

# RelyX™ Ultimate

Adhesive Resin Cement



Technical Data Sheet

# Content

<b>1. 3M ESPE RelyX™ Ultimate</b> .....	3
<b>2. Composition</b> .....	4
2.1 Cement	
2.2 Adhesive	
<b>3. Procedure</b> .....	5 – 6
3.1 Procedure Versatility	
3.2 Scotchbond™ Universal – adhesive and restoration primer	
<b>4. Bonding performance</b> .....	7 – 9
4.1 Bond to enamel and dentin	
4.2 Bond to restoration	
<b>5. Optimized properties for long-lasting esthetics</b> .....	10 – 11
5.1 Fluorescence	
5.2 Resistance to staining	
5.3 Marginal sealing	
5.4 Wear resistance	
<b>6. Clinical results and recommendations</b> .....	12 – 13
6.1 Clinical results	
6.2 Restoration pre-treatment	
6.3 Recommended procedures to achieve excellent margins with resin cements	
<b>7. Clinical case</b> .....	14
<b>8. Summary of physical and mechanical properties</b> .....	15

# 1 3M ESPE RelyX™ Ultimate

RelyX Ultimate 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 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 has an integrated dark cure activator for Scotchbond Universal which eliminates the need for a separate activator and the corresponding additional steps.

Scotchbond™ Universal 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 also functions as a metal and zirconia primer as well as a silane.

## RelyX Ultimate 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 is delivered in an automix syringe** containing 8.5g 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 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.

## 2 Composition

### 2.1 Cement

RelyX™ Ultimate 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 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 or Adper™ Single Bond.

Base Paste	Catalyst Paste
Methacrylate monomers	Methacrylate monomers
Radiopaque, silanated fillers	Radiopaque alkaline (basic) fillers
Initiator components	Initiator components
Stabilizers	Stabilizers
Rheological additives	Pigments
	Rheological additives
	Fluorescence dye
	Dark cure activator for Scotchbond Universal 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.

In addition, RelyX™ Try-in Pastes are available in the shades of RelyX Ultimate. 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.



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



**V**itrebond Copolymer provides consistent bond performance to dentin under varying moisture levels.

**M**DP provides self-etching properties and bonds to zirconia, alumina, metals and metal alloys.

**S**ilane to chemically bond to glass ceramic surfaces without using a separate ceramic primer.

#### Scotchbond™ Universal Adhesive

MDP Phosphate Monomer
Dimethacrylate resins
HEMA
Vitrebond™ Copolymer
Filler
Ethanol
Water
Initiators
Silane

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:

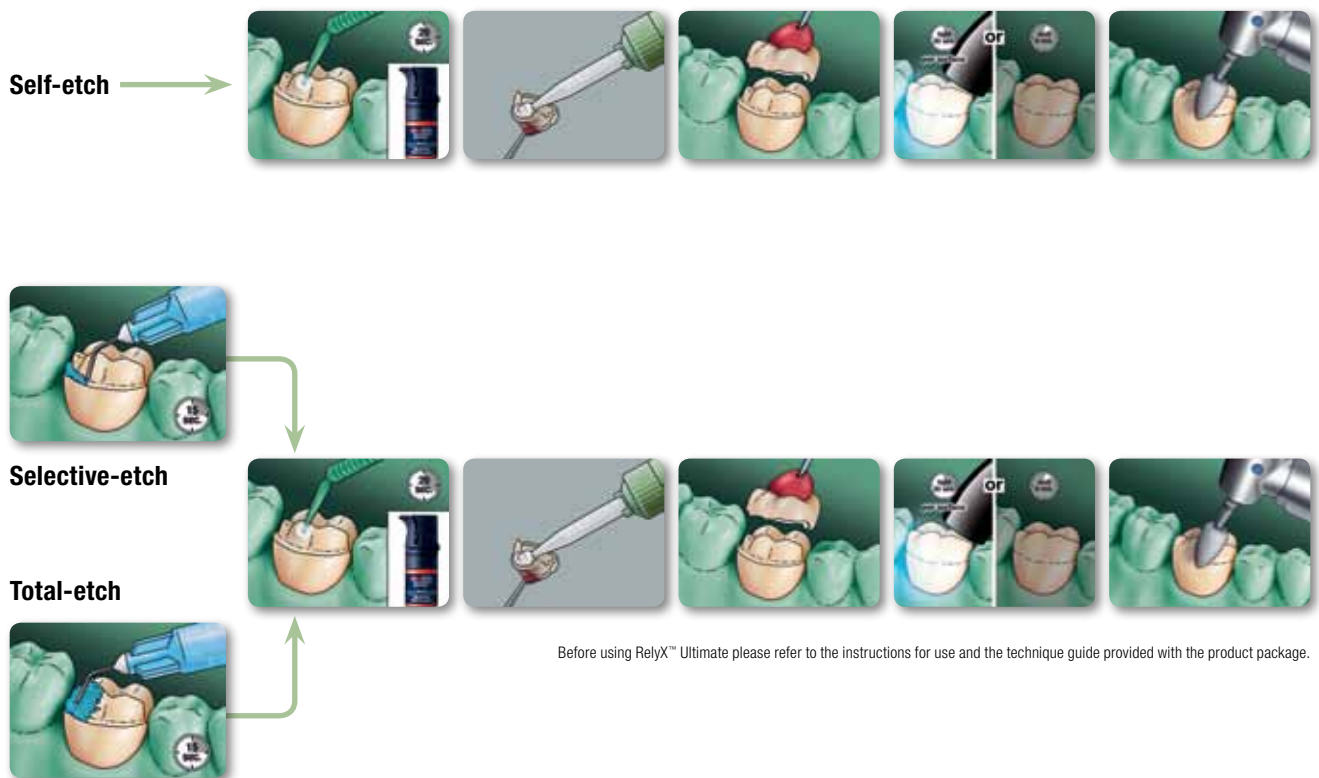
- Posts
- Full metal casts
- Opaque zirconia restorations
- Porcelain fused to metal restorations

# 3 Procedure

## 3.1 Procedure Versatility

RelyX™ Ultimate adapts to your needs. It is applicable for total-etch, selective-enamel-etch and self-etch procedure. Scotchbond™ Universal 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:



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.

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

### 3.2 Scotchbond™ Universal – 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

Scotchbond™ Universal Adhesive

Total-etch Adhesive

RelyX™ Ultimate Adhesive Resin Cement

Primers / Silane

Integrated dark cure activator for Scotchbond™ Universal

Self-etch Adhesive

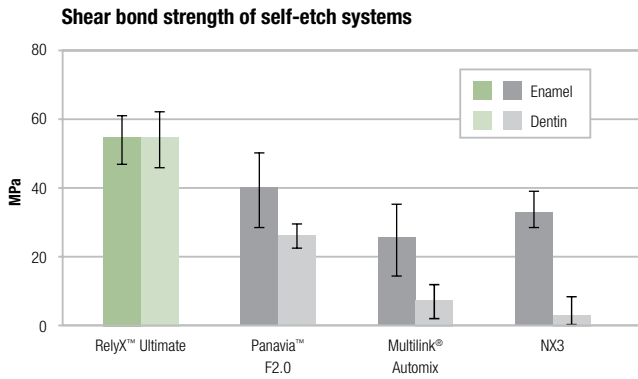
The chemistry of Scotchbond Universal including Vitrebond™ Copolymer, MDP, HEMA and water allows using the adhesive both with additional phosphoric acid etching in a total-etch approach and as self-etch adhesive, only depending on the clinical situation and personal preference. It will deliver consistent 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.

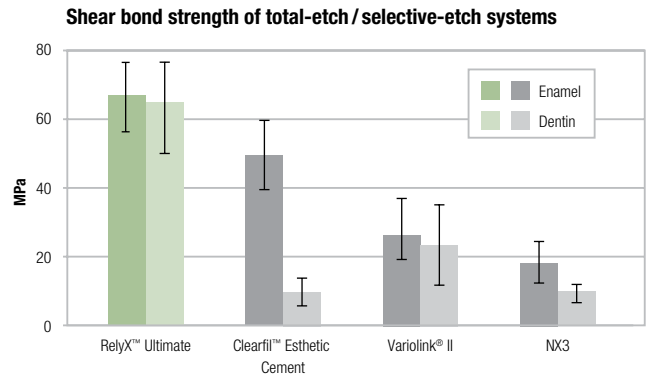
# 4 Bonding performance

## 4.1 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.



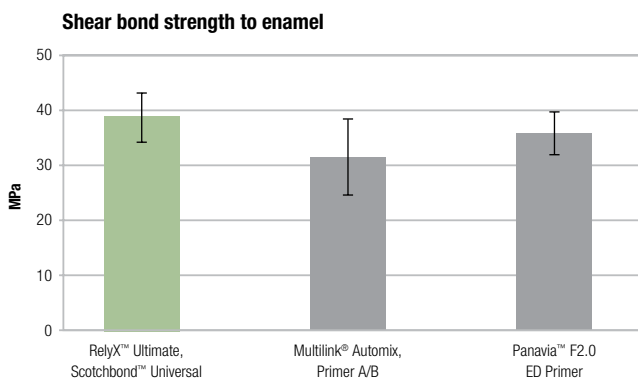
**Fig. 1:** Shear bond strength to dentin and enamel after artificial aging (5,000 thermocycles). RelyX™ Ultimate was used with Scotchbond™ Universal, the other cements with their respective adhesive. Source: 3M ESPE internal data



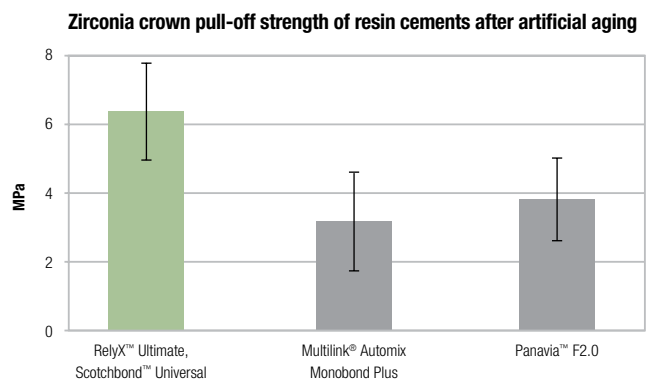
**Fig. 2:** Shear bond strength to dentin and enamel after artificial aging (5,000 thermocycles). RelyX™ Ultimate was used with Scotchbond™ Universal, the other cements with their respective adhesive. Source: 3M ESPE internal data

In independent research, RelyX Ultimate 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. 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 was used with Scotchbond™ Universal (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 when compared to traditional adhesive resin systems that use etching, priming and bonding. The researchers used RelyX Ultimate 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), were pretreated with Scotchbond™ Universal as silane, the feldspathic ceramic after HF etching and the RNC after just sandblasting.

#### Microtensile bond strength to dentin and restoration materials

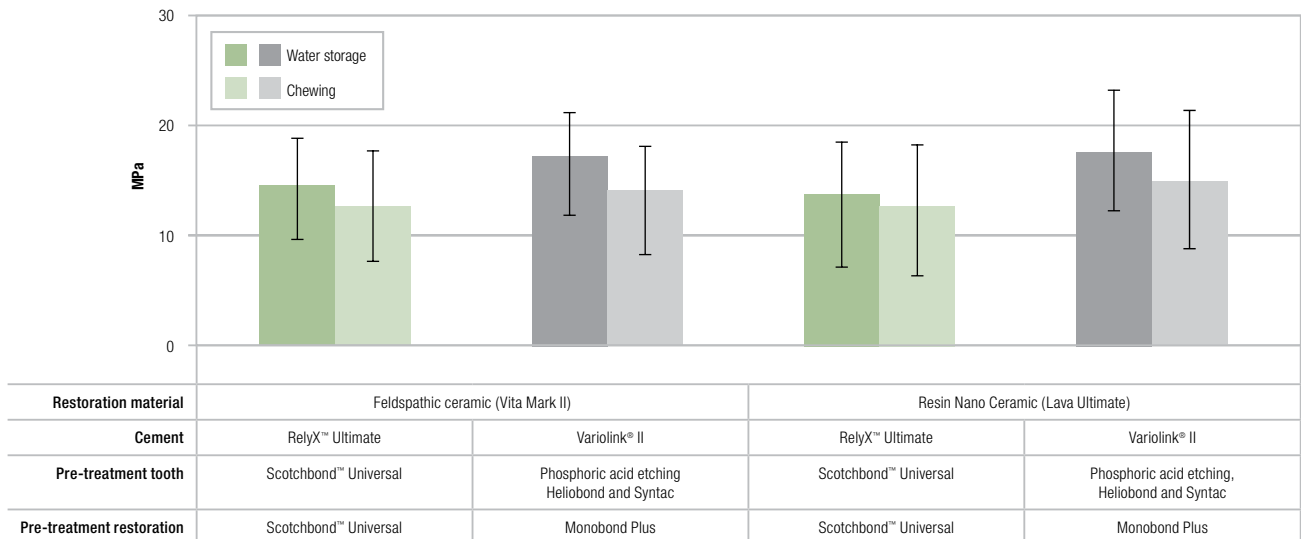


Fig. 5: Microtensile bond strength to dentin after water storage or artificial aging (chewing simulation 50N, 240,000 cycles). Different restoration materials were used to create the specimen in order to evaluate a potential influence. Source: L. Breschi, G. Turco, A. Frassetto, M. Cadenaro, University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

## 4.2 Bond to restoration

High bond strength and esthetics predestine RelyX Ultimate 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. To simplify the cementation procedure, Scotchbond Universal was used as silane replacement for all types of etchable ceramics tested.

#### Shear bond strength of RelyX™ Ultimate to etchable ceramics – before and after artificial aging

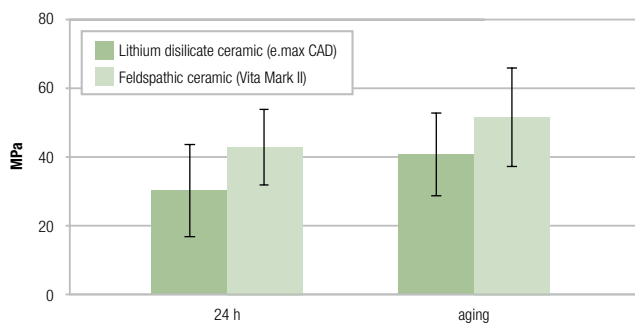


Fig. 6: Vita Mark II and e.max CAD were etched with HF according to manufacturers' instructions before silanization with Scotchbond™ Universal, all cements light cured. Artificial aging: 5,000 thermocycles (5 – 55 °C). Source: M. Rosentritt, University of Regensburg, Germany

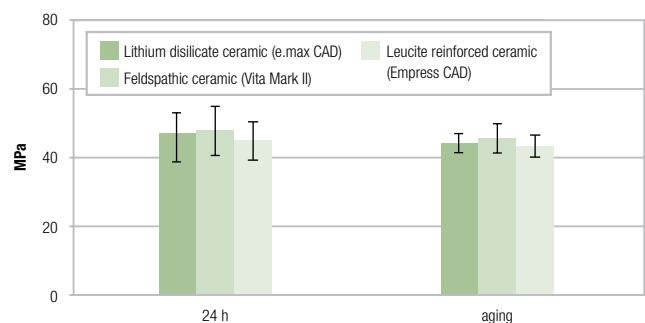
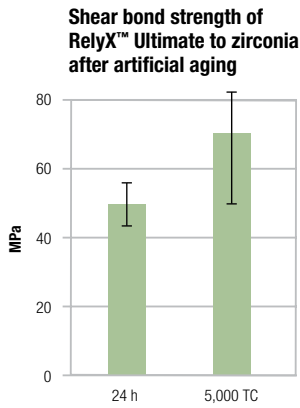


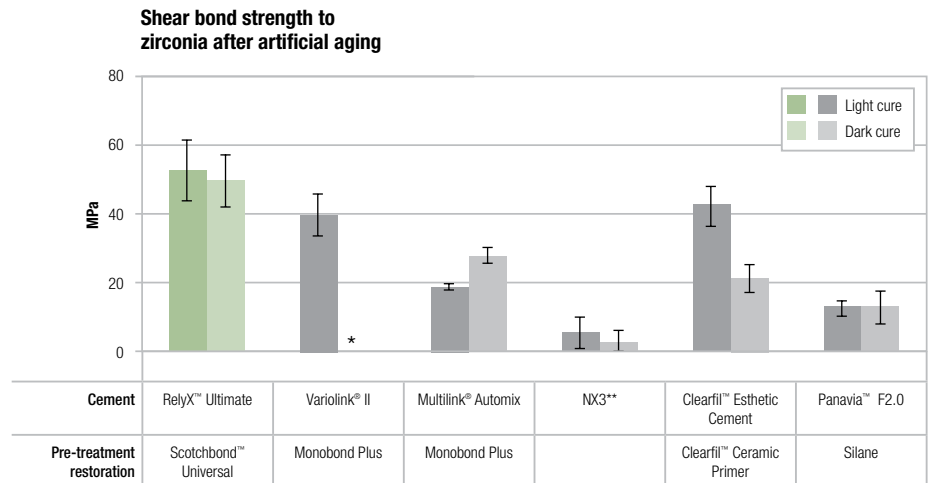
Fig. 7: All-ceramic materials were etched with HF according to manufacturers' instructions before silanization with Scotchbond™ Universal, all cements light cured. Artificial aging: 5,000 thermocycles (5 – 55 °C). Source: 3M ESPE internal data



The University of Regensburg showed extremely high bond strength to oxide ceramic restoration material for RelyX™ Ultimate, 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.



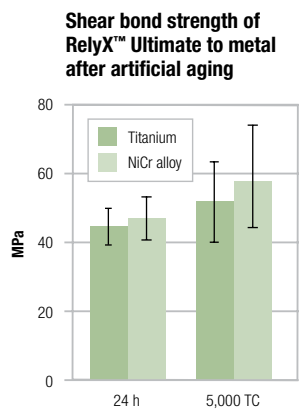
**Fig. 8:** RelyX™ Ultimate was used with Scotchbond™ Universal (left uncured). Cercon Zirconia was sandblasted (50 µm, 2.5 bar) before priming, cement light cured. Artificial aging: 5,000 thermocycles (5 – 55 °C). Source: M. Rosentritt, University of Regensburg, Germany



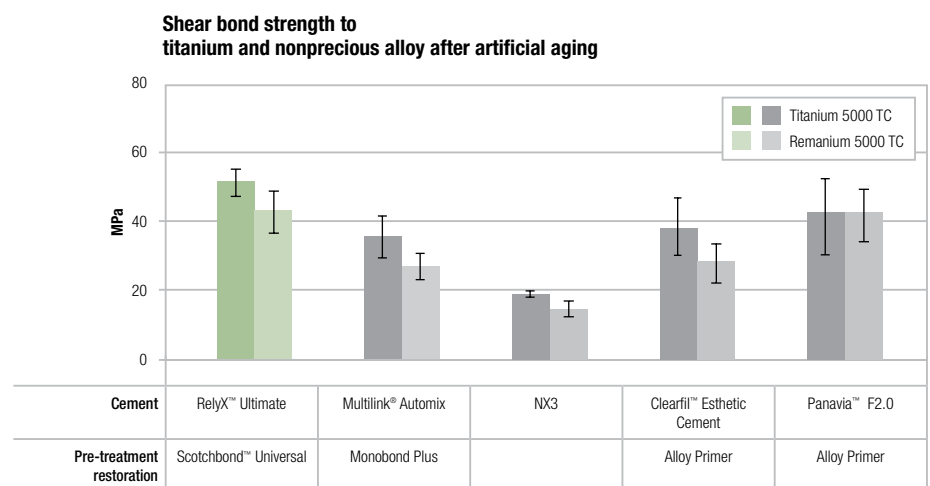
**Fig. 9:** RelyX™ Ultimate was used with Scotchbond™ Universal as primer (left uncured), the other materials were used with their respective primers if indicated by manufacturer. Cements were light cured or dark cured. Lava™ Zirconia was sandblasted (50 µm, 2.5 bar) before priming. Source: 3M ESPE internal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



**Fig. 10:** RelyX™ Ultimate was used with Scotchbond™ Universal (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













**Fig. 11:** RelyX™ Ultimate 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

# 5 Optimized properties for long-lasting esthetics

## 5.1 Fluorescence

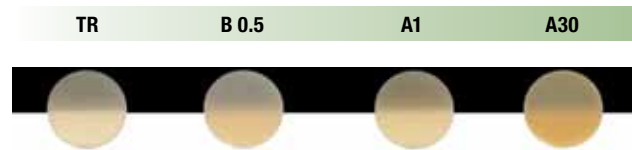
RelyX™ Ultimate takes advantage of a modern initiator technology, which is free of aromatic amine initiator components that lead to discoloration. It enables dual curing, while at the same time guaranteeing long term color stability of the cement. As a result of its color stability, the cement is suited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

### Fluorescence of cements in comparison

	10 % UV	90 % UV
Human Tooth		
RelyX™ Ultimate		
Panavia™ F 2.0		
NX3		
Clearfil™ Esthetic Cement		

Source: 3M ESPE internal data

### Available shades of RelyX Ultimate











Photos of RelyX™ Ultimate samples (1.5 mm thickness). Source: 3M ESPE internal data



## 5.2 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 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.

### Color stability of cements in comparison

	Before	Coffee
RelyX™ Ultimate		
Panavia™ F 2.0		
NX3		
Multilink® Automix		

Source: 3M ESPE internal data

### 5.3 Marginal sealing

Behr *et al.* (University of Regensburg, Germany) investigated the marginal integrity of Empress 2 MOD inlay restorations luted with RelyX™ Ultimate. 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 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 %.



Fig. 12: RelyX™ Ultimate sample of dye penetration test, no penetration of fuchsine solution into dentin or interface.

### 5.4 Wear resistance

An esthetic restoration requires marginal integrity. RelyX Ultimate 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 shows very low three-body wear. It only abrades 0.5 times more than the reference hybrid filling composite Filtek™ Z250 (3M ESPE).

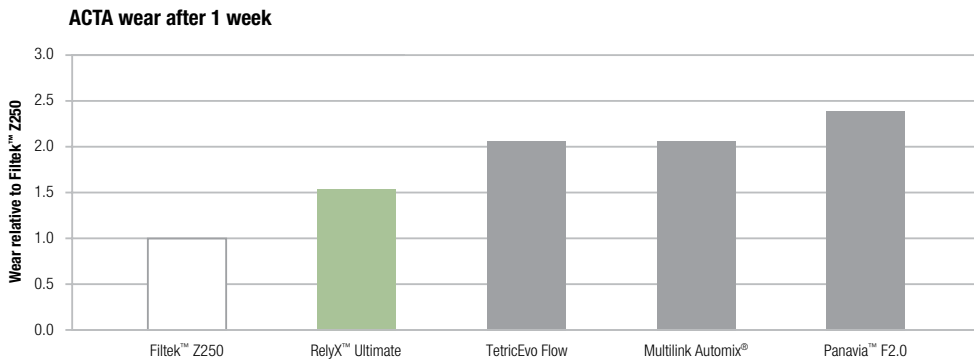


Fig. 13: ACTA three body wear test. Material abrasion calculated relative to Filtek™ Z250 (3M ESPE). Source: C. Kleverlaan, ACTA University, Netherlands

# 6 Clinical results and recommendations

## 6.1 Clinical results

More than 3,700 restorations were placed with RelyX Ultimate 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.

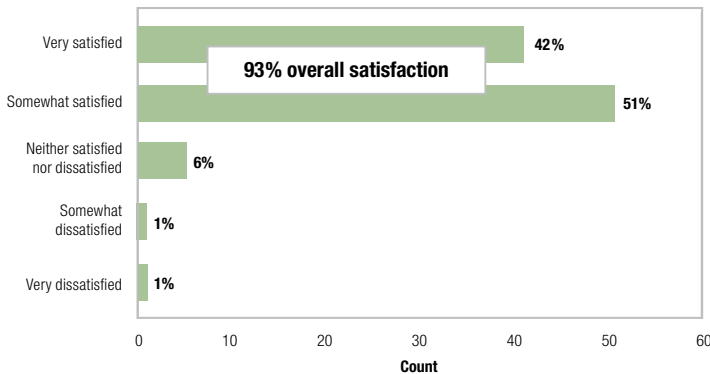


Fig. 14: General satisfaction with RelyX™ Ultimate (left) (Due to rounding errors the sum can slightly differ from 100 %). Source: Field evaluation EU conducted by 3M ESPE

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

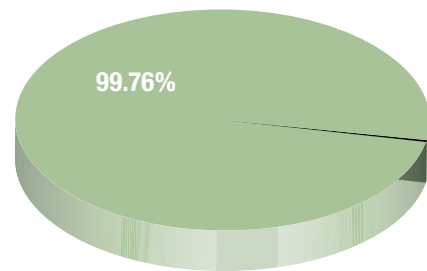


Fig. 15: Post-operative sensitivity rate. Source: Field evaluation EU conducted by 3M ESPE

## 6.2 Restoration pre-treatment

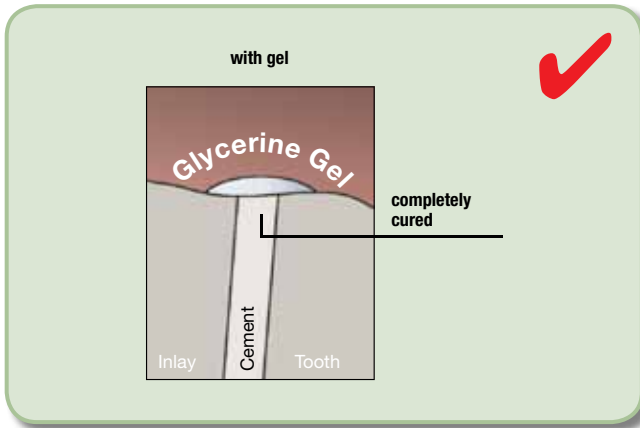
**Scotchbond™ Universal adhesive as universal restoration primer – This greatly simplifies your daily routine:**

Restoration material	Pre-treatment recommendation for <b>clean</b> surface	
<b>Glass ceramic</b> etchable feldspathic, leucite reinforced and lithium disilicate	<b>Step 1:</b> etching with hydrofluoric (HF) acid <b>Step 2:</b> Scotchbond Universal adhesive	
<b>Zirconia and Alumina</b> (oxide ceramics, non- etchable, high strength) <b>Composite,</b> <b>Metal, PFM, RNC</b>	<b>Step 1:</b> Sandblasting (< 50 µm) <b>Step 2:</b> Scotchbond Universal adhesive	
<b>Fiber reinforced composite post</b>	Scotchbond Universal adhesive	

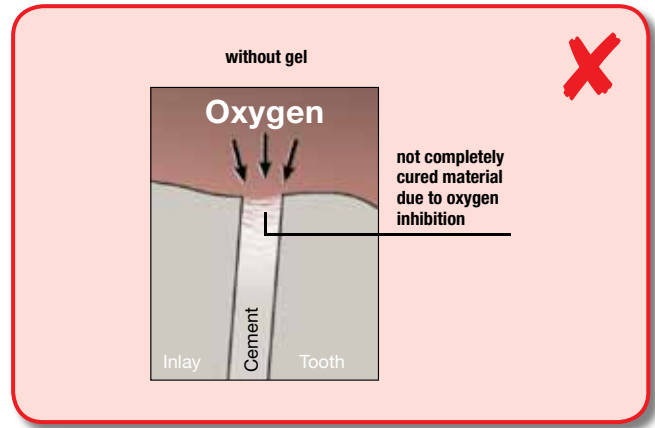
### 6.3 Recommended procedures to achieve excellent margins with resin cements

For best esthetic results remove excess cement immediately with a sponge pellet and then cover the exposed margins with glycerin gel. Coverage of the cement with glycerin gel as air block ensures the complete polymerization of the cement surface. Oxygen can inhibit curing at the surface. A cement that is not fully polymerized could absorb water which might result in increased opacity or staining. Additionally, the mechanical properties will be compromised which could result in washouts and poor marginal integrity.

#### recommended

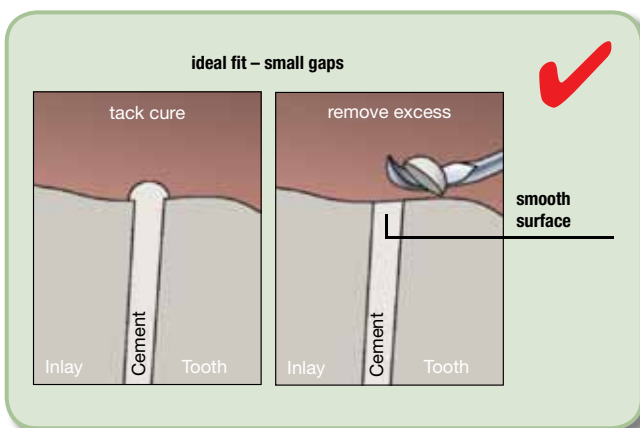


#### not recommended

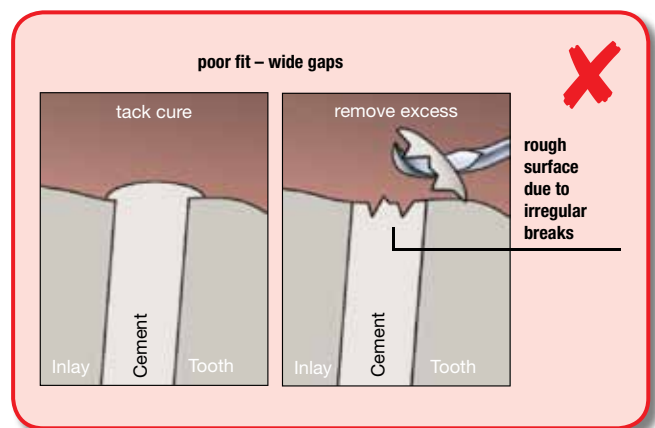


For faster results we recommend initial curing before excess removal: either light cure briefly (tack cure, approx. 1 sec.) or allow dark curing for about 1 min. in the mouth. To achieve long-term high marginal esthetics with this technique well fitting restorations are mandatory. Small gaps enable a clean break of the cement at the margin. Big gaps can result in irregular breaks which can create white lines. The optical effect of white lines occurs due to unequal light scattering. Over time plaque build-up on the rough surfaces could cause additional discoloration.

#### recommended



#### not recommended



Therefore, careful removal of excess cement followed by thorough final polishing helps to avoid discolorations. Cement or adhesive accidentally spread onto uncut enamel can also lead to different light scattering and become perceptible as white or discolored lines.

# 7 Clinical case

## Cementation of two glass ceramic inlays

Dr. Dr. Andreas Syrek, Seefeld, Dentallabor Elke Sallinger, Krailing



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 directly into the cavity using the intraoral tip.



13. After seating the inlays excess cement is removed using a sponge pellet.



14. Interproximally, a dental floss is used to remove excess cement.



15. Applying glycerin gel to the cement margin to prevent oxygen inhibition and maximize marginal quality.



16. Light curing the cement with the glycerine gel in place using Elipar™ S10 curing light from 3M ESPE (20 sec./surface).



17. Polishing the cement margins.



18. High-quality, highly esthetic glass ceramic restorations after two weeks in place.

## 8 Summary of physical and mechanical properties

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

Properties	RelyX™ Ultimate (Ic)
Flexural strength [MPa]	98
Compressive strength [MPa]	262
Modulus of elasticity [GPa]	7.7
Surface hardness (HV 0.2)	40
Film thickness [µm]	12
Water sorption [µg/mm <sup>3</sup> ]	21
Solubility [µg/mm <sup>3</sup> ]	0
Expansion after 1 month [%]	0.5



## **3M** ESPE

### **3M Health Care**

3M Australia Pty Limited  
ABN 90 000 100 096  
Building A, 1 Rivett Rd  
North Ryde NSW 2113  
Ph: 1300 363 454  
[www.3MESPE.com.au](http://www.3MESPE.com.au)

### **3M Health Care**

3M New Zealand Limited  
94 Apollo Drive  
Rosedale  
Auckland 0632  
Ph: 0800 80 81 82  
[www.3MESPE.co.nz](http://www.3MESPE.co.nz)

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