学術情報

#0581 Evaluation of bonding durability to CAD/CAM crowns

GC CORPORATION

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INTRODUCTION

CAD/CAM restorations are predicted to become mainstream. Various manufacturers have launched new types of hybrid resin block materials for CAD/CAM crown into the market. Previously, effect of thermal cycle test to bonding durability has been reported. However there are no reports that evaluated the relationship between cement film thickness and bonding durability considering the adaptation accuracy of CAD/CAM crowns. In this study, effect of cement film thickness on bonding durability of resin cement to CAD/CAM crown was evaluated using a cyclic loading test with thermal cycle assuming an occlusal load.

METHODS

Materials

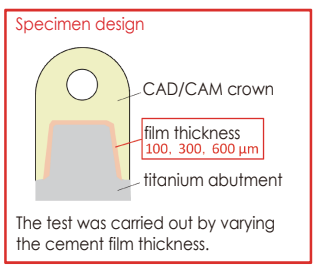
Table.1 Materials

Manufacturer	Hybrid resin block (Shade & Lot No.)	Resin Cement (Shade & Lot No.)	Primer for the block (Lot No.)	Primer for the abutment (Lot No.)
GC	CERASMART (A3LT, #1408061)	G-CEM CERASMART (TR, #1511021)	Ceramic Primer II (#1509011)	Without primer
SHOFU	HC (A3LT, #091501)	ResiCem (CLEAR, #081548)	Porcelain Primer (#081528)	M.L. Primer (#111591)
3M ESPE	LAVA Ultimate (A3LT, #N706691)	RelyX Ultimate (TR, #607749)	Scotchbond Universal Adhesive (#604416)	
VITA	ENAMIC (1M2-T, #44480)	RelyX Ultimate (TR, #607749)	Scotchbond Universal Adhesive (#604416)	

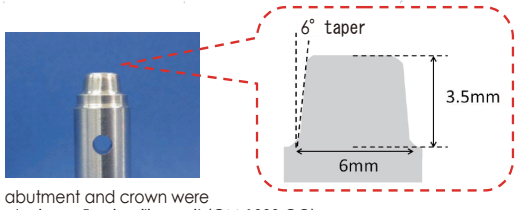
Fig.1 CERASMART

Fig.2 G-CEM CERASMART

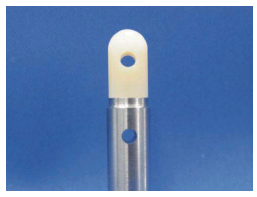
Test method



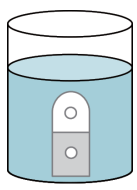
The test was carried out by varying the cement film thickness.



Titanium abutment and crown were fabricated using a 5-axis miling unit (GM-1000,GC).



Crowns were cemented to the abutment models according to the manufacturers' instructions. (Self-curing mode)

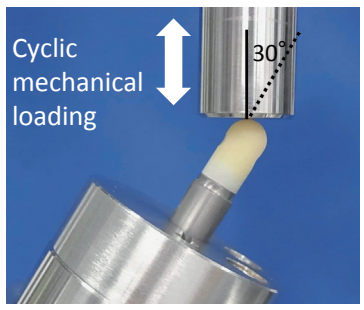


1day at 37℃ water

or

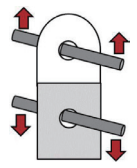
5, 000cycle, 5-55℃ 30sec

The specimens were soaked in 37 degC distilled water for 24 hours or 5,000 thermal cycling (5,000 cycle 5-55 degC at 30 sec a step)



< Test condition >
Instron universal tester(E1000)
load : 500N
frequency: 15Hz
cyclic loading: 100,000

Specimens were positioned at a 30° angle with respect to the specimen axis, and cyclic loading test was carried out up to 100,000 cycles at 15Hz in 37 degC water.



Tensile bond strength was measured (SHIMADZU AG-I/20kNT, cross head speed : 1mm/min.) with or without cyclic loading test (n=3).

No-load : No-thermal, no-mechanical load

Loaded : No-thermal, with mechanical load

TC & Loaded : with thermal and mechanical load

RESULTS & DISCUSSION

Tensile bond strength after cyclic loading test

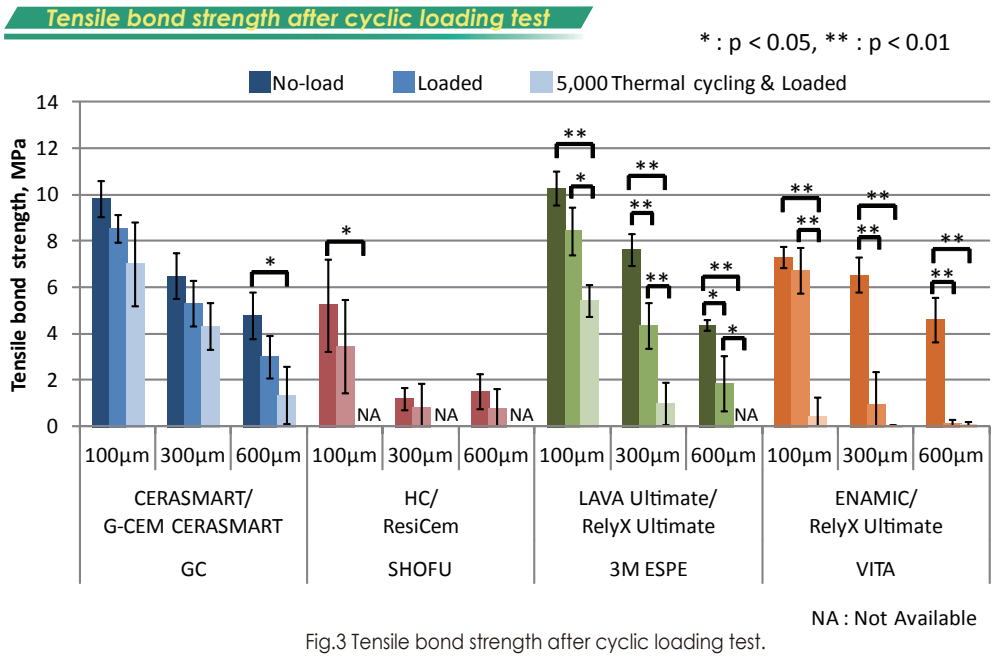


Fig.3 Tensile bond strength after cyclic loading test.

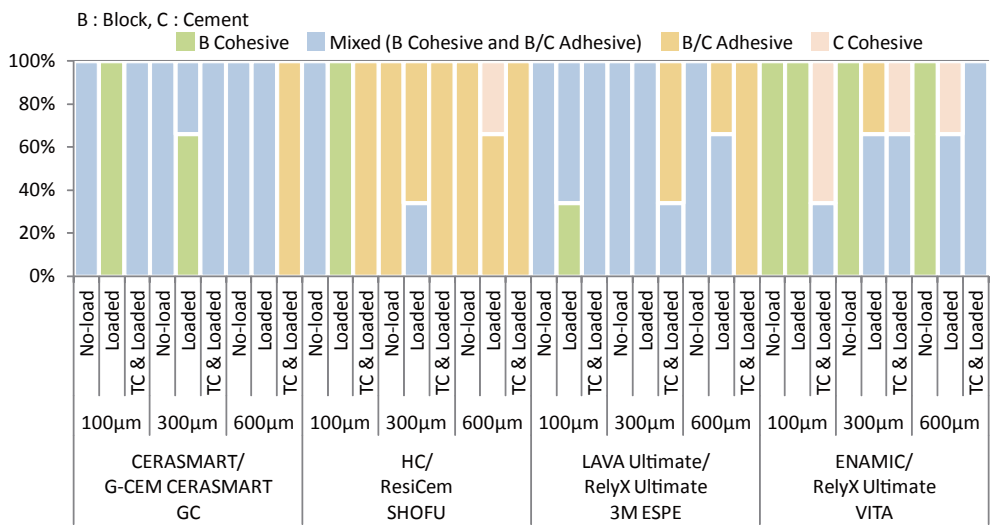


Fig.4 Failure mode with or without tensile bond test.

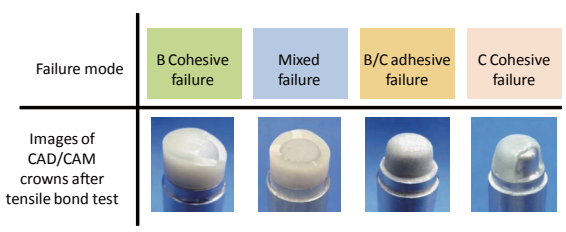


Fig.5 Images of CAD/CAM crowns after tensile bond test.

Table 2 Mechanical properties of blocks and cement.

	Compressive strength (MPa)	S.D.	Compressive elastic modulus (GPa)	S.D.
CERASMART	643	29	7.4	0.2
G-CEM CERASMART	315	11	6.2	0.1
HC	472	66	7	0.3
ResiCem	237	19	5.5	0.4
LAVA Ultimate	655	41	10.6	0.4
RelyX Ultimate	284	16	4.9	0.3
ENAMIC	157	37	9.9	0.3

Test method of Table 2
cross head speed : 1mm/1min
specimen : cylindrical 4mm × 6mm

The results were analyzed by one-way ANOVA and Tukey test, and results & discussion of each item are summarized below.

< No-load >
Bond strength of each CAD/CAM block decreased by increasing cement film thickness as noted below.

1) When cement volume is increased, the cement layer largely strain with accumulation of tensile force during tensile bond strength test, because the cement layer has lower strength and elastic modulus compared to abutment teeth and crown. This lead to adhesive failure during the test.

2) Thicker cement layer lead to higher polymerization shrinkage and this provides higher stress on adhesion interface.

< Loaded >
When cement film thickness was 300 or 600µm, no significant difference in the bond strength of CERASMART/G-CEM CERASMART was observed statistically between No-load and Loaded group as noted below.

1) Both block and cement have higher compressive strength, which leads to higher durability on cyclic loading.

2) By simillar compressive elastic modulus between block and cement, impact to adhesion interface by strain and stress during cyclic loading was lower.

< 5,000 Thermal cycling & Loaded >
When cement layer was 100 or 300µm, no significant difference in the bond strength of CERASMART /G-CEM CERASMART was observed statistically between each testing group (No-load, Loaded and 5,000 thermal cycling & Loaded), which indicates the higher bonding durability.

This result shows that combination of G-CEM CERASMART and Ceramic primer II has sufficient chemical adhesion against thermal stress.

Fig.4 shows that as the cement layer increase, a destruction part changed from block to the adhesion interface.

CONCLUSION

This study supports that cement film thickness has an affect on bonding durability of resin cement to CAD/CAM crowns. Therefore, proper abutment tooth preparation to make accurate CAD/CAM crowns and reliable bonding steps are important for long-term clinical stability.