyX U100 **Clearfil Es-thetic Cement ***Panavia F2.0	SBS	*2.59 **3.09 ***3.74	-
17-da Silva et al <sup>(120)</sup> 2014	Lava Frame (3M-Espe)	Silicatization (Cojet) + silane ESPE Sil	6 month H2O ST	RelyX ARC RelyXUnicem	MSBS	10 37.4	11.3 20.5
18-Gomes A L et al <sup>(100)</sup> 2015	Cercon®, DeguDent	Tribochemical silica coating using Rocatec system	TC	*BiFix SE **Clearfil SA	MSBS	*17.3 **15.8	*1.9 **15.3
19-Yi et al <sup>(66)</sup> 2015	Lava(3M-Espe)	Silicatization with CoJet sand	T C	Self-adhesive resin cement	SBS	-	8.54
20-Lunget al <sup>(121)</sup> 2015	Upcera (Liaoning)	Rocatec Sand Plus	H2O ST(30 d) 6000TC	RelyXUnicem	SBS	15.93	14.5 12.6
21-Sciasci et al <sup>(67)</sup> 2015	Lava(3M-Espe)	Silicatization (Rocatec) *Rocatec Soft (30 mm silica-coated Al2O3) + silane **Rocatec Plus (120 mm Al2O3, followed by 110 mm silica-coated Al2O3)+ silane	10 000 TC	RelyX ARC RelyX U100 Panavia F	SBS		*14.9 *12 *10.1 **13.8 **15.2 **11.2
22-Vicente M et al <sup>(70)</sup> 2016	Cercon1, DeguDent	Triboche 30 mm silicacoated Al2O3 mical silica coating	TC	Clearfil™ SA Cement	SBS	9.5	7
23-Mahmoodi N et al <sup>(69)</sup> 2016	ICE Zirkon Translucent, Zirconzahn,	silicatization with CoJet sand	3000 TC	*Panavia F2.0(-zirconia primer (Monobond Plus) **Clearfil SA Luting	MTBS	-	*13 **12
Mean Bond Strength/MPa						22.8	15.4

**Table 10:** Application of a tribochemical silica coating n= 23.

Author	Zirconia material	Surface treatment	Method of Artificial aging	Cement type	Test method	Bond Strength/ MPa	Bond Strength/ MPa(after aging)
1.Druck et al <sup>(127)</sup> 2015	In-Ceram YZ (Vita)	Silica nanofilms. The SiO <sub>2</sub> thin films were deposited at the Magnetism and Magnetic Materials Laboratory, UFSM using the magnetron sputtering PVD process *5nm SiO <sub>2</sub> nanofilm **500 nm SiO <sub>2</sub> nanofilm ***500 nm SiO <sub>2</sub> nanofilm1etching with 10% hydrofluoric acid	10,000 TC, H <sub>2</sub> O ST90 days	RelyX ARC	SBS	*12 **14.9 ***4.1	*7.8 **0.01 ***1.4
2.Qeblawi et al <sup>(48)</sup> 2010	Y-TZP (ZirCAD, Ivoclar Vivaden)	Silicoated + *Acid etched/silanated **Silanated ***Zirconia primer	H <sub>2</sub> O ST 90 days, and TC	Multilink Automix	SBS	15.3 *14.5 **30.9 ***21.2	**25.26
Mean Bond Strength/ MPa						16	8.6

**Table 11:** Silicoating n=2.

Author	Zirconia material	Surface treatment	Method of Artificial aging	Cement type	Test method	Bond Strength/ MPa	Bond Strength/ MPa(after aging)
1.Janda et al <sup>(122)</sup> 2003	Zirconium oxide (Degussit)	Pyrosil Pen (Flame treatment) + silane + BIS-GMA Flame treatmentTime *25 s/cm <sup>2</sup> Flame treatmenttime **5 s/cm <sup>2</sup> Flame treatment time ***10 s/cm <sup>2</sup>	-	Variolink II	SBS	*9 **16  ***9	-
Mean Bond Strength/ MPa						11.3	-

**Table 12:** PyrosilPen Technology n=1.

Author	Zirconia material	Surface treatment	Method of Artificial aging	Cement type	Test method	Bond Strength/ MPa	Bond Strength/ MPa(after aging)
1.Derand et al <sup>(80)</sup> 2005	Procera All Zircon (Nobel Biocare)	Plasma treatment (hexamethyl disiloxane 13.56 MHz) using a reactor from Plasma Electronic zirconia specimens *as received(ZF)**glazed blocks (ZG)	-	Variolink II	SBS	*5.3 **3.5	-



2.Ito Y et al <sup>(129)</sup> 2016						16.6	-
Katana,KurarayNoritake							
Low-temperature plasma treatment							
-							
CLEARFIL Esthetic cement							
SBS							
Mean Bond Strength/MPa						8.5	-

**Table 13:** plasma spray n=2.

Author	Zirconia material	Surface treatment	Method of Artificial aging	Cement type	Test method	Bond Strength/MPa	Bond Strength/MPa(after aging)
1.Jevnikar P et al <sup>(77)</sup> 2010	TZ-3YB-E Zirconia (Tosoh)	*As sintered+ alumina coating	24h in H2O	RelyXUni-cem	SBS	*24.05	*27.46
		**APA +alumina coating	12,000TC			**27.44	**
		***Polished z + alumina coating				***24	27.3
							***23.7
2.Jevnikar P et al <sup>(55)</sup> 2012	TZ-3YB-E Zirconia (Tosoh)	*As sintered	24 h in water	Rely X Unicem	SBS	*24.05	*27.46
		+alumina coating	12,000 TC	FUJI +		**27.44	**27.32
		**APA + alumina coating				*20.07	*20.18
						**17.86	**21.52
Mean Bond Strength/MPa						23.5	22.4

**Table 14:** Nano-alumina coating n=2.

Author	Zirconia material	Surface treatment	Method of Artificial aging	Cement type	Test method	Bond Strength/MPa	Bond Strength/MPa
1.Ntala P et al <sup>(132)</sup> 2010	Y:TZP ZS-Blanks (Kavo)	*Hydroxyapatite (10 wt %) mixed with P25 glaze (90 wt %)	-	Variolink II	SBS		
		**IPS Empress 2 glass-ceramic (20 wt %) with IPS e.max Ceram glaze (80 wt %) Etched for 60 s using 37% of phosphoric acid.				*5.6	
		***IPS Empress 2 glass (20 wt %) mixed with IPS e.max Ceram glaze (80 wt %) Etched for 120 s using 5% of hydrofluoric acid.				**11	
		****IPS Empress 2 glass (30 wt%) mixed with IPS e.max Ceram glaze (70 wt%)				***8.8	-
						****9.1	

2.Cura C et al <sup>(133)</sup> 2011	(ICE Zirkon-Zahn	*Glaze HF (9.5%) + neutralizing agent Silane+ adhesive +dry **Glaze HF (9.5%)+ neutralizing agent Silane+ adhesive TC ***Glaze HF (9.5%) + neutralizing agent Zirconia primer +Dry ****Glaze HF (9.5%) + neutralizing agent Zirconia Primer +TC	5000 TC	Variolink II  Multilink Automix	SBS	*9  ***4.9	**7.4  ****3.7
3.Valentino TA et al <sup>(134)</sup> 2012 ZrO2 stabilized by 5% Y2O3 (Cercon Smart Ceramics, Degudent *Glaze +50 µm APA **Glaze +50 µm APA+ silane ***Glaze + Hydrofluoric Acid ****Glaze +Hydrofluoric Acid+silane - Enforce MSBS						*17.45 **18.41 ***20.75 ****25.17	-
4.Everson P et al <sup>(131)</sup> 2012	YTZP; LAVA, 3M ESPE	*Vitadur Alpha **IvoclarEmax Ceram ***Noritake Cerabien ****Vita VM9 *****Lava Ceram + (10% hydrofluoric (HF) acid for 90 s.) silane primer (Rely-X Ceramic Primer)	-24 H -H2O ST -T C 1800	Rely-X Unicem	SBS	*25 **24.5 ***27 ****18 *****19	*24 **33 ***34 ****23 *****24
Mean Bond Strength/ MPa						16.2	21.3

**Table 15:** Zirconia ceramic glazes (glaze-on technique) n=4.

Author	Zirconia material	Surface treatment	Method of Artificial aging	Cement type	Test method	Bond Strength/ MPa	Bond Strength/ MPa(after aging)
1.Zhang Y et al <sup>(136)</sup> 2014	zirconia ceramic blocks (Cercon, DeguDent	Meso-porous zirconia coating (MZ)	-	*Rely X Unicem **Panavia F2.0	MTBS	*19.02 **21.51	-
Mean Bond Strength/ MPa						20.2	-

**Table 16:** Zirconia particle deposition n=1.

Author	Zirconia material	Surface treatment	Method of Artificial aging	Cement type	Test method	Bond Strength/ MPa	Bond Strength/ MPa(after aging)
1.Lung C et al <sup>(138)</sup> 2013	Lava(3M ESPE)	Silica coating Sol-gel process *24 h **48 h ***72 h ****141 h	6,000 TC	RelyXUnicem	SBS	*5.49 **4.59 ***6.48 ****7.97	*0.06 **0.06 ***1.94 ****2.33
2.Chen C et al <sup>(119)</sup> 2013 KaVo Everest® ZS-Ronde Silica coated via the sol-gel technique+ silane (Porcelain Primer; - Bisphenol-A diglycidylmethacrylate composite resin cement (Choice2 SBS						14	-
3.Campos TM et al <sup>(139)</sup> 2016	(Vita InCeram YZ, Vita	ZCon +) and/or in silica sol (ZIn), both of which remained in these respective media for 5 d. The silica sol (0.5 mol/L) was obtained by passing an aqueous sodium silicate solution through an ionexchanging resin	TC	Silanated with Monobond Plus or MonobondS+Variolink II	SBS	11.64	3.62
Mean Bond Strength/MPa						8.4	1.5

**Table 17:** A solid-gel process (sol-gel) n=3.

Author	Zirconia material	Surface treatment	Method of Artificial aging	Cement type	Test method	Bond Strength/ MPa	Bond Strength/ MPa(after aging)
1.Morabada-bi A et al <sup>(140)</sup> 2014	ZirkonZahn zirconia block.	Coated with a layer of a Fluorapatite-Leucite glaze	-	Panavia F2.0	SBS	4.73	-
Mean Bond Strength/ MPa						4.73	-

**Table 18:** Fluorapatiteleucite glaze or salt glaze n=1.

Author	Zirconia material	Surface treatment	Method of Artificial aging	Cement type	Test method	Bond Strength/ MPa	Bond Strength/ MPa(after aging)
1.Piasek JR et al <sup>(14)</sup> 2009	ZirCAD and ProCad, Ivoclar	APA+The zirconia surface functionalization was performed using SiCl <sub>4</sub> (Gelest SIT7085.0) reaction with H <sub>2</sub> O[ <i>gas</i> ] by vapor deposition in a commercial tool (MVD-100, Applied Microstructures, San Jose, CA). The specimens are exposed for approximately 15min to a vapor-phase mixture of H <sub>2</sub> O and SiCl <sub>4</sub> , resulting in the deposition of the SixOy seed layer with an HCl gas byproduct*2. 6 nm **23nm MVD tool for chloro-silane pretreatment.	-	C&B Cement	MTBS	*23.2 **16.2	-
Mean Bond Strength/MPa						19.7	-

**Table 19:** Molecular vapor deposition tool (MVD) n=1.

Author	Zirconia material	Surface treatment	Method of Artificial aging	Cement type	Test method	Bond Strength/MPa	Bond Strength/MPa(after aging)
1.Lung et al <sup>(121)</sup> 2015	Upcera (Liaoning)	Coating by silicon nitride Si <sub>3</sub> N <sub>4</sub> hydrolysis + 2 h 1400 °C treatment  *(6 h) **(24 h) *** (48h)	H2O ST (30 d)	RelyXUni-cem	SBS	*9.3 **11.49 ***10.95	*9.01
							9.53
							**5.96
							9.77
			TC(6000)				***12.21
Mean Bond Strength/MPa						10.6	9.3

**Table 20:** Silica coating by silicon nitride hydrolysis n=1.

Author	Zirconia material	Surface treatment	Method of Artificial aging	Cement type	Test method	Bond Strength/MPa	Bond Strength/MPa (after aging)
1.Tsuo et al <sup>(38)</sup> 2006	Zirconia ceramic, Ohtsuka	*Alloy Primer(MDP) **Super Bond Monomer Liquid ***Metal Primer II	10,000 TC	Linkmax HV	SBS	*38.4 **37.6 ***37.3	*31.8 **30.6 ***25.5
2.Cavalcanti AN et al <sup>(44)</sup> 2009	Cercon, DeguDent	*Alloy Primer(VBATDT/MDP-based) **Metal Primer II(MEPS-based) ***Metaltite primer((MTU-6-based)	-	Panavia F2.0  Calibra	MSBS	*20.4 21.0 **21.8 21.60 ***20.6 20.7	-
3.Tashkandi E <sup>(45)</sup> 2009	LAVA, 3M-ESPE	Sandblasted with 120 µm aluminum oxide particles at 0.35 MPa pressure +coated with adhesive agent (Multilink primers A and B)  (A)+ coated with an experimental primer (The silane monomers used in the primers were 3-acryloyloxypropyltrimethoxysilane,3-isocyanatopropyltriethoxysilane, styrylethyltrimethoxysilane,3-methacryloyloxypropyltrimethoxysilane- and 3-(N-allylamino)propyltrimethoxysilane)	-	Multilink	MSBS  15.1	22.61  34.5	-

4.Kitayama et al <sup>(35)</sup> 2010	Cercon (Dentsply)	APA(110- $\mu$ m Al <sub>2</sub> O <sub>3</sub> ) + * Tokuso Ceramic Primer ** GC Ceramic Primer * **RelyX Ceramic Primer * ***Clearfil Ceramic Primer ***** Shofu Porcelain Primer ***** AZ Primer	-	*Bistite II ** Linkmax *** RelyX ARC **** Panavia F 2.0 ***** Resi-cem	TBS	14.8 14.0 19.1 15.6 22.3	-
5.Magne et al <sup>(143)</sup> 2010	Lava (3M-Espe)	APA(50- $\mu$ m Al <sub>2</sub> O <sub>3</sub> ) + zirconia primer  xperimental Zirconia Primer monomers)	-	*BisCem **DuoLink ***Panavia F ****Z100	SBS	*21.89 **26.68 ***14.96 ****29.35	-
6.Dias de Souza et al <sup>(144)</sup> 2011	Lava Frame (3M-Espe)	Primer containing MDP, VBATDT (Alloy Primer	-	RelyXUni-cem	MTBS	6.1	-
7.Piasek et al <sup>(108)</sup> 2012	Lava (3M-Espe)	*ClearFil Ceramic Primer **MonoBond Plus ***Z-Prime	-	RelyXUni-cem	SBS	*10 **7.5 ***24.3	-
8.Chen et al <sup>(145)</sup> 2013	Cercon (Dentsply)	APA(50- $\mu$ mAl <sub>2</sub> O <sub>3</sub> ) +zirconiaPrimer * Monobond Plus(MDP) ** BisGMA-Modified Monobond Plus * **ZPrime Plus	-	Duolink	SBS	*18.2 **22 ***29	-
9.XIE H et al <sup>(83)</sup> 2013	Everest ZS,KAVO	*Alumina sandblasting and conditioning  witha acidic adhesive monomer containingprimer, Z-Prime Plus. **Alumina sandblasting, and conditioning  with a new acidic adhesive monomer-containing primer, Metal/Zirconia Primer.	40 days H2OST	Bis-GMA-based composite resin cement	SBS	*9.03 **8.34	*7.48 **8.44
10.Zandparsa R et al <sup>(57)</sup> 2014	Zirconia, 3M ESPE	*APA and Z-PRIME Plus; **APA and alloy primer(MDP-VBATDT)	500 TC	Panavia F2.0	SBS	-	*21.11 **11.07
11.Perdigão J et al <sup>(118)</sup> 2013	IPS e.max-ZirCAD (IPS, Ivoclar	Z-Prime Plus	24 hourH2OST	RelyXUni-cem	MTBS	17.4	11.0
12.Reddy S M et al <sup>(58)</sup> 2014	(Incoris ZI, Sirona	(Metal/Zirconia primer	-	Multilink Speed	SBS	8.66	-

13-Oba et al <sup>(146)</sup> 2014	YPS (Kuraray Noritake)	* Monobond Plus (MDP, $\gamma$ -MPTS) ** Clearfil Ceramic Primer (MDP, $\gamma$ -MPTS) * **Alloy Primer (MDP, VTD) * ***Alloy Primer+Porcelain Liner M Liquid B (MDP, VTD, $\gamma$ -MPTS) * *****Porcelain Liner M LiquidA+Liquid B (4-META, $\gamma$ -MPTS) *****21 Porcelain Liner M Liquid A (4-META) * *****Porcelain Liner M Liquid B ( $\gamma$ -MPTS)	10,000 cycles	Super-Bond C&B	SBS	*28.6 **29.6 ***26.8 ****28.4 *****22.8 *****20.7 *****15.5	*7.7 **7.6 ***5.5 ****3.9 *****0.3 *****0.1 *****0.2
14-Amaral M et al <sup>(147)</sup> 2014 15-da Silva et al <sup>(120)</sup> 2014	Vita In-Ceram YZ for inLab, VITA Lava Frame (3M-Espe)	*Z-Prime Plus **AZ Primer ***Monobond Plus ****ScotchbondUniversa *****Experimental Adhesive	-	Variolink II	TBS	*9.3 **7.1 ***10.5 ****19.1 *****25.8	-
			6 month H2O ST	*RelyX ARC **RelyXUnicem	MSBS	*8.4 **15.4 *15.9 **36.2	
16-Pereira et al <sup>(148)</sup> 2015	Lava (3M-Espe)	*Alloy primer **M Z primer ***Zirconia primer ****Monobond plus *****signum zirconia bond *****Z prim plus *****Scotchbond universal adhesive	60 days H2O ST	Rely XT ARC	SBS	-	*5.8 **6.2 ***0 ****5.1 *****9.9 *****19.5 *****8.1
17-Yi et al <sup>(66)</sup> 2015	Lava (3M-Espe)	*APA + Z-prime Plus **APA +Monobond Plus ***Z-PRIME Plus	T C	self-adhesive resin cement	SBS	-	*16.5 **8.9 ***8.27
18.Kim et al <sup>(149)</sup> 2015b	Cercon Base (Dentsply)	Adhesive with MDP + *Single Bond 2, ** Single Bond Universal, ***All-Bond Universal, ****Alloy Primer.	24 h H2O ST TC 10,000	RelyX ARC	MSBS	*8.5 **37.7 ***31.3	***26.9
Mean Bond Strength/MPa						21	11

**Table 21:** Zirconia and metal primers n= 18.

	Zirconia surface treatment	Mean bond strength/MPa	Mean bond strength/MPa(after aging)
Surface micro roughness	1- Fusion sputtering	42.5	37.9
	2-Selective infiltration etching (SIE)	32.8	40.3
	3-Chemical treatment(Hot acid)	18.2	7.8
	4-Airborne-particle abrasion	17.4	15.2
	5-Coatings of low melting temperature porcelain micropearls	14.8	-
	6-Grinding with disks and diamond rotary instruments	13.4	8.6
	7-lasers	8.6	4.4
chemical surface treatment	1-Plasma oxyfluoride	30.7	-
	2-Nano-alumina coating	23.5	22.4
	3-Application of a tribochemical silica coating	22.8	15.4
	4-Zirconia and metal primers	21	11
	5-Zirconia particle deposition	20.2	-
	6- Molecular vapor deposition tool (MVD)	19.7	-
	7-zirconia ceramic glazes (glaze-on technique)	16.2	21.3
	8-Silicoating	16	8.6
	9- Silane coupling agents	15.5	8.8
	10-PyrosilPen Technology	11.3	-
	11-Silica coating by silicon nitride hydrolysis	10.6	9.3
	12-plasma spray	8.5	-
	13-Solid-gel process (sol-gel)	8.4	1.5
	14-Fluorapatite/leucite glaze or salt glaze	4.7	-

**Table 22:** Mean bond strength of different surfaces treatment before and after aging.

Luting resin cement	Mean bond strength/MPa	Mean bond strength/MPa(after aging)
Mean of MTBS of MDP based resin cements	26.5	16.8
Mean of TBS of MDP based resin cements	19.1	40
Mean of MSBS of MDP based resin cements	17.2	15.3
Mean of SBS of MDP based resin cements	20.3	25.75
Mean of MTBS,TBS,MSBS&SBS of MDP based resin cements	23.2	24.4
Mean of MTBS of Bis-GMA based resin cements	17.2	13.6
Mean of TBS of Bis-GMA based resin cements	17.66	12.2
Mean of MSBS of Bis-GMA based resin cements	20.9	11.6
Mean of SBS of Bis-GMA based resin cements	19.9	11.7
Mean of MTBS,TBS,MSBS&SBS of Bis-GMA based resin cements	18.9	12.2
Mean of SBS of 4-META based resin cements	34.5	16.5
Mean of SBS of Glass ionomer based resin cements	10.4	7

**Table 23:** Mean bond strength of luting cements according to their main composition before and after aging.