

3M™ Scotchbond™ Universal Plus Adhesive

Scientific Facts

Dear Dental Professional,

Almost ten years ago, we successfully laid the foundation for a new category of dental adhesives by launching the original 3M™ Scotchbond™ Universal Adhesive. Now, the time has come for us to proudly introduce 3M™ Scotchbond™ Universal Plus Adhesive.

During the past decade, we carefully listened to feedback from customers and researchers in academia and monitored the literature for new trends. While maintaining all the properties that made Scotchbond Universal Adhesive popular, the **Plus** brings you these features:

- **Radiopacity like dentin** – minimizes radiolucent areas under restorations in case of adhesive pooling to reduce the risk of X-ray misdiagnosis and overtreatment
- **Bonds and seals caries-affected dentin** – maximizes preservation of natural tooth structure by supporting minimally invasive preparation guidelines
- **BPA free formulation** – free of BPA derivatives like BisGMA
- **Gold standard adhesion to all dental substrates** – including glass ceramic
- **Full dual- and self-cure compatibility** – no need for an additional dual-cure activator bottle
- **Fully aligned system** – high performance with 3M™ RelyX™ Universal Resin Cement

Scotchbond Universal Plus Adhesive is available in a streamlined vial with a smoother surface and fewer edges than Scotchbond Universal Adhesive and a unit dose for more efficient hygiene management.

This booklet contains a collection of in-vitro studies covering areas like bond strength to different substrates, hybrid layer formation and interface to the tooth, marginal integrity, radiopacity, and performance data together with RelyX Universal Resin Cement. These studies show that in all aspects tested, the performance of Scotchbond Universal Plus Adhesive is similar to or in many cases better than that of the original Scotchbond Universal Adhesive and other well known, popular materials.

In the field evaluation, over 300 dentists from the US and several European countries used Scotchbond Universal Plus Adhesive in vivo in over 20,000 applications. They gave extremely favorable feedback on Scotchbond Universal Plus Adhesive – regardless whether they had previously used Scotchbond Universal Adhesive or a different adhesive.

Enjoy reading!

Dr. Christoph Thalacker,

Lead Specialist Product Development, 3M Oral Care

Table of Contents

| | |
|---|----|
| Bonding Characteristic of Recent Adhesive Systems Used for Repair Restoration (M. Maeno, T. Kawai, T. Murata, M. Okada, S. Nagai and Y. Nara) | 4 |
| Bonding Performance of Recent All-in-one Adhesive Systems to Cervical Tooth-substance (Y. Nara, M. Okada, M. Maeno, T. Kawai, T. Murata, and I.L. Dogon) | 5 |
| Shear Bond Strengths of Adhesives to Multiple Substrates (F. Farheen, J. O. Burgess, C. Huang, P. Chen, N. Lawson) | 6 |
| Performance of an Experimental Universal Adhesive (M. Schuckar, H. Loll, B. Anich, K. Dede, C. Thalacker, A. Andres) | 7 |
| Adhesion of an Experimental Universal Adhesive to Feldspathic Glass Ceramic (C. Thalacker, M. Schuckar, K. Dede, H. Loll, B. Anich, A. Andres) | 8 |
| Dentin Interface Characterization of Universal Adhesives by Raman Microscopy (B. Anich, B. Dippel, G. Mishra, H. Loll, C. Thalacker, A. Lopez) | 9 |
| Radiopacity of an Experimental Universal Adhesive (H. Loll, O. Brinkmann, B. Anich, K. Dede, B. Craig, A. S. Abuelyaman, C. Thalacker) | 10 |
| Interaction of an Experimental Universal Adhesive with Caries-Affected Dentin (C. Thalacker, H. Loll, B. Anich, K. Dede, J. Madden, A. S. Abuelyaman, B. Craig) | 11 |
| First Feedback on a New Universal Adhesive – A Non-interventional Study (H. Mayr, M. Schuckar, H. Loll, C. Thalacker, K. Dede, B. Shukla, A. S. Abuelyaman, B. Craig) | 12 |
| Ultra-morphological Evaluation of the Interaction of an Experimental Universal Adhesive with Dentin (Prof. Dr. J. Perdigao) | 13 |
| Quantitative Margin Analysis at Class V Restorations Using the Experimental Universal Adhesive ADH-XTE in Combination with a Composite Resin in Vitro (Dr. U. Blunck) | 15 |
| Shear Bond Strength of a New 3M Universal Adhesive to Glass-Ceramic (Lithium Disilicate) (Prof. Dr. B. Van Meerbeek) | 16 |
| 3M ADH-XTE Experimental Adhesive: Ultra-structural Characterization of Adhesive Dentin-interface and Adhesive Enamel-interface (Prof. Dr. B. Van Meerbeek) | 18 |

Bonding Characteristic of Recent Adhesive Systems Used for Repair Restoration

Published by: M. Maeno, T. Kawai, T. Murata, M. Okada, S. Nagai and Y. Nara

Published in: J Dent Res 98 (Spec Iss A), No. 1324, 2019,

<https://iadr.abstractarchives.com/abstract/19iags-3179621/bonding-characteristic-of-recent-adhesive-systems-used-for-repair-restoration>

Objectives:

A couple of recent all-in-one adhesive systems contain silane. Those systems are useful to simplify procedure of treatment such as repair restoration. The aim of this study was to examine the bonding characteristic of recent adhesive systems used for repair restoration.

Methods:

Two adhesive systems contained silane as ingredient; an experimental adhesive (XTE, 3M ESPE) and Scotchbond Universal (SBU, 3M ESPE), and two adhesive systems required an application step of silane coupling agent; Clearfil Universal Bond Quick with Clearfil ceramic primer PLUS (UBQ, Kuraray Noritake Dental) and G-Premio BOND with Ceramic Primer II (GPB, GC) were used. For bonded substrates, resin composite (SU:Filtek Supreme Ultra, 3M ESPE), lithium-disilicate glass-ceramic (EM:IPS e.max CAD, Ivoclar vivadent), feldspathic ceramic (VB:VITABLOCS Mark II, VITA), sound enamel (SE) and dentin (SD) of human extracted tooth were selected. Each bonded substrate was ground with SiC paper of 600 grit, and sand-blasted for 5sec except SE and SD. The bonded area was standardized by aluminum tape with a 2.4mm diameter hole, and treated with each system according to manufacturer's instruction. Cylindrical resin composite, 4.0mm diameter x 7.0mm height, was built-up on the treated surface by incremental technique, and the tensile-bond strengths (TBS, n=5) were measured. The data were analyzed with two-way ANOVA, Tukey's test and Weibull analysis.

Results:

The mean TBS (SD) in MPa to five bonded substrates, Weibull modulus and the stress value in MPa for 10% probability of failure level [PF10] were XTE:19.1(6.2)<3.6>[11.3], SBU:19.1(7.0)<2.4>[8.7], UBQ:16.8(5.8)<3.4>[9.6], GPB:12.8(4.0)<3.7>[7.7]. The TBS of four systems did vary with bonded substrates. The Wm of XTE, UBQ and GPB were significantly higher than SBU. Furthermore, the PF10 of XTE was significantly superior to other systems.

Conclusions:

The bonding characteristic of recent adhesive systems did vary with bonded substrates. The mean bond strength, bonding reliability and durability of experimental system to five types of substrate were similar or superior to other systems.

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<https://iadr.abstractarchives.com/abstract/19iags-3179621/bonding-characteristic-of-recent-adhesive-systems-used-for-repair-restoration>, 2019

TABLES

| | Tensile Bond Strength in MPa | | | | |
|--|------------------------------|----------|-----------|-------------------|-------------------|
| | Filtek Supreme Ultra | e.max | Vitablocs | Sound Enamel (SE) | Sound Dentin (SD) |
| ADH-XTE (experimental, 3M) | 25.4±5.7 | 13.8±1.8 | 15.1±4.2 | 18.6±3.8 | 22.8±6.1 |
| Scotchbond Universal (SBU, 3M) | 25.8±3.3 | 9.2±3.1 | 14.6±3.2 | 22.3±3.1 | 23.6±3 |
| Clearfil Universal Bond Quick (UBQ, Kuraray) | 15±2.3 | 12.1±3.7 | 13.2±3.7 | 21.1±4.4 | 22.6±6.1 |
| G-Premio Bond (GPB, GC) | 10.8±3.1 | 12.8±5.8 | 13.3±4.5 | 14.1±3.4 | 13.1±3.9 |

3M Summary:

The table shows the mean bond strength to the individual substrates. XTE* afforded statistically the same or higher bond strength to the tooth and restoration substrates than the other materials. In the context of repairing dental restorations, the advantage of using a universal adhesive containing silane is that it reduces the number of required working steps and materials. The results of this in-vitro study show that compared to its predecessor 3M™ Scotchbond™ Universal Adhesive, XTE shows an improved bond strength to lithium disilicate IPS e.max® CAD when used in repair procedures. The values are at least equal to those obtained with other universal adhesives plus separate silane application.

*Now commercially available under the product name 3M™ Scotchbond™ Universal Plus Adhesive

Bonding Performance of Recent All-in-one Adhesive Systems to Cervical Tooth-substance

Published by: Y. Nara, M. Okada, M. Maeno, T. Kawai, T. Murata, and I.L. Dogon

Published in: J Dent Res 98 (Spec Iss A), No. 1910, 2019, <https://iadr.abstractarchives.com/abstract/19iags-3182014/bonding-performance-of-recent-all-in-one-adhesive-systems-to-cervical-tooth-substance>

Objectives:

To examine the bonding performance of four recent multiple-use all-in-one adhesive systems to three types of cervical-tooth-substance. The difference in bonding-behavior among cervical tooth-substances was also investigated.

Methods:

Two pretreatment-time prescribed all-in-one adhesive systems; an experimental adhesive (XTE, 3M ESPE) and Scotchbond Universal Adhesive (SBU, 3M ESPE), and two zero-pretreatment-time all-in-one systems; G-Premio BOND (GPB, GC) and Clearfil Universal Bond Quick (UBQ, Kuraray Noritake Dental) were used. Cervical abrasion-lesion-dentin (ALD) of 32 extracted-human-premolars was cleaned with a low-speed-rotated polishing-brush and water. Standardized V-shaped buccocervical cavity consisting of a gingival sound-dentin-wall (SD) and an occlusal-dentin-wall with beveled sound-enamel (SE) was prepared in 32 intact-premolars. The surfaces of ADL and both SD and SE (as control) were pretreated with each system according to the manufacturer instructions. The immediate-tensile-bond-strength (ITBS) of the systems to ALD, SD and SE were measured (n=8). The data were examined using ANOVA, Tukey's q-test and Weibull analysis.

Results:

The mean ITBS(SD) in MPa to ALD/SD/SE were XTE;26.5(8.2)/29.0(8.8)/24.0(8.4), SBU;24.6(6.0)/26.5(5.9)/24.3(5.1), GPB;23.2(7.3)/22.3(5.5)/17.9(7.0), UBQ; 22.4(5.5)/27.1(4.6)/24.9(5.3). The type of cervical-tooth-substance did not influence the ITBS-value, but the system difference affected the value. The ITBS of XTE to the cervical-tooth-substances was significantly greater than the value of GPB (p<0.05). Weibull modulus and the stress-value in MPa for 10% probability of failure [PF10] were XTE;<3.6>[15.6], SBU;<4.9>[17.2], GPB;<3.4>[12.2], UBQ;<5.3>[17.6]. Those values of three cervical-tooth-substances were ALD; <4.0>[15.2], SD;<4.6>[17.6] and SE;<3.8>[13.9]. The Wm and PF10-values of XTE, SBU and UBQ were significantly greater (p<0.05) than or similar to the values of GPB. In comparison with SE, ALD indicated similar value for Wm-value and demonstrated significantly greater value for PF10-value.

Conclusions:

For the bonding performance focused on ITBS, Wm (bonding reliability) and PF10 (bonding durability), XTE, SBU and UBQ were superior or similar to GPB. The bonding reliability of ALD was similar to that of SE and the bonding durability of ALD was superior to SE.

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<https://iadr.abstractarchives.com/abstract/19iags-3182014/bonding-performance-of-recent-all-in-one-adhesive-systems-to-cervical-tooth-substance>, 2019

TABLES

| Material | Mean Tensile Bond Strength (SD) in MPa | | |
|--|--|--------------|--------------|
| | Abrasion Lesion Dentin | Sound Dentin | Sound Enamel |
| ADH-XTE (Experimental, 3M) | 26.5±8.2 | 29±8.8 | 24±8.4 |
| Scotchbond Universal (SBU, 3M) | 24.6±6 | 26.5±5.9 | 24.3±5.1 |
| G-Premio BOND (GPB, GC) | 23.2±7.3 | 22.3±5.5 | 17.9±7 |
| Clearfil Universal Bond Quick (UBQ, Kuraray) | 22.4±5.5 | 27.1±4.6 | 24.9±5.3 |

3M Summary:

The immediate tensile bond strength to enamel and dentin, the Weibull modulus and the stress value for probability of failure are key indicators for the performance of an adhesive. Based on the results of this in-vitro study, it may be assumed that the use of ADH-XTE* leads to consistent and reliable bond strength not only to sound enamel and dentin, but also to cervical abrasion lesion dentin, which is highly sclerotic.

*Now commercially available under the product name 3M™ Scotchbond™ Universal Plus Adhesive

Shear Bond Strengths of Adhesives to Multiple Substrates

Published by: F. Farheen, J. O. Burgess, C. Huang, P. Chen, N. Lawson

Published in: J Dent Res 98 (Spec Iss A), No. 1322, 2019, <https://iadr.abstractarchives.com/abstract/19iags-3186961/shear-bond-strengths-of-adhesives-to-multiple-substrates>

Objectives:

To compare the shear bond strength (SBS) of 4 adhesives to etched human enamel and dentin and measure the SBS of 2 Universal adhesives (UA) to 5 restorative materials.

Methods:

64 caries free human molar teeth were collected following IRB approval. The teeth were ground with abrasive disks (ending with 400 grit) to flatten enamel and dentin occlusal surfaces. Each bonding adhesive* was applied to the flattened surfaces following the manufacturers' instructions. Specimens were prepared by etching enamel and dentin with phosphoric acid etching (32%, 15 seconds)*. The adhesives were applied and cured (Elipar Deep Cure curing light, >800mW/cm²). The 2 UA were bonded to 5 restorative materials**. A tube filled with Z100 (A2) composite resin (diameter-2.9mm) was placed over the adhesive and light-cured 40sec. Specimens were stored in an incubator at 37°C for 24 hours in tap water and loaded in shear to failure (Instron, model 5565, Canton, MA, 1mm/min cross-head speed). Failure loads were calculated, and data analyzed using ANOVA and Tukey test (p=.05). Materials in each column with different letters are statistically different.

Results:

Mean bond strength (MPa) (n=8) UA = Universal Adhesive TABLE 1 and TABLE 2 Materials and substrate were significant factors

Conclusions:

Both UA showed equal or higher bond strength than conventional total etch adhesives. Supported by a grant from 3M.

TABLE 1

| Bonding agent * | Etched Enamel | Etched Dentin |
|-------------------------|---------------|---------------|
| Experimental UA | 29.8±4.2a | 20.1±6.5 |
| Optibond Solo Plus | 21.7±4.0b | 18.2±7.8 |
| Scotchbond Universal UA | 25.3±5.2a,b | 23.2±9.1 |
| Prime and Bond NT | 23.0±4.1b | 21.6±7.1 |

TABLE 2

| ** | Zirconia | Nickel-chromium | Gold | Lithium disilicate | Porcelain |
|-----------------------|----------|-----------------|----------|--------------------|-----------|
| Experimental adhesive | 21.1±9.0 | 18.9±3.2b | 11.4±4.2 | 20.3±3.7 | 23.3±7.4 |
| Scotchbond Universal | 25.2±7.5 | 23.2±2.4a | 8.0±2.3 | 19.1±7.1 | 16.2±6.7 |

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3M summary:

The ability to establish a reliable bond to various substrates is a characteristic property of universal adhesives. The results of this in-vitro study are a positive proof of the fact that both, the experimental universal adhesive*** and its predecessor are able to develop reliable bond strengths to zirconia, nickel-chromium, gold, lithium disilicate and porcelain as well as etched enamel and dentin. The obtained values are equal to or higher than those obtained with conventional total-etch adhesives.

***Now commercially available under the product name 3M™ Scotchbond™ Universal Plus Adhesive

Performance of an Experimental Universal Adhesive

Published by: M. Schuckar, H. Loll, B. Anich, K. Dede, C. Thalacker, A. Andres

Published in: J Dent Res 98 (Spec Iss B), No. 0444, 2019,

<https://iadr.abstractarchives.com/abstract/ced-iadr2019-3222994/performance-of-an-experimental-universal-adhesive>

Objectives:

Aim of this study was to assess the shear bond strength (SBS) of an experimental universal adhesive (ADH-XTE, 3M) to enamel and dentin in total etch (TE) and self-etch (SE) application modes.

Methods:

Bovine incisors were embedded in cold-cure acrylic resin. The labial surface of each tooth was ground to expose enamel or dentin. A cylindrical button of Filtek™ Supreme Ultra/XTE A2E (3M, 2.36mm diameter, 2mm height) was cured on the tooth surfaces treated with ADH-XTE (3M), Scotchbond™ Universal (SBU, 3M), G-Premio Bond (GPB, GC), Prime&Bond Active (PBA, Dentsply-Sirona), Clearfil Universal Bond Quick (CUBQ, Kuraray-Noritake), Optibond Universal (OBU, Kerr), Tokuyama Universal Bond (TUB, Tokuyama), BeautiBond Universal (BBU, Shofu) according to manufacturers' instructions (n=10). SBS was measured using the notched-edge method according to ISO 29022:2013.

Results:

The table shows the SBS in MPa. The standard deviations (SD) are given in parentheses. All data per substrate and application mode were analyzed by ANOVA and multiple comparisons using Fisher's LSD procedure ($p < 0.05$). Means with the same letters are statistically the same.

Conclusions:

Multiple statistically significant differences were found. ADH-XTE yielded equivalent or higher SBS than the controls.

TABLES

| Material | Enamel_TE SBS [MPa] | Dentin_TE SBS [MPa] | Enamel_SE SBS [MPa] | Dentin_SE SBS [MPa] |
|----------|------------------------|------------------------|------------------------|------------------------|
| ADH-XTE | 40.1(5.2) A | 32.8(5.0)A | 26.9(3.2)A | 35.2(7.5)A |
| SBU | 29.8(5.2)B | 27.4(5.4)B | 26.4(3.4)A | 27.9(3.5)B |
| GPB | 19.3(2.8)D | 13.4(5.0)CD | 22.0(4.6)B | 15.7(3.6)D |
| PBA | 24.7(5.6)C | 31.7(4.7)AB | 18.2(3.5)C | 27.4(4.8)B |
| CUBQ | 30.7((7.9)B | 12.8(5.8)D | 21.6(3.2)BC | 20.2(5.5)CD |
| OBU | 30.3(6.4)B | 17.9(5.3)C | 28.4(4.5)A | 23.2(9.1)BC |
| TUB | 24.4(6.8)C | 10.3(8.0)D | 14.0(5.9)D | 5.7(7.0)E |
| BBU | 30.0(3.9)B | 12.1(3.8)D | 19.1(3.4)BC | 23.1(3.5)BC |

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<https://iadr.abstractarchives.com/abstract/ced-iadr2019-3222994/performance-of-an-experimental-universal-adhesive>, 2019

3M summary:

Universal adhesives stand out due to their ability to establish a strong and reliable bond to enamel and dentin independent of the application mode (self-etch, selective enamel etch and total-etch). The 24-hour shear bond strengths measured in this in-vitro study support the assertion that ADH-XTE* meets this requirement. Its bond strength to enamel and dentin in both total- and self-etch modes was similar to or even better than those of the other products tested.

*Now commercially available under the product name 3M™ Scotchbond™ Universal Plus Adhesive

Adhesion of an Experimental Universal Adhesive to Feldspathic Glass Ceramic

Published by: C. Thalacker, M. Schuckar, K. Dede, H. Loll, B. Anich, A. Andres

Published in: J Dent Res 98 (Spec Iss B), No. 0196, 2019, <https://iadr.abstractarchives.com/abstract/ced-iadr2019-3223456/adhesion-of-an-experimental-universal-adhesive-to-feldspathic-glass-ceramic>

Objectives:

Aim of this study was to investigate the bond strength of an experimental universal adhesive (ADH-XTE, 3M) to feldspathic glass ceramic.

Methods:

Feldspathic glass ceramic blocks (Vitablocs Mark II, Vita) were etched with hydrofluoric acid (HF), rinsed with water and treated with an experimental universal adhesive (ADH-XTE, 3M), Scotchbond™ Universal (SBU, 3M), and the combination of the conventional silane RelyX™ Ceramic Primer and Scotchbond™ 1XT (RCP/SB1XT, 3M) according to manufacturers' instructions. As an experimental alternative to HF treatment, blocks were sandblasted with CoJet sand (3M) and treated with ADH-XTE.

A cylindrical button of Filtek™ Z250 A3 (3M ESPE, 2.36mm diameter, 2mm height) was cured on the samples (n=5), which were stored in water at 37°C for 24h. Shear bond strength (SBS) was tested using the notched-edge method according to ISO 29022:2013.

Results:

The table shows SBS in MPa. The standard deviations (SD) are given in parentheses. SBS data were analyzed by ANOVA and multiple comparisons using Fisher's LSD procedure ($p < 0.05$). Means with the same letters are statistically the same. Only cohesive failures in the blocks were observed.

Conclusions:

With both pretreatments, ADH-XTE afforded similar bond strength as the controls on HF etched substrates.

TABLES

| Adhesive | Pretreatment | SBS(SD)[MPa] |
|-----------|--------------|--------------|
| ADH-XTE | HF | 31.5(2.9)A |
| ADH-XTE | CoJet | 29.6(6.4)A |
| SBU | HF | 26.3(5.5)A |
| RCP/SB1XT | HF | 24.8(5.6)A |

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3M summary:

Due to their frequent use in non-retentive designs, the clinical success of glass ceramic restorations depends on a strong and durable bond. This in-vitro study confirms that ADH-XTE* achieves higher bond strength to feldspathic glass ceramic than the gold standard of a conventional silane primer.

*Now commercially available under the product name 3M™ Scotchbond™ Universal Plus Adhesive

Dentin Interface Characterization of Universal Adhesives by Raman Microscopy

Published by: B. Anich, B. Dippel, G. Mishra, H. Loll, C. Thalacker, A. Lopez

Published in: J Dent Res 98 (Spec Iss B), No. 0443, 2019, <https://iadr.abstractarchives.com/abstract/ced-iadr2019-3223718/dentin-interface-characterization-of-universal-adhesives-by-raman-microscopy>

Objectives:

Aim of this study was to investigate morphology and chemical nature of the dentin interface of an experimental (ADH-XTE, 3M) and a commercial universal adhesive (Scotchbond™ Universal, SBU, 3M).

Methods:

The labial surface of bovine incisors was ground to expose dentin and treated with ADH-XTE or SBU in total etch (TE) or self-etch (SE) modes according to manufacturers' instructions. A 1mm thick layer of Filtek™ Z250 (3M) A3 was placed on the adhesive and cured (Elipar S10, 3M). Samples were ground perpendicular to the bonded surface to expose the interface for confocal Raman microscopy (Witec 300R with a 100X objective, NA 0.9; excitation wavelength 532nm). Bands at 1607cm⁻¹ (phenyl C=C of adhesive and composite) and 965cm⁻¹ (P=O of hydroxyapatite) were evaluated for spatially resolved spectra from linescans across the interface (step size 180 nm) at different locations of the samples (n≥4), to determine chemical nature and thickness of hybrid layer (HL) and adhesive layer (AL).

Results:

The confocal Raman microscope used allows to record Raman spectra of the interface composite-AL-HL-dentin with high lateral resolution. For each sample, a distinct AL and HL was detected. Raman microscopy revealed full adhesive penetration of the HL. HL and AL thickness in μm is given in the table, with the standard deviation (SD) in parentheses. Data by column were analyzed by ANOVA and multiple comparisons using the Tukey test (p<0.05). Means with the same letters are statistically the same.

Conclusion:

HL was significantly thicker for TE vs SE samples. There was no significant difference for HL between ADH-XTE and SBU when used in the same etching mode. ADH-XTE afforded similar AL thickness as SBU in TE mode, and lower AL thickness in SE mode.

TABLES

| Adhesive | Etching Mode | HL(SD)[μm] | AL(SD)[μm] |
|----------|--------------|------------|------------|
| ADH-XTE | TE | 4.0(1.8)A | 9.9(1.1)A |
| ADH-XTE | SE | 1.3(0.1)B | 10.1(0.3)A |
| SBU | TE | 5.1(1.3)A | 10.8(1.3)A |
| SBU | SE | 1.0(0.1)B | 14.1(1.3)B |

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3M summary:

The quality of the adhesive interface has a decisive impact on the long-term performance of composite restorations. At the adhesive-dentin interface, a distinct hybrid layer should be formed and fully penetrated by the adhesive. This is the case for ADH-XTE* when applied to dentin either in the self-etch or total-etch mode, as shown with the aid of Raman microscopy.

*Now commercially available under the product name 3M™ Scotchbond™ Universal Plus Adhesive

Radiopacity of an Experimental Universal Adhesive

Published by: H. Loll, O. Brinkmann, B. Anich, K. Dede, B. Craig, A. S. Abuelyaman, C. Thalacker

Published in: J Dent Res 99 (Spec Iss A), No. 0757, 2020, <https://iadr.abstractarchives.com/abstract/20iags-3322660/radiopacity-of-an-experimental-universal-adhesive>

Objectives:

Aim of this study was to assess the radiopacity of an experimental universal adhesive (ADH-XTE, 3M) versus commonly used adhesives.

Methods:

Solvents were evaporated from adhesives (ADH-XTE, 3M; Scotchbond™ Universal, SBU, 3M, AdheSE™ Universal, ADU, Ivoclar-Vivadent; Prime&Bond™ NT, PBNT, Dentsply-Sirona; Prime&Bond Active™, PBA, Dentsply-Sirona; Clearfil™ SE Bond, CSE, Kuraray-Noritake; Optibond™ Solo Plus™, OSP, Kerr). The remaining liquid was cured in polytetrafluoroethylene moulds (10mm diameter, 1mm height) using an Elipar S10 curing light (3M) to produce disks (n=3). 1mm thick disks of mid-coronal dentin of human molars were prepared using a circular saw (Accutom, Struers, n=3). Radiopacity was determined according to ISO13116:2014, using a Heliident Plus device (Dentsply-Sirona) and VistaScan digital imaging equipment (Dürr Dental), voltage 60kV. Class I cavities (4mm deep) were prepared in extracted human molars. Adhesives were applied using a fully saturated disposable applicator according to manufacturers' instructions, and gently air dried to provoke pooling at the cavity bottom. Cavities were restored with Filtek™ One (3M). Radiographs of teeth were taken using above equipment and examined for radiolucent areas underneath the fillings.

Results:

The table shows the radiopacity in % of aluminium, and the occurrence of radiolucent areas under the restorations. Standard deviations (SD) are given in parentheses. Radiopacity data were analyzed by ANOVA and multiple comparisons using the Tukey test (p<0.05). Means with the same letters are statistically the same.

Conclusions:

ADH-XTE and human mid-coronal dentin had statistically the same radiopacity. All other adhesives tested had significantly lower radiopacity. Radiopacity of the adhesive may reduce the occurrence of doubtful X-ray images, where a radiolucent thicker adhesive layer under a restoration might be misinterpreted as caries, gap or void resulting in unnecessary treatment.

TABLES

| Material | Radiopacity(SD) [% Al] | Distinct radiolucent area underneath Class I restoration |
|----------|------------------------|--|
| Dentin | 99.0(6.6)A | n.a. |
| ADH-XTE | 93.7(3.8)A | No |
| SBU | 21.0(1.0)C | Yes |
| ADU | 21.0(1.0)C | Yes |
| PBNT | 20.3(0.6)C | Yes |
| PBA | 17.3(0.6)C | Yes |
| CSE | 21.3(0.6)C | Yes |
| OSP | 36.0(7.2)B | Yes |

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3M summary:

Insufficiently radiopaque or non-radiopaque adhesives may pool at the bottom of the cavity and lead to ambiguous radiolucency under the restoration. This radiolucency could be interpreted as secondary caries, marginal gaps or voids. By provoking pooling in this in-vitro study, the authors were able to show that ADH-XTE* has a dentin-like radiopacity. This feature minimizes misdiagnosis of secondary caries compared to other universal adhesives.

*Now commercially available under the product name 3M™ Scotchbond™ Universal Plus Adhesive

Interaction of an Experimental Universal Adhesive with Caries-Affected Dentin

Published by: C. Thalacker, H. Loll, B. Anich, K. Dede, J. Madden, A. S. Abuelyaman, B. Craig

Published in: J Dent Res 99 (Spec Iss A), No. 0191, 2020, <https://iadr.abstractarchives.com/abstract/20iags-3322611/interaction-of-an-experimental-universal-adhesive-with-caries-affected-dentin>

Objectives:

In order to minimize the loss of healthy tooth structure, there is a growing trend toward less invasive preparation techniques, where caries-infected dentin (CID) is removed, and caries-affected dentin (CAD) is left behind. Aim of this study was to assess shear bond strength (SBS) and hybrid layer (HL) formation of an experimental universal adhesive (ADH-XTE, 3M) on human CAD.

Methods:

Extracted human molars with dentin caries having a mostly flat lesion bottom were embedded in cold-cure acrylic resin and ground on a lapidary wheel, close to the lesion bottom. Remaining CID was removed with a polymer bur (SmartBur™ II, SS White), to expose CAD. SBS (n=7) according to ISO29022:2013 to CAD and sound human dentin (SD) was measured for ADH-XTE in self-etch (SE) and total etch (TE) modes, using a Zwick Z010 testing machine. SBS of Scotchbond™ Universal (SBU, 3M) to SD was determined as control. Filtek™ Z250 (3M) was used as composite. HL formation on CAD and SD was investigated using scanning electron microscopy (SEM, Auriga, Zeiss).

Results:

The table shows SBS [MPa], and approximate HL thickness [μm] for SE and TE modes. Standard deviations (STD) are given in parentheses. SBS data were analyzed by ANOVA and multiple comparisons using the Tukey test ($p < 0.05$). Means with the same letters are statistically the same.

Distinct HL were found with an approximate thickness of $<1\mu\text{m}$ for SE and $5\mu\text{m}$ for TE samples, irrespective of CAD or SD substrate. No voids or gaps were found in HL indicating full resin impregnation of the HL.

Conclusions:

No statistically significant differences were found for SBS. ADH-XTE afforded in both etching modes similar SBS to CAD and SD as the control SBU to SD. Fully resin impregnated HL were found with a thickness depending predominantly on the etching mode.

TABLES

| Adhesive Substrate Mode | SBS(STD)[MPa] | Approx. HL[μm] |
|-------------------------|---------------|-----------------------------|
| ADH-XTE_SD_SE | 36.5(4.2)A | <1 |
| ADH-XTE_SD_TE | 34.9(6.9)A | 5 |
| ADH-XTE_CAD_SE | 34.0(7.3)A | <1 |
| ADH-XTE_CAD_TE | 36.1(6.0)A | 5 |
| SBU_SD_SE | 35.9(4.4)A | <1 |
| SBU_SD_TE | 35.8(7.9)A | 5 |

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3M summary:

An important prerequisite for the success of selective caries removal techniques is effective sealing of the caries-affected dentin that is left untouched. The results of this laboratory investigation confirm that ADH-XTE* has similar bond strength on caries-affected and sound dentin, and forms a continuous hybrid layer without gaps or voids on caries-affected dentin surfaces in both self-etch and total-etch mode. This indicates full resin infiltration, which creates the seal required to support minimally invasive techniques and the preservation of natural tooth structure.

*Now commercially available under the product name 3M™ Scotchbond™ Universal Plus Adhesive

First Feedback on a New Universal Adhesive – A Non-interventional Study

Published by: H. Mayr, M. Schuckar, H. Loll, C. Thalacker, K. Dede, B. Shukla, A. S. Abuelyaman, B. Craig

Published in: J Dent Res 99 (Spec Iss A), No 0758, 2020,

<https://iadr.abstractarchives.com/abstract/20iags-3326387/first-feedback-on-a-new-universal-adhesive--a-noninterventional-study>

Objectives:

To assess the satisfaction among dentists with a new universal adhesive (ADH19, 3M) in a first clinical evaluation.

Methods:

The research was conducted via a web-based survey which was administered after a trial period of 8 weeks. Participants of the test received a kit containing 5ml vial of ADH19, 20 unit-dose ADH19 and accessories. Participants were asked to use ADH19 in their clinical routine following the instructions for use and to rate overall and handling satisfaction and performance against their currently used preferred adhesive. 300 dentists from Europe had been pre-selected to take part in this evaluation during the testing period (August to October 2019). Quantified responses for satisfaction rating with ADH19 (handling and compared to preferred adhesive) were analyzed using descriptive statistics (Minitab18, Minitab Inc., USA).

Results:

Up to now 65 participants answered the questionnaire. About 3500 direct and 500 indirect restorations were placed. Quantified responses on 5-level even-point-scales (coding: 1=not satisfied at all/ADH19 much worse, 3=neutral, 5=very satisfied/ADH19 much better) were statistically analyzed and are summarized in table 1.

Data showed that satisfaction with ADH19 was rated very high (mean overall=4.5 ±0.9; mean handling=4.5±0.9) and ADH19 was rated better than preferred adhesive (mean overall=3.6±0.7; mean handling=3.6±0.9). Median of results for satisfaction and for comparison was 5 and 4, respectively, for both current users of 3M™ Scotchbond™ Universal (SBU) and other adhesives (see Tab 1).

Conclusions:

Dentists stated high satisfaction levels overall and with handling of ADH19. Data on comparison of ADH19 to their currently used adhesive showed that there is no difference in rating between users of SBU and users of competitive products.

TABLES: Statistical data in dependence of current adhesive

| Variable | Current Adhesive | N | Median | 95% CI |
|-----------------------|------------------|----|--------|--------|
| Satisfaction overall | Other | 28 | 5 | 4;5 |
| Satisfaction overall | SBU | 34 | 5 | 5;5 |
| Handling satisfaction | Other | 28 | 5 | 4;5 |
| Handling satisfaction | SBU | 35 | 5 | 5;5 |
| Comparison overall | Other | 28 | 4 | 3;4 |
| Comparison overall | SBU | 35 | 4 | 3;4 |
| Handling comparison | Other | 26 | 4 | 3;4 |
| Handling comparison | SBU | 35 | 4 | 3;4 |

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<https://iadr.abstractarchives.com/abstract/20iags-3326387/first-feedback-on-a-new-universal-adhesive--a-noninterventional-study>, 2020

3M summary:

Apart from reliable performance in in-vitro tests, a new adhesive should also offer beneficial handling characteristics for successful use in the clinical environment. This clinical evaluation shows that ADH19* handles very well and tends to receive higher satisfaction ratings than adhesives currently on the market. Users of the predecessor 3M™ Scotchbond™ Universal Adhesive were also highly satisfied with the new adhesive.

*Now commercially available under the product name 3M™ Scotchbond™ Universal Plus Adhesive

Ultra-morphological Evaluation of the Interaction of an Experimental Universal Adhesive with Dentin

Prof. Dr. J. Perdigao, University of Minnesota, US

Final Report to 3M, 2019

Abstract:

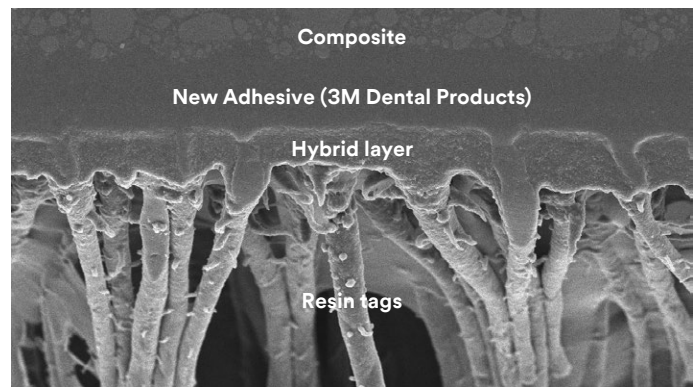
Purpose: To study the dentin-resin interfacial ultra-morphology of a novel universal adhesive (New adhesive, 3M Oral Care). **Methods:** Middle dentin was exposed in 8 sound extracted molars and randomly divided into 4 groups: (1) Scotchbond Universal Adhesive (3M Dental Products) applied to dentin that had been etched with 32% phosphoric acid (Scotchbond Universal Etchant, 3M Dental Products) for 15 sec, rinsed for 10 sec, and kept visibly moist without water pooling; (2) Scotchbond Universal Adhesive (3M Dental Products) applied to dentin that had been etched with 32% phosphoric acid (Scotchbond Universal Etchant, 3M Dental Products) for 15 sec, rinsed for 10 sec, and air-dried for 5 sec with an air-water syringe; (3) New adhesive (3M Dental Products) applied to dentin that had been etched with 32% phosphoric acid (Scotchbond Universal Etchant, 3M Dental Products) for 15 sec, rinsed for 10 sec, and kept visibly moist without water pooling; (4) New adhesive (3M Dental Products) applied to dentin that had been etched with 32% phosphoric acid (Scotchbond Universal Etchant, 3M Dental Products) for 15 sec, rinsed for 10 sec, and air-dried for 5 sec with an air-water syringe. After curing the respective adhesive, dentin disks were restored with 1 mm-thick layer of flowable composite and processed for FESEM evaluation.

Findings:

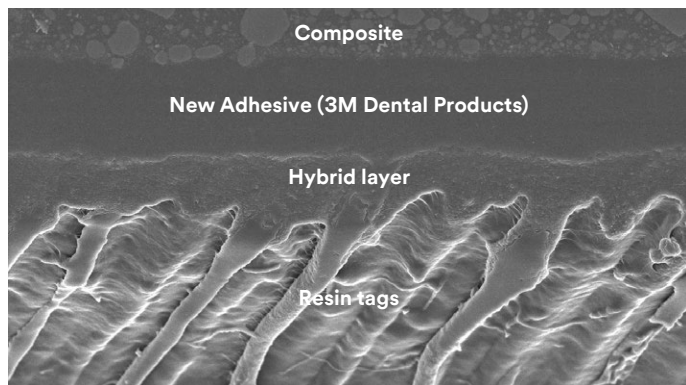
1. A fully formed hybrid layer, which was measured on the intertubular area to avoid the hybridization around tubules, was observed for all four groups, without discernible differences among groups. Well-defined lateral peritubular triangular hybridization and resin tag hybridization were also observed.
2. In spite of the NaOCl deproteinizing challenge, the hybrid layer was intact without signs of exposed collagen fibers. Collagen fibers in the hybrid layer were apparently fully enveloped by polymerized adhesive resin.
3. The thickness of the hybrid layer is shown in the SEM legends in the images attached to this report. Air-drying dentin for 5 sec after rinsing off the etchant (Groups 2 and 4) did not influence the morphology of the hybrid layer regardless of the adhesive used.
4. Both adhesives were able to infiltrate dentinal tubules and secondary anastomoses, forming prominent resin tags.
5. No gaps were observed between the adhesive and the flowable composite resin or between the adhesive and the hybrid layer.



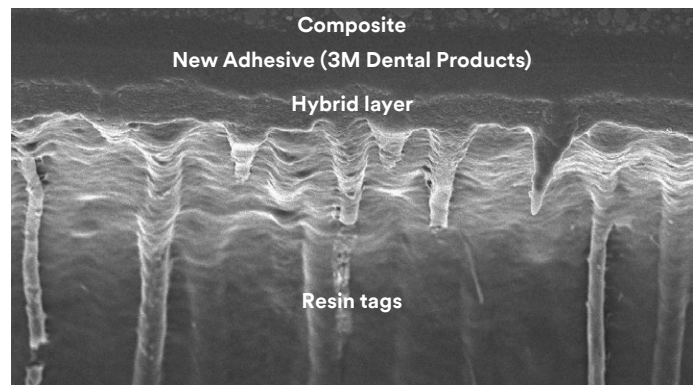
Moist Dentin



Dry Dentin



Moist Dentin



Dry Dentin

SEM images 2,500X magnification

3M summary:

Moisture tolerance of an adhesive is an important feature, as it ensures consistent bonding results on all dentin surfaces. This SEM investigation reveals that the interface produced with New Adhesive* (3M Dental Products) on etched dry dentin and etched moist dentin is of high quality, with fully formed hybrid layers, infiltrated dentinal tubules and prominent resin tags – similar to the original 3M™ Scotchbond™ Universal Adhesive.

*Now commercially available under the product name 3M™ Scotchbond™ Universal Plus Adhesive

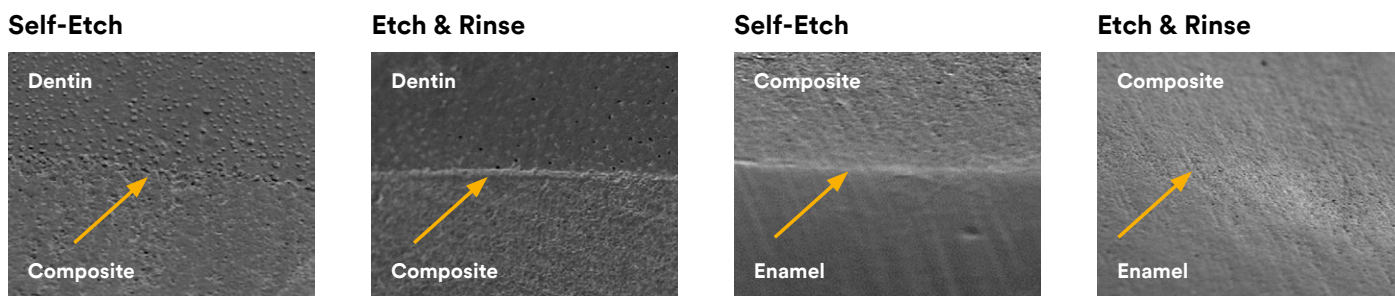
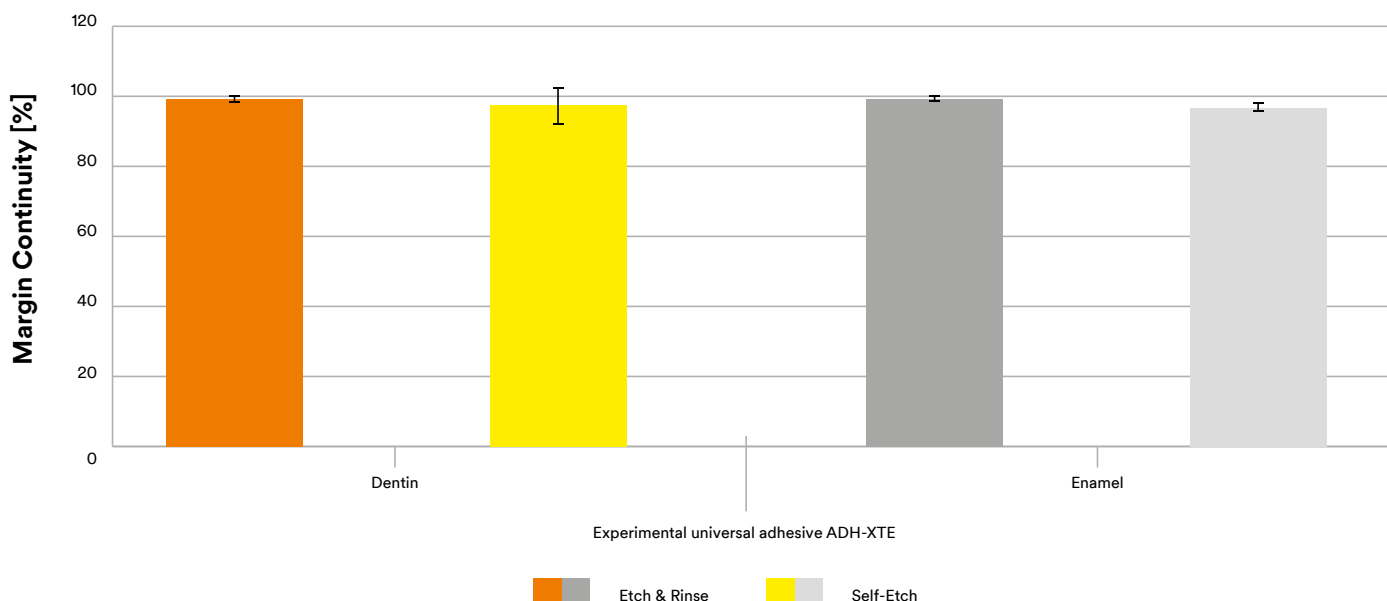
Quantitative Margin Analysis at Class V Restorations Using the Experimental Universal Adhesive ADH-XTE in Combination with a Composite Resin in Vitro

Dr. U. Blunck, Charité University of Berlin, Germany

Final Report to 3M, 2019

In extracted teeth, stored in 0.5 % chloramine-T solution, eight Class V cavities per group were prepared and filled with the composite resin Filtek Z250 using the experimental universal adhesive ADH-XTE in the application modes self-etch and etch&rinse. After finishing and water storage for 21 days, replica were taken before and after 2,000 thermocycles (TC) between 5 C and 55 C and a quantitative margin analysis in the SEM was performed at a magnification of 200X using four defined criteria.

The evaluation of the marginal adaptation after thermocycling at the Class V restorations in dentin and enamel provided with median and mean values of about 97 to 100 % very high amounts of margin quality 1. From this study it can be concluded that the tested experimental universal adhesive ADH-XTE is very effective in bonding to enamel and dentin in both application modes, in etch&rinse technique and as a self-etching adhesive.



SEM images of the continuous margin (quality 1) 200x magnification

3M summary:

The success of composite resin restorations is highly dependent on their marginal adaptation immediately after restoration placement and in the long run. This in-vitro study shows that even after simulated aging, ADH-XTE* provides an excellent marginal seal independent of the application mode (self-etch or total-etch).

*Now commercially available under the product name 3M™ Scotchbond™ Universal Plus Adhesive

Shear Bond Strength of a New 3M Universal Adhesive to Glass-Ceramic (Lithium Disilicate)

Prof. Dr. B. Van Meerbeek, University of Leuven, Belgium

Final Report to 3M, 2020

Purpose:

The purpose of this project was to investigate the bonding effectiveness of a new 3M Universal adhesive onto glass-ceramic.

Materials and Methods:

SUBSTRATE TREATMENTS:

- ✓ As milled' (no further surface treatment; ground using FEPA P320 SiC paper as final surface treatment);
- ✓ Air abraded (CoJet) (repair and possible alternative to HF etching);
- ✓ HF-acid etched ('<5%' HF; IPS Ceramic Etching Gel, Ivoclar Vivadent); the polished surface was HF-etched for 20 s, thoroughly rinsed for 60 s under running tap water, post-etched with phosphoric acid (3M Universal Etchant) for 20 s to remove any residue and finally air-dried;
- ✓ Metallo-graphically polished to high gloss.

On lithium disilicate with different pretreatments (as above described), the following materials were applied and cured:

1. 3M™ ADH-XTE experimental adhesive (containing silane)
2. 3M™ Scotchbond™ Universal Adhesive (SBU, containing silane)
3. 3M™ RelyX™ Ceramic Primer + 3M™ Adper™ Scotchbond™ 1XT Adhesive (clinically proven classic silane + separate adhesive)
4. 3M™ RelyX™ Ceramic Primer + 3M™ ADH-XTE experimental adhesive (to assess influence of additional silane)
5. 3M™ RelyX™ Ceramic Primer + 3M™ Scotchbond™ Universal Adhesive (to assess influence of additional silane)

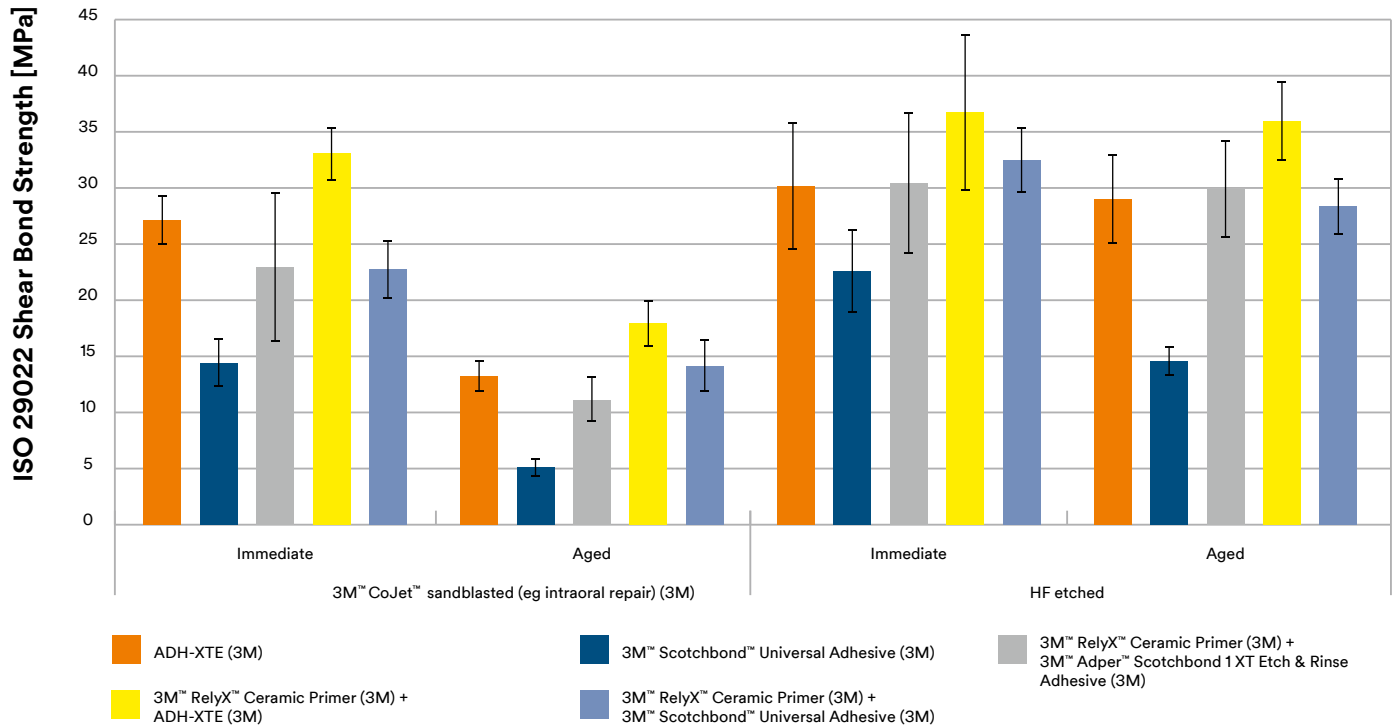
Next, a composite button (3M™ Filtek™ Z250 Universal Restorative, 3M) was cured on the treated specimen surface using a mold according to ISO 29022:2013. Notched edge shear bond strength according to ISO 29022:2013 was measured immediately and after aging.

Results:

1. When the ceramic surface was pre-treated with CoJet or HF, no significant difference in shear bond strength (SBS) was recorded between the group, in which only ADH-XTE was applied, and the control group, in which the ceramic primer was applied prior to SB1-XT.
2. Higher 'immediate' and 'aged' SBS was achieved by ADH-XTE than by SBU, when the pretreated (CoJet or HF-treated) ceramic surface did not receive the additional ceramic primer.
3. Upon aging, significant reduction in SBS was recorded for both ADH-XTE and SBU when bonded to the CoJet-pretreated ceramic surfaces.

Conclusions

1. The experimental adhesive ADH-XTE performed better than Scotchbond Universal for glass-ceramic (e.max CAD) bonding.
2. After the glass-ceramic was etched with HF acid, a favorable ‘IMMEDIATE’ and ‘AGED’ SBS were recorded for the experimental adhesive ADH-XTE.



3M summary:

ADH-XTE* offers a higher bond strength to lithium disilicate than its predecessor. Hydrofluoric acid etching, the recommended preparation method according to manufacturers of glass ceramic materials, gives optimal results even after artificial aging and achieves the same level as conventional silane primers. The new universal adhesive achieves higher bond strength to glass ceramics regardless of whether it has been HF etched or sandblasted.

*Now commercially available under the product name 3M™ Scotchbond™ Universal Plus Adhesive

3M ADH-XTE Experimental Adhesive: Ultra-structural Characterization of Adhesive Dentin-interface and Adhesive Enamel-interface

Prof. Dr. B. Van Meerbeek, University of Leuven, Belgium

Final Report to 3M, 2019

The interface of 3M ADH-XTE experimental Adhesive to etched and unetched dentin was investigated in a transmission electron microscopy (TEM) study. In both etching modes, there was a well-defined hybrid layer without voids or gaps. Its thickness depended on the etching mode. Further observations included that the adhesive layer was relatively thin (between 3-6 μm). There were no voids in adhesive layer. During specimen preparation and imaging, no interface debonding occurred, which indicates a tight bond to bur-cut dentin.

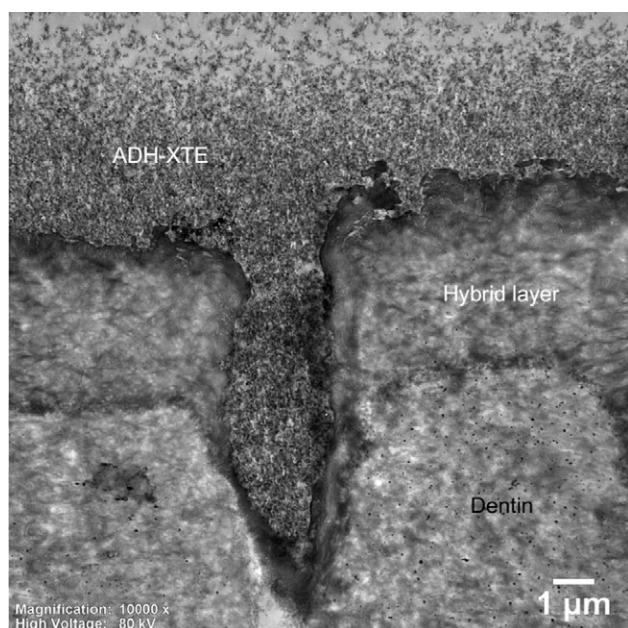


Fig.: Transmission electron MICROGRAPHS of the hybrid layer of 3M™ ADH-XTE experimental adhesive on etched dentin (demineralized, stained). Note the hybrid layer thickness of about 5 μm (as consequence of phosphoric acid etch), and formation of a resin tag in a dentin tubule.

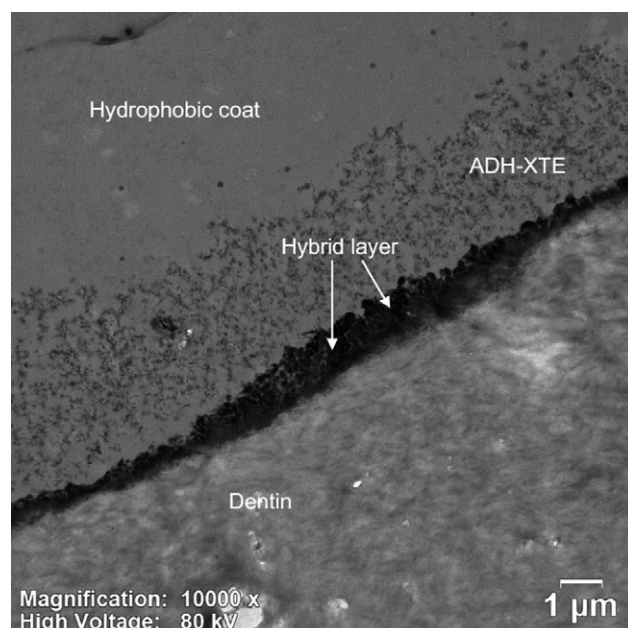
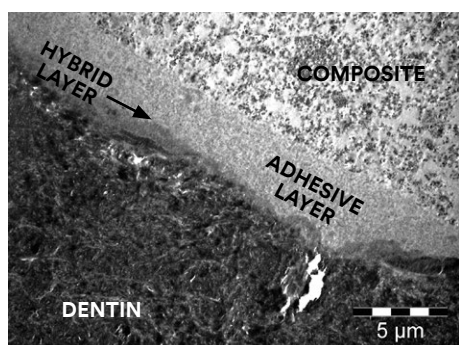
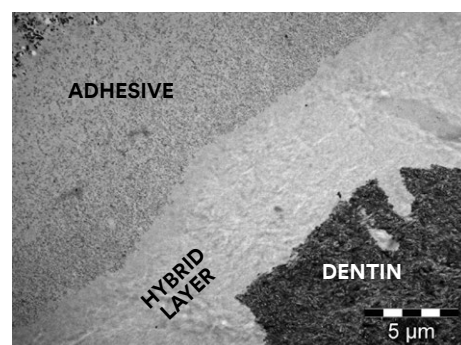
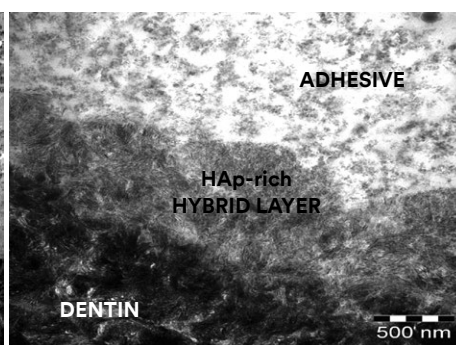


Fig.: Transmission electron micrograph of the hybrid layer of 3M™ ADH-XTE experimental adhesive on unetched dentin (demineralized, stained). Note the hybrid layer thickness of 0.5-1 μm (as consequence of self-etch application).

These results are comparable to the results obtained with 3M™ Scotchbond™ Universal Adhesive, also conducted by Prof. Dr. Bart Van Meerbeek in 2011: TEM Evaluation of the interface between 3M™ Scotchbond™ Universal Adhesive and dentin when used in the Self-Etch and Total-Etch Mode. The TEM pictures showed an adhesive film thickness in the range of 5–10 microns and a well-defined hybrid layer of approximately 5 microns. (see the pictures below).



3M™ Scotchbond™ Universal Adhesive interface with dentin in self-etch mode.



3M™ Scotchbond™ Universal Adhesive interface with dentin in total-etch mode.

3M summary:

The TEM section analyses carried out in this in-vitro study reveal that ADH-XTE* forms an adhesive-dentin-interface and an adhesive-enamel-interface with the same characteristics as its predecessor 3M™ Scotchbond™ Universal Adhesive.

*Now commercially available under the product name 3M™ Scotchbond™ Universal Plus Adhesive



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