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RelyX™ Ultimate Adhesive Resin Cement

RelyX Ultimate cement is an innovative dual cure, adhesive resin cement from 3M ESPE. The cement was developed with the specific needs of glass ceramic cementation in mind. RelyX Ultimate cement ensures uncompromising results and guarantees ultimate bond strength and high, long-lasting esthetics. The cement was designed for optimal performance when combined with Scotchbond™ Universal Adhesive. RelyX Ultimate cement has an integrated dark cure activator for Scotchbond Universal adhesive which eliminates the need for a separate activator and the corresponding additional steps.

Scotchbond Universal adhesive is a one-component dental adhesive, designed to cover all techniques and all indications. It can be used in a self-etch mode, selective-enamel-etch mode or in a total-etch (or “etch and rinse”) mode for both direct and indirect dental restorative procedures. In addition to serving as the adhesive on tooth substance Scotchbond Universal adhesive also functions as a metal and zirconia primer as well as a silane.

RelyX Ultimate Cement Benefits at a Glance:

- Ultimate bond strength
- Fewer components (eliminates the need for up to 4 separate bottles)
- Can be used in either self-etch, selective-etch or total-etch approach
- Dual cure with integrated dark cure activator for Scotchbond Universal adhesive
- High esthetics and tooth like fluorescence
- Moisture tolerance for challenging clinical situations

RelyX Ultimate cement is delivered in an automix syringe containing 8.5 g base paste/catalyst paste, which is sufficient for approximately 16 applications. For color coordination there are four different shades: Translucent, B0.5 (Bleach), A1 and A3 Opaque. Corresponding try-in pastes are available as well. Shelf life in aluminium pouch is 18 months. Neither the cement nor the adhesive require refrigeration.

RelyX Ultimate cement covers the whole spectrum of indirect indications:

- Final cementation of all-ceramic, composite or metal inlays, onlays, crowns and bridges; 2–3-unit Maryland bridges and 3-unit inlay/onlay bridges*
- Final cementation of all-ceramic or composite veneers
- Final cementation of all-ceramic, composite, or metal restorations to implant abutments
- Final cementation of posts and screws … and is especially designed for glass ceramics

* Excluded for patients with bruxism or periodontitis.
Composition

Cement

RelyX™ Ultimate Adhesive Resin Cement is formulated to meet the highest demands for glass ceramic cementation as well as to allow easy handling. The qualitative composition is shown in the following table. While RelyX Ultimate cement was designed for optimal performance when combined with Scotchbond™ Universal Adhesive, it is also compatible with other 3M ESPE adhesives, e.g. Adper™ Scotchbond™ Multi-Purpose Dental Adhesive or Adper™ Single Bond Adhesive. RelyX Ultimate cement offers all properties specially needed for cementing veneers: high mechanical strength, radiopacity, high wear resistance, high adhesive strength and low film thickness. For dentists that prefer a light cure only material, 3M ESPE recommends RelyX™ Veneer Cement.

In addition, RelyX™ Try-in Pastes are available in the shades of RelyX Ultimate cement. These pastes are used during shade selection for the final cementation. RelyX Try-in pastes contain polyethylene glycol (PEG), zirconia and silica fillers and pigments. All Try-in pastes are water-soluble and can be cleaned up easily both from tooth and restoration.

Adhesive

The Scotchbond Universal chemistry utilizes phosphorylated monomers in a water/ethanol based solution that provides acidity and allows the adhesive to bond to dentin and enamel without the use of a separate phosphoric acid etching step. With its pH of 2.7 it can be considered as a mild self-etch adhesive.

Scotchbond Universal adhesive uses three trusted and well known adhesion promoters in one formulation (VMS technology) and thus also bonds to restoration substrates.

<table>
<thead>
<tr>
<th>Base Paste</th>
<th>Catalyst Paste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methacrylate monomers</td>
<td>Methacrylate monomers</td>
</tr>
<tr>
<td>Radiopaque, silanated fillers</td>
<td>Radiopaque alkaline (basic) fillers</td>
</tr>
<tr>
<td>Initiator components</td>
<td>Initiator components</td>
</tr>
<tr>
<td>Stabilizers</td>
<td>Stabilizers</td>
</tr>
<tr>
<td>Rheological additives</td>
<td>Rheological additives</td>
</tr>
<tr>
<td>—</td>
<td>Fluorescence dye</td>
</tr>
<tr>
<td>—</td>
<td>Dark cure activator for Scotchbond Universal adhesive</td>
</tr>
</tbody>
</table>

In combination with RelyX Ultimate cement the integrated activator in the cement cures the Scotchbond Universal adhesive. This eliminates the need for light curing or additional activator liquids. However, light curing the adhesive remains optional. This dual cure mechanism allows reliable cementation of:

- Posts
- Opaque zirconia restorations
- Full metal casts
- Porcelain fused to metal restorations

Vitrebond Copolymer provides consistent bond performance to dentin under varying moisture levels.

MDP provides self-etching properties and bonds to zirconia, alumina, metals and metal alloys.

Silane to chemically bond to glass ceramic surfaces without using a separate ceramic primer.
Procedure

Procedure Versatility

RelyX™ Ultimate Adhesive Resin Cement adapts to your needs. It is applicable for total-etch, selective-enamel-etch and self-etch procedure. Scotchbond™ Universal Adhesive can be left uncured, as the dark cure activator is integrated in the cement. Light curing is optional. Additionally, Scotchbond Universal adhesive functions as a pretreatment agent for all kinds of restoration surfaces.

Self-etch or Total-etch Procedure:

<table>
<thead>
<tr>
<th>3M ESPE recommends self-etch procedure when:</th>
<th>3M ESPE recommends selective or total-etch when:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk of tooth sensitivity or proximity to pulp exists</td>
<td>Situation calls for bonding to enamel (rather than to dentin)</td>
</tr>
<tr>
<td>Situation calls for bonding to dentin (rather than to enamel)</td>
<td>Preparation is non-retentive</td>
</tr>
<tr>
<td>Risk of moisture contamination exists</td>
<td>No risk of post-op sensitivity exists (e.g. non-vital tooth)</td>
</tr>
<tr>
<td>Cementation needs to happen quickly</td>
<td>Situation is easy to keep dry</td>
</tr>
</tbody>
</table>

Self-etching simplifies the technique and provides protection to the dentin surface to reduce the potential for post-operative sensitivity. Total-etching on the other hand usually provides higher bond strength to cut and especially uncut enamel but is traditionally more technique sensitive on dentin.

When combining a selective-enamel-etching step with a self-etch adhesive, the clinician can maximize the enamel bond strength and takes advantage of the low post-operative sensitivity feature that the self-etch adhesive provides and still achieves a strong bond to dentin.
Scotchbond™ Universal Adhesive — Adhesive and Restoration Primer

Scotchbond Universal adhesive functions not only as a self-etch or total-etch adhesive, but also as a primer for metal and zirconia restorations as well as a silane for glass ceramics. This eliminates one of the major drawbacks of older adhesive cement systems which is the need for a high number of accessory primers and activators. The required functionality has simply been integrated into either the cement or the adhesive. With its special initiator system, the cement initiates curing in the adhesive layer, so no separate dark cure activator is needed.

100% compatible

The chemistry of Scotchbond Universal adhesive including Vitrebond™ Copolymer, MDP, HEMA and water allows using the adhesive both with additional phosphoric acid etching in a total-etch approach and as self-etch adhesive, only depending on the clinical situation and personal preference. It will deliver consistent performance even to etched dentin whether it is kept moist as recommended or dry. This is a major advantage compared to typical 5th generation or 2-step etch-and-rinse systems that require the dentin surface to be moist or otherwise result in reduced bond strength and potential sensitivity if the dentin surface is dried prior to the application of the adhesive. The same adhesive can be used as a universal restoration primer, containing MDP for adhesion to oxide ceramics and metals and silane to chemically bond to glass ceramic surfaces, simplifying procedure and inventory.
Bonding Performance

Bond to Enamel and Dentin

Internal and third party adhesion test data show excellent results to dentin and enamel — both in the self-etch (Fig. 1) and total-etch (Fig. 2) mode. This is especially true for dentin, when the smear layer is still present and the adhesive is used in the self-etch mode. All tests were performed both 24 hours after bonding as well as after additional artificial aging for 5,000 thermocycles between 5 and 55 °C.

In independent research, RelyX™ Ultimate Adhesive Resin Cement shows the highest bond strength to enamel (Fig. 3) as well as highest retention strength for Lava™ Zirconia crowns (Fig. 4) compared to other resin cements that use a self-etching primer system.

Tufts University investigated shear bond strength to enamel 24 h after cementation. The group of Dr. John Burgess cemented Lava zirconia crowns to teeth with non-retentive preparations and compared the pull-off forces of various resin cements after artificial aging with mechanical loading (100,000 × 20 N) and thermocycling (10,000 × 5 – 55°C).

Fig. 1: Shear bond strength to dentin and enamel after artificial aging (5,000 thermocycles). RelyX™ Ultimate Adhesive Resin Cement was used with Scotchbond™ Universal Adhesive, the other cements with their respective adhesive. Source: 3M ESPE internal data

Fig. 2: Shear bond strength to dentin and enamel after artificial aging (5,000 thermocycles). RelyX™ Ultimate Adhesive Resin Cement was used with Scotchbond™ Universal Adhesive, the other cements with their respective adhesive. Source: 3M ESPE internal data

Fig. 3: Shear bond strength to enamel after 24 h storage, cement was light cured. Source: C. Decoteau, M. Ogledzki, G. Kugel, and R.D. Perry; Tufts University, Boston, USA, IADR/AADR 2011, # 375

Fig. 4: RelyX™ Ultimate Adhesive Resin Cement was used with Scotchbond™ Universal Adhesive (no extra light curing), the other materials with their respective primers. Zirconia was sandblasted (< 50µm) before priming, all cements light cured. Source: J. Burgess, D. Cakir, University of Alabama Birmingham, AL, USA
Research at the University of Trieste, Italy, also confirmed excellent adhesion for RelyX™ Ultimate Adhesive Resin Cement when compared to traditional adhesive resin systems that use etching, priming and bonding. The researchers used RelyX Ultimate cement without a tooth etching step, Scotchbond™ Universal Adhesive was just applied to the dentin. Due to its versatility, both tested restoration materials, feldspathic glass ceramic and Resin Nano Ceramics (RNC, like Lava™ Ultimate CAD/CAM Restorative), were pretreated with Scotchbond™ Universal adhesive as silane, the feldspathic ceramic after HF etching and the RNC after just sandblasting.

**Microtensile Bond Strength to Dentin and Restoration Materials**

<table>
<thead>
<tr>
<th>Restoration Material</th>
<th>Feldspathic ceramic (Vita Mark II)</th>
<th>Resin Nano Ceramic (Lava Ultimate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td>RelyX™ Ultimate Adhesive Resin Cement</td>
<td>Variolink® II RelyX™ Ultimate Adhesive Resin Cement</td>
</tr>
<tr>
<td>Pre-treatment Tooth</td>
<td>Scotchbond™ Universal Adhesive</td>
<td>Phosphoric acid etching Heliobond and Syntac</td>
</tr>
<tr>
<td>Pre-treatment Restoration</td>
<td>Scotchbond™ Universal Adhesive</td>
<td>Monobond Plus</td>
</tr>
</tbody>
</table>

**Fig. 5**: Microtensile bond strength to dentin after water storage or artificial aging (chewing simulation 50N, 240,000 cycles). Different restoration materials were used to create the specimen in order to evaluate a potential influence. Source: L. Breschi, G. Turco, A. Frassetto, M. Cadenaro, University of Trieste, Italy

**Bond to Restoration**

High bond strength and esthetics predestine RelyX Ultimate cement for the cementation of glass ceramic restorations. The bond strength data to different types of glass ceramics shown in Fig. 6 and Fig. 7 underlines the performance of RelyX Ultimate cement. To simplify the cementation procedure, Scotchbond Universal adhesive was used as silane replacement for all types of etchable ceramics tested.

**Shear Bond Strength of RelyX™ Ultimate Adhesive Resin Cement to Etchable Ceramics — Before and After Artificial Aging**

**Fig. 6**: Vita Mark II and e.max CAD were etched with HF according to manufacturers' instructions before silanization with Scotchbond™ Universal Adhesive, all cements light cured. Artificial aging: 5,000 thermocycles (5 – 55 °C). Source: M. Rosentritt, University of Regensburg, Germany

**Fig. 7**: All-ceramic materials were etched with HF according to manufacturers' instructions before silanization with Scotchbond™ Universal Adhesive, all cements light cured. Artificial aging: 5,000 thermocycles (5 – 55 °C). Source: 3M ESPE internal data
The University of Regensburg showed extremely high bond strength to oxide ceramic restoration material for RelyX™ Ultimate Adhesive Resin Cement, both before and after artificial aging (Fig. 8). Figure 9 shows the bonding performance of different cements in the self and light cure mode. For testing, all zirconia materials were sandblasted and then pretreated with Scotchbond™ Universal or as recommended by the respective manufacturer.

![Shear Bond Strength of RelyX™ Ultimate Adhesive Resin Cement to Zirconia After Artificial Aging](image1)

**Fig. 8:** RelyX™ Ultimate Adhesive Resin Cement was used with Scotchbond™ Universal (left uncured). Cercon Zirconia was sandblasted (50 µm, 2.5 bar) before priming, cement light cured. Artificial aging: 5,000 thermocycles (5 – 55 °C). Source: M. Rosentritt, University of Regensburg, Germany

![Shear Bond Strength to Zirconia After Artificial Aging](image2)

**Fig. 9:** RelyX™ Ultimate Adhesive Resin Cement was used with Scotchbond™ Universal Adhesive as primer (left uncured), the other materials were used with their respective primers if indicated by manufacturer. Cements were light cured or dark cured. Lava™ Zirconia was sandblasted (50 µm, 2.5 bar) before priming. Source: 3M ESPE internal data

* Dark cure procedure is not clearly described in the manufacturer’s instructions for use for Variolink II.
** Manufacturer does not specify zirconia pretreatment.

Figure 11 shows the shear bond strength of different cements to titanium and nonprecious alloy. All cements were tested in the dark cure mode. The high bond strength of RelyX Ultimate was also confirmed by the University of Regensburg (Fig. 10).

![Shear Bond Strength to Titanium and Nonprecious Alloy After Artificial Aging](image3)

**Fig. 10:** RelyX™ Ultimate Adhesive Resin Cement was used with Scotchbond™ Universal Adhesive (left uncured). Metals were sandblasted (50 µm, 2.5 bar) before priming, cement light cured. Artificial aging: 5,000 thermocycles (5 – 55 °C). Source: M. Rosentritt, University of Regensburg, Germany

![Shear Bond Strength to Titanium and Nonprecious Alloy After Artificial Aging](image4)

**Fig. 11:** RelyX™ Ultimate Adhesive Resin Cement was used with Scotchbond™ Universal as primer (left uncured), the other materials were used with their respective primers if indicated by manufacturer. The cements were left to dark cure. The metals were sandblasted (50 µm, 2.5 bar) before priming. Source: 3M ESPE internal data
Optimized Properties for Long-lasting Esthetics

Fluorescence

RelyX™ Ultimate Adhesive Resin Cement takes advantage of a modern initiator technology, which is free of aromatic amine initiator components that lead to discoloration. It enables dual curing, while at the same time guaranteeing long term color stability of the cement. As a result of its color stability, the cement is suited for use with highly esthetic restorations such as ceramic or composite crowns, inlays, and veneers. RelyX Ultimate cement is available in 4 shades. For brilliant natural color imitation, a fluorescence dye is added to the cement.

<table>
<thead>
<tr>
<th>Fluorescence of Cements in Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human Tooth</td>
</tr>
<tr>
<td>RelyX™ Ultimate Adhesive Resin Cement</td>
</tr>
<tr>
<td>Panavia™ F 2.0</td>
</tr>
<tr>
<td>NX3</td>
</tr>
<tr>
<td>Clearfil™ Esthetic Cement</td>
</tr>
</tbody>
</table>

Source: 3M ESPE internal data

Resistance to Staining

To maintain high esthetics, the resin cement must be resistant against staining. Food and beverages can be a major source of staining. Compared to other leading products, RelyX Ultimate cement shows the lowest discoloration after incubation in coffee solution. The pictures show cement samples after storage in standardized coffee solution for 3 days at 36 °C.

<table>
<thead>
<tr>
<th>Color Stability of Cements in Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>RelyX™ Ultimate Adhesive Resin Cement</td>
</tr>
<tr>
<td>Panavia™ F 2.0</td>
</tr>
<tr>
<td>NX3</td>
</tr>
<tr>
<td>Multilink® Automix</td>
</tr>
</tbody>
</table>

Source: 3M ESPE internal data
Marginal Sealing

Behr et al. (University of Regensburg, Germany) investigated the marginal integrity of Empress® 2 MOD inlay restorations luted with RelyX™ Ultimate Adhesive Resin Cement. The reference group was Multilink Automix®. After chewing simulation and thermo-cycling the marginal integrity was investigated by dye penetration and topological SEM analysis.

The control group Multilink Automix showed statistically higher dye penetration than RelyX Ultimate cement independently of the luting protocol. RelyX Ultimate works excellent under all luting conditions — in the self-etch and total-etch mode, both when light cured and when dark cured. According to the SEM examination, perfect margins in dentin as well as in enamel were in the range of 95% to 100%.

Wear Resistance

An esthetic restoration requires marginal integrity. RelyX Ultimate cement is optimized for a high wear resistance. This will help maintain a good marginal sealing over the life time of the restoration and prevents marginal discoloration due to marginal grooves and gaps.

When compared to other resin cements and flowable filling composites, RelyX Ultimate cement shows very low three-body wear. It only abrades 0.5 times more than the reference hybrid filling composite Filtek™ Z250 Universal Dental Restorative (3M ESPE).

![Fig. 13: ACTA three body wear test. Material abrasion calculated relative to Filtek™ Z250 Universal Dental Restorative (3M ESPE). Source: C. Kleverlaan, ACTA University, Netherlands]
Clinical Results and Recommendations

Clinical Results

More than 3,700 restorations were placed with RelyX™ Ultimate Adhesive Resin Cement in an in-office evaluation with over 130 dentists from Europe. 93% of the testers were satisfied or even very satisfied with the product. Ease of use, strong adhesion and paste viscosity were named as the dentists’ most preferred features. The post-operative sensitivity rate was very low. Of 3,727 cases, in only 9 cases post-operative sensitivity was reported.

<table>
<thead>
<tr>
<th>Very satisfied</th>
<th>Somewhat satisfied</th>
<th>Neither satisfied nor dissatisfied</th>
<th>Somewhat dissatisfied</th>
<th>Very dissatisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>42%</td>
<td>51%</td>
<td>6%</td>
<td>1%</td>
<td>1%</td>
</tr>
</tbody>
</table>

Fig. 14: General satisfaction with RelyX™ Ultimate Adhesive Resin Cement (left) (Due to rounding errors the sum can slightly differ from 100 %). Source: Field evaluation EU conducted by 3M ESPE

99.76% of restorations were free of post-operative sensitivities.

Fig. 15: Post-operative sensitivity rate. Source: Field evaluation EU conducted by 3M ESPE

Restoration Pre-treatment

<table>
<thead>
<tr>
<th>Restoration Material</th>
<th>Pre-treatment Recommendation for Clean Surface</th>
</tr>
</thead>
</table>
| **Glass ceramic**    | **Step 1:** etching with hydrofluoric (HF) acid  
                        **Step 2:** Scotchbond Universal adhesive |
| etchable feldspathic, leucite reinforced and lithium disilicate |
| **Zirconia and Alumina** (oxide ceramics, non-etchable, high strength) **Composite**, **Metal**, **PFM**, **RNC** | **Step 1:** Sandblasting (<50 µm)  
                        **Step 2:** Scotchbond Universal adhesive |
| **Fiber reinforced composite post** | Scotchbond Universal adhesive |
Clinical Case

Cementation of Two Glass Ceramic Inlays
Dr. Andreas Syrek, Seefeld, Dentallabor Elke Sallinger, Krailling

1. Initial situation: Insufficient composite inlay restorations on premolars. The patient chose to replace the composite restorations with highly esthetic glass ceramic inlays (Vita PM9, Vita).

2. Hydrofluoric acid is used to etch the ceramic surface (Vita PM9, Vita).

3. Scotchbond™ Universal Adhesive is applied to the restoration surface eliminating the need for a separate silane agent (20 sec.).

4. The restoration surface is gently air dried until the solvent has completely evaporated (5 sec.).

5. Protect the pretreated inlay from ambient light to assure an optimal fit.

6. The temporary restoration is removed.

7. Cleaning the prepared tooth with pumice to remove any remnants of temporary cement.

8. Selective-etching of the enamel with Scotchbond Universal etchant (15 sec.).

9. Rinsing off the Scotchbond™ Universal Etchant after 15 seconds incubation time.

10. Applying Scotchbond Universal adhesive to the tooth structure (20 sec.).

11. Thinning the adhesive with a gentle air stream until the solvent has completely evaporated (5 sec.).

12. Applying RelyX™ Ultimate Adhesive Resin Cement directly into the cavity using the intra-oral tip.

13. After seating the inlays excess cement is removed.

14. Light cure the cement using Elipar™ S10 LED Curing Light from 3M ESPE (20 sec./surface).

15. Polishing the cement margins.

16. High-quality, highly esthetic glass ceramic restorations after two weeks in place.
Summary of Physical and Mechanical Properties

The physical and mechanical properties of RelyX™ Ultimate Adhesive Resin Cement were adjusted based on 3M ESPE’s long standing experience with dental cements.

<table>
<thead>
<tr>
<th>Properties</th>
<th>RelyX™ Ultimate Adhesive Resin Cement (Ic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexural strength [MPa]</td>
<td>98</td>
</tr>
<tr>
<td>Compressive strength [MPa]</td>
<td>262</td>
</tr>
<tr>
<td>Modulus of elasticity [GPa]</td>
<td>7.7</td>
</tr>
<tr>
<td>Surface hardness (HV 0.2)</td>
<td>40</td>
</tr>
<tr>
<td>Film thickness [μm]</td>
<td>12</td>
</tr>
<tr>
<td>Water sorption [μg/mm³]</td>
<td>21</td>
</tr>
<tr>
<td>Solubility [μg/mm³]</td>
<td>0</td>
</tr>
<tr>
<td>Expansion after 1 month [%]</td>
<td>0.5</td>
</tr>
</tbody>
</table>