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CRA STATUS REPORT

CORE BUILDUP & ADHESIVE COMPATIBILITY

When buildup of vital tooth structure is necessary, lack of post-operative sensitivity & long term retention are major clinical challenges. As adhesive development by companies progressed, use with buildup resins was apparently not a consideration, as evidenced by very low to no bond of 62% of 24 adhesives tested with buildup resins in 2000 (See Jun '00 CRA Newsletter). After 3 years of many changes, report below updates clinicians on the current state of buildup resin–adhesive compatibility & other characteristics.

IN THIS ISSUE:

1. CLINICAL CONSIDERATIONS IN CORE BUILDUP PROCEDURES

A. BUILDUP SIZE RELATES TO CHOICE OF BUILDUP MATERIAL & ADHESIVE.

Buildups can vary from small additions to existing vital dentin to significantly large restorations on non-vital teeth. For vital teeth, materials & techniques that control post-op sensitivity are the most crucial, since the bond to tooth structure is derived mainly from mechanical features placed in the preparation. Buildups on posts in non-vital teeth have opposite needs. Information below illustrates these points:

(1) FILLER

LESS THAN 1/2 OF TOOTH PREPARATION MISSING ON A VITAL TOOTH. This is the most commonly occurring augmentation need. Technically this is a replacement for *previous* amalgam or composite resin. Mechanical retention usually is not necessary. Bonded compomer is the easiest restoration. Only moderate strength is necessary, but desensitization is mandatory.

(2) BUILDUP

MORE THAN 1/2 OF CORONAL TOOTH STRUCTURE IS MISSING ON A VITAL TOOTH. This situation occurs less frequently now because higher strength cements are used during crown seating by many for the dentin replacement instead of performing a separate buildup procedure. Retention is achieved with "pot holes", grooves, channels, & if necessary, pins. Bonded composite resin is the easiest & best solution. High strength, bond, retention, & desensitization are all mandatory.

(3) POST & CORE

MORE THAN 1/2 OF CORONAL TOOTH STRUCTURE IS MISSING ON A NON-VITAL TOOTH. This situation has increased because more teeth are retained longer & endodontic therapy is more common. Anti-rotational features can include "pot holes", grooves, channels, & if necessary, pins. Bonded composite resin is the easiest, best, & most popular technique. High strength, bond, & retention are mandatory & desensitization is unnecessary.

B. POST OPERATIVE SENSITIVITY RELATES TO CHOICE OF ADHESIVE.

The critical concern with any buildup on vital teeth is post-op sensitivity. In these cases, adhesives with well established clinical history of no post-op sensitivity are products of choice. Brand names include Amalgambond Plus, Clearfil Liner Bond 2V, & Clearfil SE Bond. Newest brand names of adhesives using "self-etching primer" concept are: AdheSE, Brush & Bond, iBond, Nano-Bond, One-Up Bond F, Optibond Solo Plus SEP, Simplicity, Solobond Plus, Tenure Uni-Bond, Touch & Bond, Tyrian One-Step Plus, Unifil Bond, & Xeno III. Theoretically, post-op sensitivity should not be a problem with these 13 newest products but time is needed to establish this clinically.

C. BUILDUP RETENTION RELATES TO CHOICE OF ADHESIVE-BUILDUP RESIN COMBINATION.

Four factors below present critical challenges to all 3 types of buildups described above in section A.

(1) Forces & vibration during cutting of the crown prep minutes after buildup polymerization.
(2) Forces during withdrawal of impression material minutes after buildup polymerization.
(3) Forces during removal of temporary crown several weeks after buildup placement.
(4) Everyday forces of mastication.

In all cases, reliance on bond strength of adhesive alone to secure buildup resin to tooth structure is not advisable. Use of undercuts in dentin for mechanical retention such as groves, channels, "pot holes", & pins & posts are all viable techniques to establish long term retention. However, adhesive–buildup resin combinations with reliable high bond strengths are desirable, & incompatibilities are unacceptable.

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2. 10 MINUTE BOND STRENGTHS OF 34 ADHESIVES TO 8 BUILDUP RESINS

One light cure, 5 dual cure, & 2 auto cure buildup resins were tested using the Notched Shear Bond Test Method (see Jun '02 CRA Newsletter). 34 adhesives indicated by their manufacturer for use with light only, or also with dual or auto cure resins were tested with the 8 buildup resins. All materials were used strictly per manufacturer's directions. The same curing light was used throughout. (Optilux 500 conventional halogen light, 10mm light guide, 715 mW/cm^2 constant output, 4.3mm distance from adhesive & 2.3mm from single layer of buildup resin, & cure time of 5 to 30 seconds for adhesives & 30-40 seconds for buildup resins per each manufacturer's directions.) All numbers below are from tests conducted at 10 minutes after buildup placement (auto cure) or resin polymerization (light & dual cure buildup resins).

KEY:

Light Cure	Strengths 15 MPa or greater
Dual Cure	Strengths 14.9 to 5 MPa
Auto Cure	Strengths less than 5 MPa

CRA TERMINOLOGY FOR ADHESIVE SYSTEM TYPE

SYSTEM 1 = Etch, Rinse, Prime, Adhesive all in separate steps (E-R-P-A), ie: All-Bond 2.
SYSTEM 2 = Etch, Rinse, Primer & Adhesive combined (E-R-PA), ie: One-Step.
SYSTEM 3 = Etchant & Primer combined, no rinse, Adhesive (EP-A), ie: Clearfil SE Bond.
SYSTEM 4 = Etchant, Primer, & Adhesive all combined (EPA), ie: Adper Prompt L-Pop.

Shear bond strengths (MPa) of 34 adhesives listed from greatest to least mean bond strength across 8 core buildup materials.

	A ADHESIVE NAME	B ADHESIVE TYPE (CRA term for system type)	C COMPANY	D PhotoCore‡ (Kuraray)	E Build-It FR (Pentron)	F LuxaCore§ (DMG)	G CoreRestore2§ (Kerr)	H FluoroCore (Dentsply Caulk)	I Core Paste§ (Den-Mat)	J Ti-Core Gray (EDS)	K Core-Flo (Bisco)
ADHESIVES MANUFACTURERS INDICATE FOR USE WITH LIGHT, DUAL, OR AUTO CURE RESINS											
1	Optibond FL	1	Kerr	41.9	30.1	30.1	30.5	32.0	25.0	27.2	27.8
2	All-Bond 2	1	Bisco	37.1	24.9	29.9	29.2	24.3	22.9	23.1	21.5
3	Dentastic Uno Duo✱	2	Pulpdent	40.4	28.1	26.8	24.7	13.9	21.6	19.9	18.5
4	One-Step	2	Bisco	31.3	22.5	21.3	26.0	18.8	27.0	12.9	18.7
5	Brush & Bond	4	Parkell	28.0	22.5	25.2	26.5	24.1	21.6	11.6	9.9
6	Cabrio✱	2	Discus	32.6	23.7	23.5	18.7	14.1	23.7	15.3	15.2
7	Tenure Uni-Bond & Bond Link	3	Den-Mat	29.8	18.4	15.9	23.6	20.9	17.3	19.0	20.4
8	Amalgambond Plus	1	Parkell	22.6	25.6	24.3	23.8	19.0	19.7	11.8	4.9
9	Tyrian One-Step Plus	3	Bisco	22.1	18.3	16.6	20.2	19.4	21.9	15.7	15.5
10	Optibond Solo Plus ✱	2	Kerr	36.8	29.9	13.9	14.8	15.9	11.5	10.2	8.1
11	Optibond Solo Plus SEP ✱	3	Kerr	39.6	16.4	14.0	17.3	14.3	13.3	13.7	12.0
12	Prime & Bond NT✱	2	Dentsply Caulk	24.8	12.7	16.0	17.4	15.0	22.6	13.6	9.7
13	Tenure	2	Den-Mat	24.5	24.6	19.0	13.3	13.2	10.8	12.5	13.7
14	Bond 1 ✱	2	Pentron	23.6	21.9	16.4	19.9	20.8	22.1	0.5	0.4
15	Simplicity	3	Apex Dental	22.3	23.1	16.9	15.9	15.7	17.8	0.9	7.8
16	Solobond Plus	3	Voco	20.4	16.7	17.8	11.6	25.3	6.5	5.6	6.6
17	Clearfil Liner Bond 2V ✱	3	Kuraray	24.2	8.4	13.9	15.5	9.0	12.1	9.7	8.3
18	IntegraBond✱	2	Premier Dental	15.0	14.7	12.9	13.9	8.5	8.4	14.0	11.3
19	Scotchbond Multi-Purpose Plus✱	1	3M ESPE	2.3	18.4	9.1	14.8	18.8	14.2	9.2	5.9
20	Touch & Bond	4	Parkell	17.2	17.2	10.7	14.5	9.2	8.1	7.5	6.6
21	Multibond✱	2	Centrix	9.9	10.9	15.3	4.7	15.6	3.1	17.0	13.7
22	Nano-Bond✱	3	Pentron	19.7	8.4	9.9	6.0	10.0	19.8	8.3	4.6
23	Encore Bond	2	Centrix	0.0	0.2	0.3	1.3	1.0	0.9	0.6	0.5
ADHESIVES MANUFACTURERS INDICATE FOR USE WITH LIGHT CURE RESINS ONLY											
24	Clearfil SE Bond	3	Kuraray	37.4	NR	NR	NR	NR	NR	NR	NR
25	Single Bond	2	3M ESPE	36.8	NR	NR	NR	NR	NR	NR	NR
26	Gluma Comfort Bond + Desensitizer	2	Heraeus Kulzer	32.8	NR	NR	NR	NR	NR	NR	NR
27	Unifil Bond	3	GC America	28.2	NR	NR	NR	NR	NR	NR	NR
28	AdheSE	3	Ivoclar Vivadent	26.6	NR	NR	NR	NR	NR	NR	NR
29	Adper Prompt L-Pop	4	3M ESPE	25.7	NR	NR	NR	NR	NR	NR	NR
30	Xeno III	4	Dentsply Caulk	20.7	NR	NR	NR	NR	NR	NR	NR
31	One-Up Bond F	4	J. Morita	20.4	NR	NR	NR	NR	NR	NR	NR
32	iBond	4	Heraeus Kulzer	17.5	NR	NR	NR	NR	NR	NR	NR
33	Excite	2	Ivoclar Vivadent	15.9	NR	NR	NR	NR	NR	NR	NR
34	Fuji Bond LC	2	GC America	5.2	NR	NR	NR	NR	NR	NR	NR

‡ = When this light cure buildup resin was used with dual cure adhesives marked with a ✱ in column A, dual cure component was not used per adhesive manufacurer's directions.
§ = Buildup chemistry was changed since test results reported in Jun '00 CRA report.
✱ = Dual cure adhesive component was used when bonding to dual or auto cure buildup resins & was not used with the light cure buildup resin.
NR = Not Recommended for use with dual or auto cure buildup resins per each adhesive manufacturer.

See Summary of Chart top of page 3.

SUMMARY OF CHART:

A. Buildup resin chemistry was a major variable that affected bond strengths. PhotoCore light cure buildup resin had highest percentage of high bond strengths (85%) & the 2 auto cure buildup resins (Ti-Core Gray & Core-Flo) both had only 30% high bonds. The 5 dual cure resins had 57% to 74% high bonds, depending on formulation.

B. No buildup resin had high bonds with all adhesives tested.

C. Only 4 adhesives had high bonds with all 8 buildup resins tested (All-Bond 2, Optibond FL, Tenure Uni-Bond & Bond Link, & Tyrian One-Step Plus). One adhesive (Encore Bond) had very low to no bond with all 8 buildup resins tested.

D. The number of adhesive-buildup resin incompatibilities (see red cells in chart) are reduced significantly compared to the June '00 CRA report on this same subject.

3. *CLINICALLY IMPORTANT POINTS RELATED TO THESE BUILDUP–ADHESIVE TESTS*

A. DUAL CURE BUILDUP RESINS NEED LIGHT ACTIVATION.

Statistically significant increases in bond strengths were found when light initiation was used with the 5 dual cure buildup resins *vs*. reliance on their auto cure alone.

B. THE DUAL CURE COMPONENT IN DUAL CURE ADHESIVES IS NEEDED WHEN THEY ARE USED WITH AUTO CURE BUILDUP RESINS.

CRA tested dual cure adhesives both with, & without, their dual cure component with auto cure buildup resins & found in all cases but one that bond strengths were improved by its use. (Bond 1 had low bond strengths both with, & without, its dual cure component.) Numbers in the page 2 chart include dual cure component use with both the auto cure buildup resins.

C. BOND OF DUAL CURE ADHESIVE TO DUAL CURE BUILDUP RESINS MAY, OR MAY NOT, BE IMPROVED WITH DUAL CURE COMPONENT.

Data below illustrate fact that dual cure component use does not always improve bond strengths to dual cure buildup resins. At this time, clinicians have no basis to judge whether or not to use the dual cure component. Manufacturer must test & include brand name recommendations in their directions.

Bond strengths (MPa) of adhesives with, & without, dual cure component.

BUILDUP RESIN	Prime & Bond NT (Light Cure)	Prime & Bond NT (Dual Cure)	Optibond Solo Plus (Light Cure)	Optibond Solo Plus (Dual Cure)	Clearfil Liner Bond 2V (Light Cure)	Clearfil Liner Bond 2V (Dual Cure)
Built-It FR	24.2	12.7	25.8	29.9	20.2	8.4
Core Paste	23.7	22.6	23.5	11.5	21.2	12.1

= Indicates statistically lower bond strengths.

D. ANY TYPE OF RESIN CURING LIGHT COULD BE USED WITH THE BUILDUPS & ADHESIVES TESTED.

Halogen, plasma arc, & LED lights cured all materials well. However, the light cure buildup resin (PhotoCore) cured deeper than the dual cure buildup resins per unit time.

E. DUAL BARREL SYRINGES WITH AUTO-MIX TIPS FOR BUILDUP RESINS HAD ADVANTAGES & DISADVANTAGES.

Advantages were fast, convenient, easy to use, & possibility for more consistent dispensing & mixing. Disadvantages were cost, waste, & potential for inconsistent dispensing & mixing resulting in low bonds if clinician does not extrude small amount of material before attaching auto-mix tip to assure proper material flow from both syringe barrels.

F. SOME BUILDUP RESINS & ADHESIVES WERE MUCH EASIER TO USE.

Ease of use promotes consistent, reliable results & speeds treatment. Build-It, CorePaste, & Luxacore buildup resins, & Brush & Bond adhesive were notably easier to use.

G. BUILDUP RESIN COSTS PER UNIT WEIGHT VARY GREATLY.

Pricing differs by dispensing mode. Buildup resins packaged in gun expressed double barrel syringes had lowest cost of $1.19 – $2.96 per gram including cost of tips. Jar dispensing had medium cost of $1.77 – $4.14 per gram. Single syringe or small hand expressed dual syringe systems had highest cost at $3.50 – $8.35 per gram.

4. *CONCLUSIONS*

Ideally, buildup resins & adhesives should have high bond strengths to tooth, no chemical incompatibility, & no post-op sensitivity. Products where these 3 characteristics are well established clinically & in these tests are PhotoCore buildup with Clearfil SE Bond & Clearfil Liner Bond 2V adhesives, & any of the 6 light or dual cure buildup resins tested with Amalgambond Plus. 13 new self etching primer adhesives (designated as Systems 3 or 4 in column B on page 2 chart) have potential to meet these 3 criteria as clinical use establishes lack of post-op sensitivity. Chart on page 2 shows buildup resins these 13 adhesives bond to best. If post-op sensitivity is not a concern, the chart on page 2 can help clinicians determine systems with high bond strengths & section 3 F above indicates products with best ease of use.

See CRA Website (www.cranews.com) for methods & complete data.

CRA CONFIRMED USEFUL **NOTEWORTHY—**

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ORABASE SOOTHE-N-SEAL

Established name with new formulation of over the counter medical grade "Super Glue" (2-octyl cyanoacrylate) applied to oral canker sores & other oral abrasions. Sponge applicator releases liquid onto dried tissue to provide protective film & prevent irritation. Advantages: (1) Immediate pain relief; (2) Easy & fast to use; (3) Application system worked well; & (4) Barrier stayed in place. Disadvantages: (1) "Glues" unintended tissues together if not allowed to dry thoroughly or if handled carelessly; (2) Applicator tip can irritate sores during drying & application; & (3) Applicator handles were too short to reach some areas. NOTE: Currently only available in the U.S.

74% of 35 CRA Evaluators stated this product would replace products they use currently, & **89%** rated it excellent or good & worthy of trial by colleagues.

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IMAGEMAX

Desktop unit combines convenience of an automatic processor with film quality of a dip tank. Films are held in the processing tank & solutions are moved to the film by air pressure from sealed one quart reservoirs without rollers or moving parts. User sets temperature (68-85°F) based on image quality & speed desired. Lower temperatures produce best resolution, but require longer times. Unit automatically adjusts processing time based on temperature & type of film (intraoral or pan/ceph) following Kodak's guidelines to produce maximum image quality. Optional daylight loader is available which encloses entire processor.

Unit develops 1 pan or ceph, or up to 24 intraoral films at a time. New films cannot be added until film being processed is done. Films waiting to be processed are loaded into holder & placed into light-tight staging box that has an indicator LED that blinks when it contains films to be processed.

CRA tests showed dry-to-dry processing times of:
7:08 minutes - intraorals at 83°F
7:55 minutes - pan at 83°F
11:10 minutes - intraorals at 68°F (highest image quality)
Endo films (run at 85°F) could be viewed after 1:15 minutes.

ADVANTAGES:
A. Produces high quality films with good contrast & no roller marks.
B. Easy to use.
C. LCD screen shows processing status at all times, tracks chemistry usage, & prompts when service needed.
D. No moving parts. Requires less cleaning & maintenance.
E. Self-contained. Can be located conveniently without plumbing. Small size without daylight loader: 18" wide x 15" deep x 19.5" high; 47.6 lbs. (with solutions).
G. Large tinted viewing window in optional daylight loader.
H. Films can be viewed anytime (endo), then returned to unit to complete processing to create archival quality films.
I. Sealed solution containers reduce fumes, spills, & oxidation.

DISADVANTAGES:
A. Longer processing time for archival quality intraoral films *vs*. other processors (about 7 min. *vs*. 5 min.) but can be read wet (about 5 min).
B. Films must be processed in batches & cannot be added at any time.
C. Daylight loader is bulky (20.5" wide x 21" deep x 24" high) & cuffs were reported as difficult to work with for some Evaluators.
D. Frequent need to replace wash water.
E. Unit does not maintain low temperature setting during periods of constant use.
F. Loading films requires extra step & more time than other processors.
G. Audible beep that indicates processing is complete is too quiet.

CONCLUSIONS: ImageMax is best suited for small offices with low x-ray demands &/or clinicians who demand high quality films. It could be an ideal back-up processor since the tanks can be filled, machine turned on, & film processing begun within a few minutes time.