

G-BOND

In a class of its own

“GC”

“The ultimate proof of performance of an adhesive should follow from clinical research.”

PROFESSOR BART VAN MEERBEEK
Catholic University of Leuven

Two independent clinical trials of G-BOND have reported 100% retention at 3 years confirming the exceptional characteristics of the ground-breaking G-BOND formulation.

G-BOND is a single bottle, one application adhesive that delivers 100% performance.

G-BOND is designed with durability and simplicity clearly in mind. Its patented formulation was developed to provide a solution to the recognised problem of dentine bond degradation and features exceptional chemical bonding potential, hydrophobic resin formulation with no HEMA and a remarkably simple application technique.

G-BOND is simply in a class of its own



100% RETENTION

Three-year Clinical Evaluation of G-Bond in Non-carious Cervical Lesions

M. Tyas, M. Burrow

J Dent Res 88(Spec Iss A): abstr 0545, 2009

Three-year Clinical Evaluation of Gradia Direct restorations

J. Sugizaki, M. Morigami, S. Uno, T. Yamada

J Dent Res 88(Spec Iss A): abstr 3244, 2009



G-BOND baseline



G-BOND 1 year



G-BOND 2 years



G-BOND 3 years

Prof M. Burrow, Melbourne Dental School

A recent review of bond durability in clinical trials in non-carious cervical lesions identified that only five resin based adhesive systems and three glass-ionomer products (including Fuji BOND LC and Fuji II LC) had achieved 100% retention after three years.

A Critical Review of the Durability of Adhesion to Tooth Tissue: Methods and Results
J. De Munch, K. Van Landuyt, M. Peumans, A. Poitevin, P. Lambrechts, M. Braem and
B. Van Meerbeek *J Dent Res 84(2):118-132, 2005*

G-BOND simplicity delivers consistency

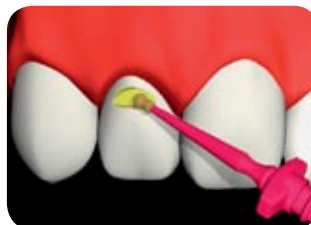
One bottle, one application

G-BOND is fast to apply and features an innovative drying step that reduces technique sensitivity from moisture variations by consistently ensuring a dry matt surface is left after every application.

G-BOND has a 2 year shelf life without refrigeration.

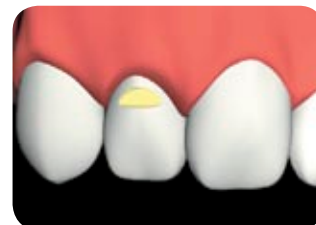
See and feel the difference

Unlike traditional adhesives G-BOND leaves a matt surface that holds composite to the tooth. As well as greater control during manipulation of composite, G-BOND gives a clear visual check of where the adhesive has been placed.



1. Application

Apply G-BOND to the entire dried cavity.



2. Waiting

Leave undisturbed for **5 - 10 seconds**.



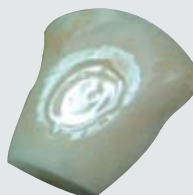
3. Drying

Using **MAXIMUM** air pressure, dry thoroughly for **5 seconds** with vacuum suction.

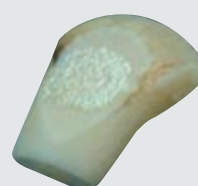


4. Light cure

10 seconds.



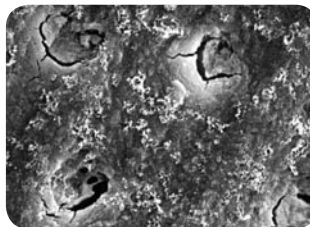
Traditional adhesives leave a wet gloss surface after light activation.



G-BOND creates a matt, frosty surface to aid composite manipulation and adhesion.

No sensitivity

Immediately after application to exposed dentine G-BOND is able to stop fluid movement in the tubules and stop any sensitivity.



Dentine tubules are occluded after application of G-BOND.



Following application G-BOND ensures the dentine is immediately desensitised.

Dr A. Sendu

Invisible margins

G-BOND has a low film thickness of just 10 micrometres to ensure an aesthetic transition from composite to tooth at the restoration margins. G-BOND removes the risk of radiolucent zones under composite restorations, which are caused by pooling of bonding agents in the bottom of cavities.



Dr G. Millicich

For bonding to three different surfaces

G-BOND is designed for strong chemical bonding to dentine, enamel, and glass-ionomer cement (GIC). As the majority of clinicians are utilising glass-ionomer liners and bases under their composite restorations, G-BOND's fast application technique and chemical bonding make it an ideal choice to link GIC and composite in the sandwich technique.



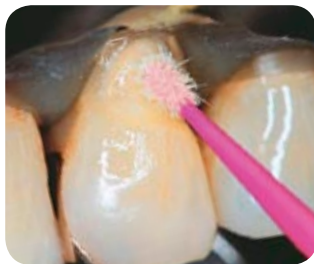
Dr G. Millicich

G-BOND clinical applications

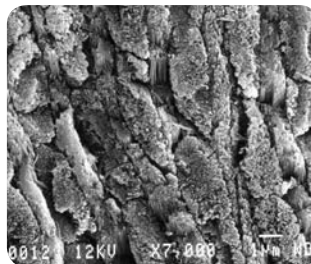
Achieving optimum clinical results with G-BOND



1. Wedge-shaped defect and caries on tooth 24. No phosphoric acid etching of enamel is required, except with uncut enamel. Etching of dentine is contraindicated.



2. Apply a thin layer of G-BOND and leave for 5-10 seconds. Only a thin application of G-BOND is required to wet the tooth surface. Immediately following application G-BOND will seal and desensitise.



3. SEM of enamel showing the etch pattern following G-BOND application (7000x SEM).



4. Air dry G-BOND with maximum pressure for 5 seconds. High air pressure ensures there is full evaporation of the solvent and subsequent formation of a strong but thin bond layer - less is best.



5. Light cure for 10 seconds. At this point G-BOND is hydrophobic. The G-BOND surface should have a matt/frosty appearance. The matt surface aids composite placement.



6. The final restoration following composite placement, finishing and polishing.

G-BOND and the glass-ionomer, composite laminate technique

Routine radiographs in a high caries risk patient identify a deep lesion with significant reparative dentine response in the pulp, but no obvious symptoms of irreversible pulpitis. The patient has a low salivary pH and is aged in their mid 20's.



Treatment strategy

Utilise Fuji VII White as a deep liner and remineralising agent under a GRADIA DIRECT composite restoration. G-BOND is ideally suited as the composite adhesive as it will chemically bond GRADIA DIRECT to the glass-ionomer base as well as the surrounding dentine and enamel surfaces.



The cavity preparation ensures a peripheral margin of sound dentine is established and softened dentine is left over the pulp to avoid the risk of pulpal exposure.



Following etching of enamel and conditioning of dentine, Fuji VII White is manipulated into place using a small microbrush.



Once the Fuji VII has set all surfaces, G-BOND is applied to be left for 5-10 seconds, then vigorously air dried. Light cure for 10 seconds.



The "closed sandwich" restoration is completed using GRADIA DIRECT composite shades A3 and NT (Natural Translucent).

Preparation of uncut enamel

For additional mechanical retention, uncut enamel can be etched prior to G-BOND placement. Etching enamel does not compromise the chemical bonding mechanism of G-BOND, however etching dentine is contraindicated.



1. Stained composites require replacement.
2. Composite is removed, enamel margins beveled and surrounding enamel cleaned.
3. Phosphoric acid gel applied to enamel margins only.
4. Etched enamel margins.
5. G-BOND is applied to dentine and etched enamel for 5-10 seconds, followed by vigorous air drying for 5 seconds and light curing.
6. Note the matt surface of the G-BOND. An increment of GRADIA DIRECT X shade AO2 is placed on the palatal margin to prevent "shine through".
7. Shade A2 is placed in the gingival third and shade A1 in the rest of the cavity.
8. A final increment of WT (White Translucent) is placed.
9. Completed restorations following finishing and glazing with G-COAT PLUS.

Designed for durability

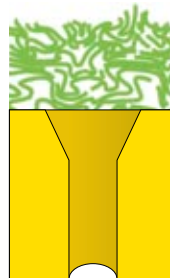
Mild self etching of dentine

The research into adhesive interface degradation has clearly defined the negative impact of aggressive etching of dentine which strips hydroxyapatite crystals from around the collagen fibres. As a result of this insult, matrix metalloproteinases (MMPs) are released from the etched dentine and subsequently start the degradation of collagen fibres. This self degradation process has been described as being similar to that of caries when bacterial acid demineralises dentine. Surprisingly, researchers have identified this process will take place over a relatively short period of time.

Tjäderhane L, Larjava H, Sorsa T, Uitto VJ, Larmas M, Salo T (1998). The activation and function of host matrix metalloproteinases in dentine matrix breakdown in caries lesions. *J Dent Res* 77:1622-1629

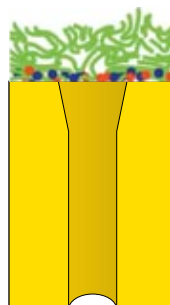
Hashimoto M, Tay FR, Ohno H, Sano H, Kaga M, Yiu C, et al (2003b). SEM and TEM analysis of water degradation of human dentinal collagen. *J Biomed Mater Res B Appl Biomater* 66:287-298

Pashley DH, Tay FR, Yiu C, Hashimoto M, Breschi L, Carvalho RM, et al (2004). Collagen degradation by host-derived enzymes during aging. *J Dent Res* 83:216-221



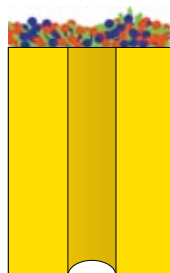
Total etch techniques and low pH self etching systems strip hydroxyapatite crystals from around the collagen fibres.

Over time the exposed collagen structure is susceptible to degradation.



Low-medium pH self-etching systems leave some mineral surrounding collagen at the bottom of the demineralised zone.

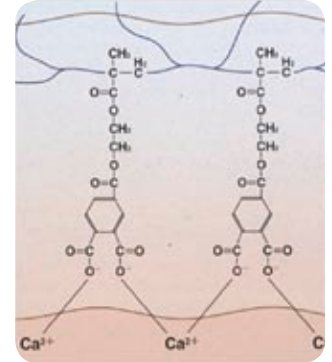
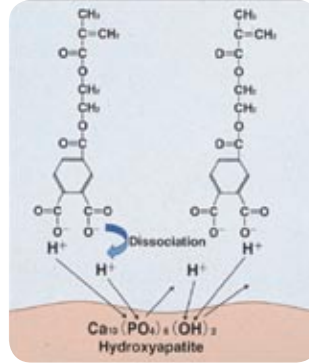
Over time the exposed collagen structure is susceptible to degradation.



G-BOND is a mild self-etching system that leaves mineral surrounding collagen through the full thickness of the demineralised zone. This zone (called a nano-interaction zone) provides a structure that will provide micro-mechanical retention; and support strong, stable chemical adhesion to dentine with long term durability of seal.

Chemical bonding

G-BOND utilises both 4-MET and a phosphoric ester monomer to gain strong chemical adhesion to hydroxyapatite. As well as providing retention, the chemical reaction creates a more acid resistant zone providing greater physical and chemical stability for the bond interface.

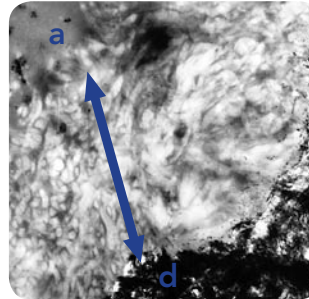


Nano Interaction Zone provides durability

“The image of the interface formed by G-BOND is totally different from that of the interface formed by earlier bonding materials. The surface of the dentine is decalcified only slightly, and there is almost no exposure of collagen fibres. This suggests an extremely thin (300 nanometres or less) interface is formed and that in this area, functional monomers contained in the bonding material react with hydroxyapatite at the 'nano' level, to form insoluble calcium. When compared to the 'normal' hybrid layer, this interface, with a reacted layer at the nano level, and lack of complete exposure of collagen fibres, is at reduced risk of deterioration by enzymes contained in the mouth. Therefore, the interface formed by G-BOND is expected to be stronger and more durable than that formed by other bonding materials. It would appear appropriate to call the interface exhibiting this property, a Nano Interaction Zone (NIZ), or a reacted layer at the 'nano' level, as opposed to the traditional hybrid layer appellation.”

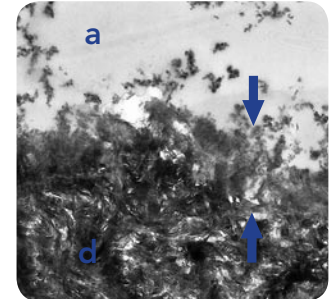
Indications for a new key word in adhesion. Professor H Sano, Hokkaido University, Graduate School of Dentistry, Japan

Normal Hybrid Zone (TEM image)



The area shown by the arrow, between the cured bonding layer (a) and the dentine (d), is the hybrid layer. It is clearly shown that severe decalcification occurred.

Nano Interaction Zone formed by G-BOND (TEM image)



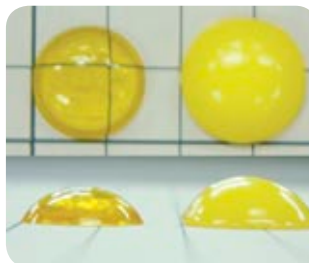
The arrow indicates the interface which is unique to G-BOND. Hydroxyapatite is left around the collagen fibres to provide the basis for chemical bonding without collagen degradation.

G-BOND contains no HEMA

Most adhesive manufacturers continue to use HEMA for its wetting properties. However HEMA remains hydrophilic after polymerisation resulting in water uptake, plasticisation of resin and subsequent degradation over time.

HEMA infiltrated hybrid zones are more susceptible to degradation especially if residual water is not removed. For self etch adhesives HEMA hydrogels are formed as water diffuses through the semi-permeable layer of adhesive. These zones are areas of weakness, which have potential for further hydrolytic breakdown and/or become areas of stress concentration leading to physical breakdown.

De Munck J, Van Landuyt k, Peumans M, Poitevin A, Lambrechts P, Braem M, Van Meerbeek B. A Critical Review of the Durability of Adhesion to Tooth Tissue: Methods and Results. *J Dent Res* 84(2):118-132, 2005



Similar sized samples of polymerised TEGDMA and HEMA have been left in water for 2 weeks. Poly-TEGDMA is hydrophobic, poly-HEMA is hydrophilic. Note swelling of the poly-HEMA.



Poly-TEGDMA remains hard, after 2 weeks water storage.

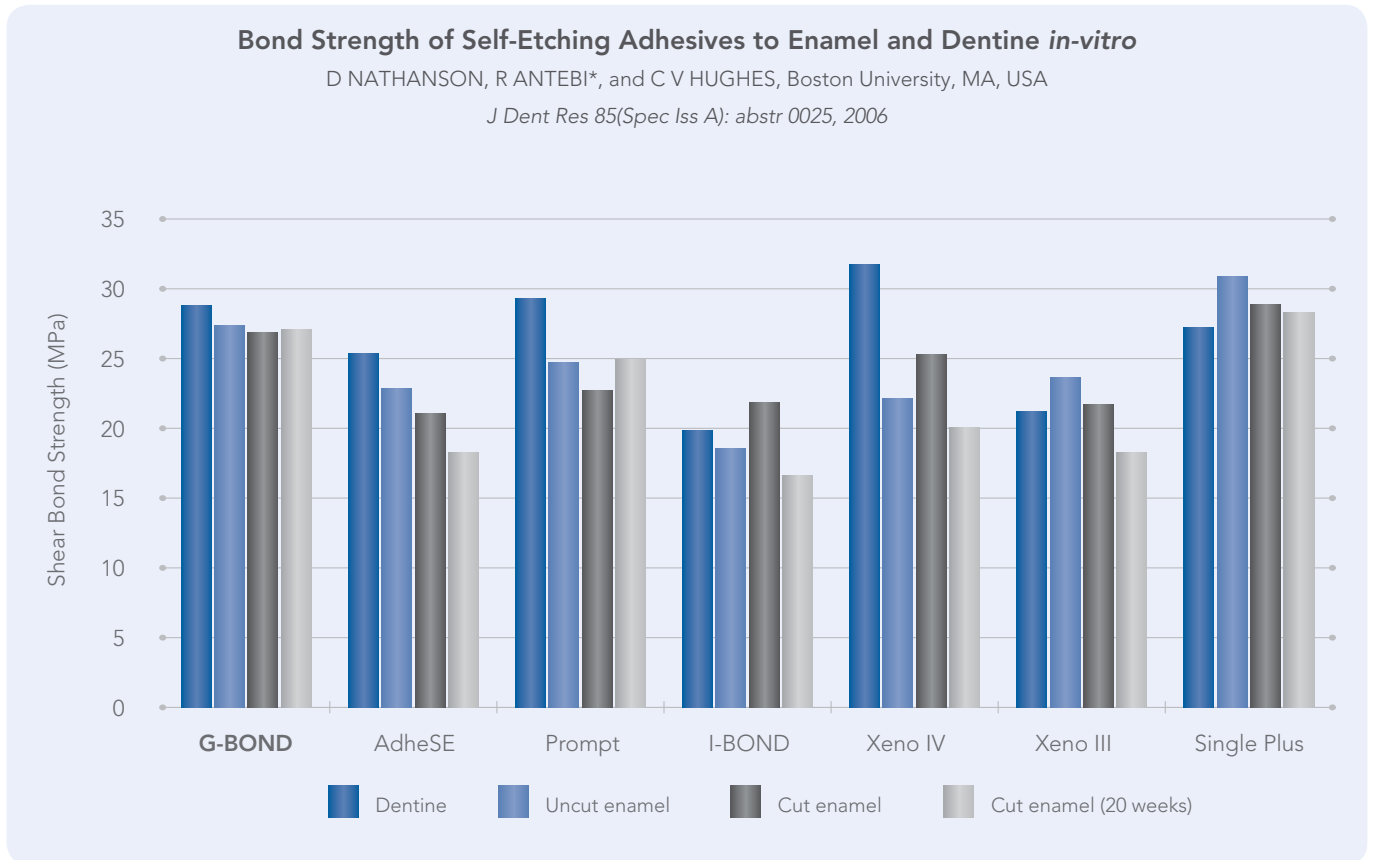


Poly-HEMA is very soft after 2 weeks water storage..

Laboratory evaluations of G-BOND

Bond strengths

Bond strength testing is conducted via many different methods which will result in a wide variation of bond strength results. Of great importance is the ability to maintain good bond strengths through stability at the tooth interface.



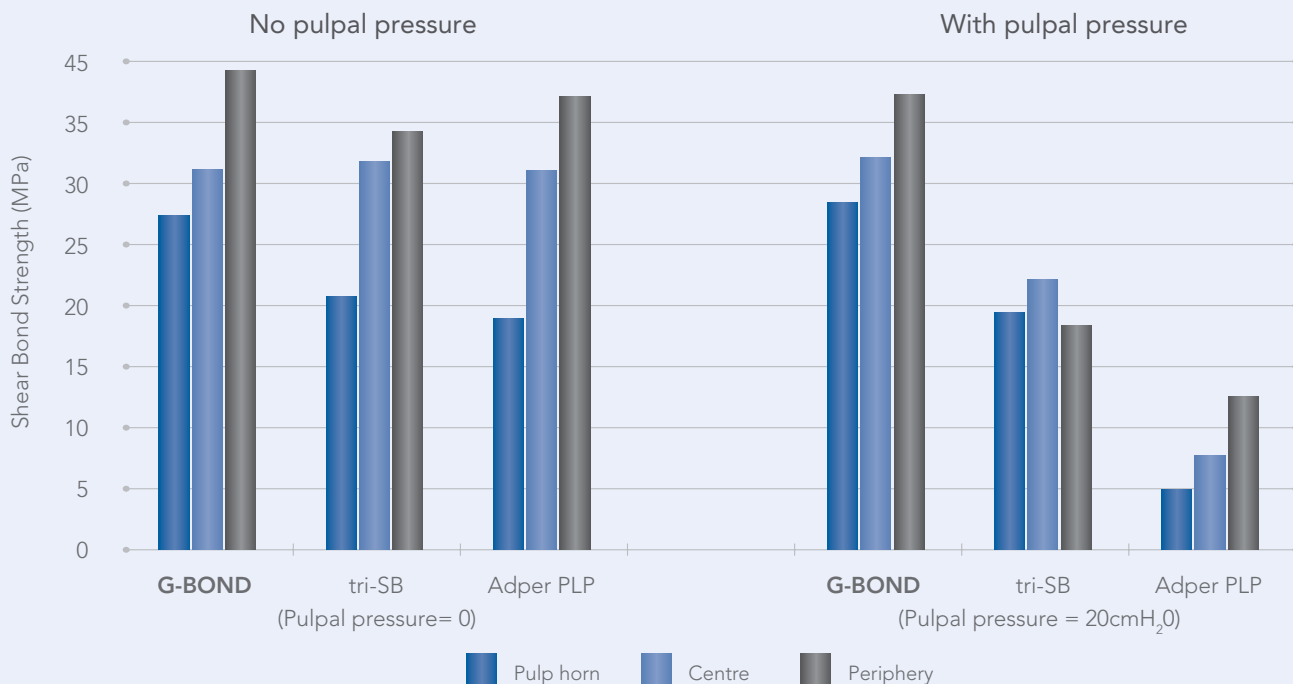
Bond strengths under positive pulpal pressure

Simulation of conditions associated with bonding to different structural zones in vital dentine provides insight into the potential consistency of clinical results following adhesive application. While this type of test methodology is more difficult to undertake, the results have greater relevance for routine clinical bonding applications.

The Effect of Perfusion on Bonding to Dentine

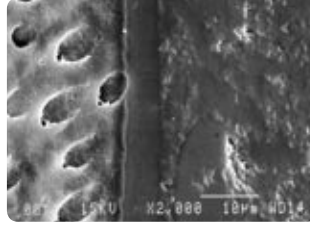
M FUJITA, S K SIDHU, T E CARRICK, O T AL-NAIMI, M B LOPES, Z YAN, H SANO, J F MCCABE

J Dent Res 85 (Spec Iss B) asbtr. 0031, 2006

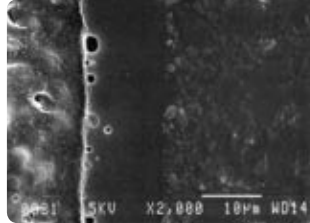


Importance of strong air drying

To provide long term durability, G-BOND utilises a hydrophobic resin formulation which is combined with an acetone carrier to give optimum wettability during application. As G-BOND contains no HEMA it has no ability to absorb excess water from the dentine at the time of application. Therefore it is essential to blast dry with high pressure air to remove acetone and surface water leaving a strong, bubble-free hydrophobic bond layer.



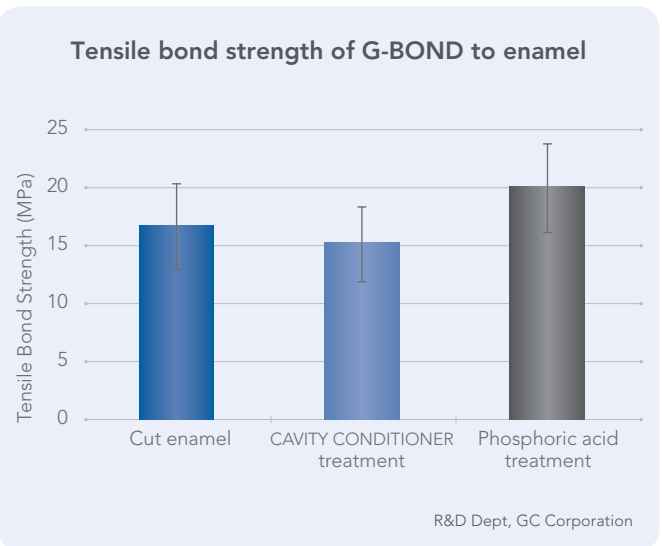
Correct technique:
drying with high air pressure leaves no bubbles in the bond layer.



Incorrect technique:
drying with low air pressure can leave bubbles of water in the hydrophobic bond layer.

Effect of etching on bond strengths to enamel

Acid etching will slightly increase bond strength to enamel.



Background: Degradation of the adhesive interface with dentine

It has been more than 20 years since the first publication reporting the breakdown of resin adhesives to dentine (Kiyomura M, 1987). In more recent years, *in vivo* research has offered significant insight into the mechanism of degradation. Excerpts from some of these publications follow:

***In vivo* Degradation of Resin-Dentine Bonds in Humans Over 1 to 3 Years**

Hashimoto M, Ohno H, Kaga M, Endo K, Sano H, Oguchi H

J Dent Res 79(6):1385-1391, 2000

This paper evaluated bond strength and interfacial characteristics between **Scotchbond Multi-Purpose** and dentine over 1 to 3 years in deciduous teeth.

"There were significant differences in tensile-bond strength among all 3 groups ($p < 0.05$), with mean values ranging from 28.3 ± 11.3 MPa (control), to 15.2 ± 4.4 MPa (1 to 2 years), to 9.1 ± 5.1 MPa (2 to 3 years)."

"Moreover, under fractographic analysis, the proportion of demineralised dentine at the fractured surface in specimens aged in an oral environment was greater than that in control specimens."

"Microstructural evidence suggests that the collagen and gelatin of the exposed collagen network was digested by proteolytic enzymes, which were released from leukocytes, salivary glands, and bacteria in plaque."

"Analysis of the results of this study indicated that the degradation of resin-dentine bond structures occurs after ageing in the oral cavity."

Long-term Durability of Dentine Bonds made with a Self-etching Primer, *in vivo*

Sano H, Yoshikawa T, Pereira PNR, Kanemura N, Morigami M, Tagami J, Pashley DH

J Dent Res 78(4):906-911, 1999

This paper evaluated changes after 1 year in the interface between Clearfil Liner Bond II and dentine, under 12 restorations placed in a monkey.

*"After 1 year of function, a remarkable loss of resinous material was found between the collagen fibrils which remained partially coated with resinous material. Thus, long-term morphological changes at the adhesive interface *in vivo* might be caused by the extraction of resinous material by water.*

It would appear that the hybrid layer is a weak link in the coupling of resin to dentine and that it may be susceptible to hydrolytic attack. *This was suggested by the increased porosity seen at the top of the hybrid layer over time."*

Effect of resin hydrophilicity and water storage on resin strength

Yiu CKY, King NM, Pashley DH, Suh BI, Carvalho RM, Carrilho MRO, Tay FR

Biomaterials 25 (2004) 5789 – 5796

This study evaluated the ultimate tensile strength (UTS) of five polymerised resin blends of increasing hydrophilicity after 12-month water storage. Three of the hydrophilic blends contained HEMA.

"The percentage reduction in UTS increased with the hydrophilicity of the resin blends. Long-term water storage of hydrophilic resin blends such as those employed in dentine adhesives, resulted in a marked reduction in their

mechanical strength that may compromise the durability of resin-dentine bonds."

"The adhesive-dentine interface has been shown to be a porous collagen network infiltrated primarily by hydrolytically unstable 2-hydroxyethyl methacrylate (HEMA). This permeable hybrid layer appears to be highly susceptible to slow water hydrolysis, leaching of the resin component, or degradation of the incompletely infiltrated collagen fibrils."

"The results of this study clearly indicate that resin hydrophilicity is the prime factor in determining the extent of water absorption."

In vivo degradation of resin-dentine bonds produced by a self-etch vs. a total-etch adhesive system

Koshiro K, Inoue S, Tanaka T, Koase K, Fujita M, Hashimoto M, Sano H

Eur J Oral Sci 112:368-375, 2004

This paper evaluated and compared changes after 1 year in the interface between **GC Unifil Bond** and dentine, and **3M.ESPE Single Bond** and dentine, in class V cavities prepared on the facial surfaces of 14 teeth in two monkeys. All cavosurface margins were in enamel.

NB. *Unifil Bond* is the predecessor of G-BOND. *Unifil Bond* contains HEMA.

“...degradation of the interface occurred in the case of Single Bond. SEM images of 1-day specimens indicated good penetration of resinous components into interfibrillar spaces and the formation of a thick hybrid layer and long resin tags at the interface of Single Bond and dentine... However, 1 year later gaps at the interface, indicating disappearance of the hybrid layer and increasing porosity were found.”

“Cyclic masticatory function in the oral environment may fatigue the integrity of resin-enamel bonds, thereby permitting micro- or nano-leakage of the peripheral enamel seal. This, in turn, could extract resinous materials and/or leads to degradation of both resin and exposed collagen fibrils.”

“Repeated occlusal forces, configuration factors, outward fluid flow from dentinal tubules in vital teeth, fluid permeation through the adhesive interface and/or thermal stress in the mouth of monkeys, might have contributed to a more rapid degradation of resin-dentine bonds in vivo.”

“The SEM images of the resin-dentine interface produced by Unifil Bond were unchanged over time ... One possible explanation is the fact that *Unifil Bond* contains 4-MET as a functional monomer, which has been reported to have a chemical bonding capacity to hydroxyapatite that remained around the collagen fibrils, even after self etching treatment, as a result of its relatively high pH value (≈ 2). Moreover, Yoshida et al claim that interactions between hydroxyapatite crystals and functional monomers of self-etching primers may create insoluble calcium salts. Those insoluble salts may prevent the loss of calcium from the matrix over time.”

“It is concluded, within the limitations of this study, that bonding interfaces formed using self-etching primers appeared to be more stable over time compared to those formed with the wet bonding system, even though the bond strengths of both adhesive systems decreased over time.”

Q&A

Q: What is the composition of G-BOND?

A: UDMA (hydrophobic resin), 4-MET (adhesive monomer), phosphoric ester monomer, water, acetone, silica filler, photo initiator. The combination of these components and subsequent chemical stability (shelf life) is technology patented by GC.

Q: Why do you include 5% silica filler in G-BOND?

A: Filler inclusion strengthens the bond layer and provides stress-absorbing characteristics to help maintain the integrity of the bond/tooth interface. Filler inclusion also allows us to get the optimum viscosity to provide a consistent film thickness with one coat and help block any open tubules to aid in desensitising.

Q: How many applications can you expect from a 5ml bottle?

A: There are 300 drops of G-BOND in a 5ml bottle.

Q: What is the film thickness of G-BOND?

A: Only 10 micrometres. In comparison to other adhesives this is very low (many adhesives sit in the 50-100 micrometre range). The ease of achieving a uniform low film thickness using G-BOND means it consistently delivers aesthetic composite/tooth margins.

Q: Are all single bottle adhesive systems similar in technology?

A: No. Most single bottle adhesives contain both hydrophilic (ie, HEMA) and hydrophobic resins. This combination of resins has a high potential for phase separation when applied to wet dentine leading to variable clinical results. G-BOND does not contain HEMA and the use of vigorous air drying following its application ensures a uniform bond interface with vital dentine is consistently achieved.

Q: Do you need to etch enamel prior to G-BOND application?

A: In most situations no, however when bonding to enamel surfaces which haven't been cut by a bur (eg, erosion lesions) etching enamel is suggested to help "roughen" the surface and increase mechanical retention of G-BOND.

Q: What about bonding to fluorosed enamel – do you need to treat these surfaces any different to normal enamel?

A: No. Research results have reported no difference in bond strengths between normal and fluorosed enamel.

Ratnaweera PM et al., *J Dent Res* 84 (Spec Iss A): abstr 2958, 2005

- Q:** Why do you have to wait until the last minute before dispensing and applying G-BOND?
- A:** G-BOND is acetone based so will start to evaporate soon after dispensing. It is important to apply G-BOND immediately after dispensing so you have the best possible wetting characteristics and can achieve the strongest adhesion to tooth surfaces.
- Q:** How much G-BOND should you apply to the cavity?
- A:** Enough to wet the surface so it initially looks glossy, but no more than that.
- Q:** Do you need to scrub the surface after applying G-BOND?
- A:** No. Just apply and leave for 5-10 seconds before air drying with maximum air pressure.
- Q:** From a clinician's perspective what are the benefits of air drying under maximum pressure?
- A:** Firstly, the instruction is clear and totally reproducible each time G-BOND is applied. Technique insensitivity equals bonding consistency. Secondly, maximum air pressure leaves a very low film thickness of bond. This helps create highly aesthetic composite/tooth margins, and stops pooling of bond in the line angles of prepared cavities.
- Q:** Wouldn't blowing with maximum air cause a pulpal response, especially where G-BOND has been applied to deep dentine?
- A:** No. Immediately following application of G-BOND there is a desensitising effect. G-BOND self-etch chemistry is designed to leave smear plugs in place; and even if they are only partially present (or not present at all), G-BOND is still effective at desensitising. It is supposed that the adhesive monomers coagulate and precipitate proteins in the dentinal fluid significantly reducing fluid flow in the tubules. Further to this the 5% nano-sized filler in G-BOND helps create dentinal plugs stopping fluid flow in the tubules and the potential for a pulpal reaction caused by air drying.
- Q:** How do you know you have air dried sufficiently?
- A:** The surface of G-BOND should have a matt surface.
- Q:** What procedure should you follow if G-BOND is contaminated with moisture, saliva or blood AFTER it has been light activated?
- A:** It's recommended to rinse with water then air dry and to re-apply G-BOND, following the instructions for use.

G-BOND

Intro kit contains:

- 1x 5ml bottle of G-BOND
- 50x micro-tips
- 1x micro-tip applicator
- 1x dispensing dish

G-BOND Unit Dose

Contains:

- 50x 0.1ml unit doses of G-BOND
- 50x micro-brush applicators



GRADIA DIRECT X

Anterior/Posterior

Standard: X-A1, X-A2, X-A3, X-A3.5, X-B1, X-B2, X-C2, X-BW

Inside shade: X-AO2

Outside shade: X-WT

Available: In both 5 gram (2.7ml) syringes and 0.3 gram (0.16ml) unitips



GRADIA DIRECT

Anterior

Standard: XBW, BW, A1, A2, A3, A3.5, A4, B1, B2, B3, C3, CV, CVD

Inside shades: AO2, AO3, AO4

Outside shades: DT, CT, GT, NT, WT, CVT

Available: In both 4 gram (2.7ml) syringes and 0.24 gram (0.16ml) unitips

GC

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