kuraray

Noritake

ADVANCEMENTS IN ADHESIVE TECHNOLOGY:

CLEARFIL™ Universal Bond Quick 2

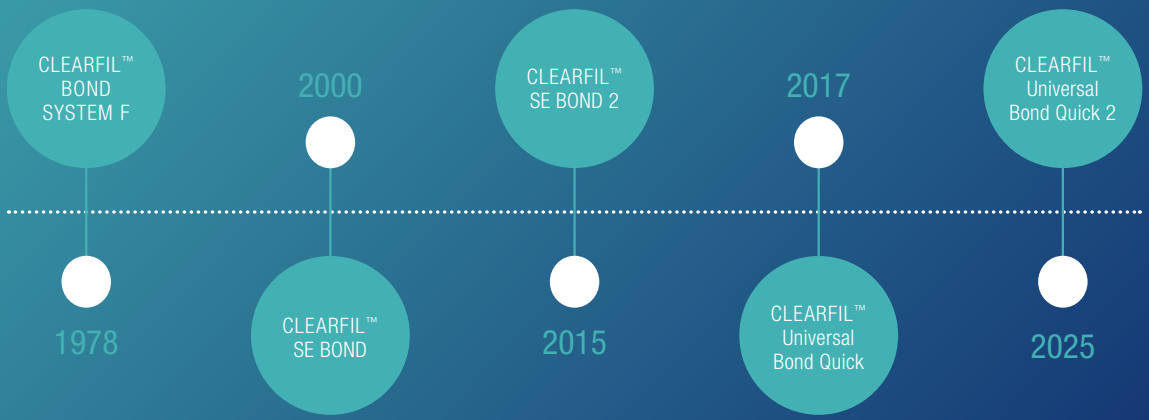
WELL-EQUIPPED FOR SUCCESS

INTRODUCTION

Adhesive dentistry has seen significant advancements over the past decades. Initially, dental adhesives evolved from no-etch systems to etch-and-rinse systems, which consisted of multiple components. From then on, manufacturers shifted focus toward simplifying the procedure. Different generations of self-etch adhesives and, finally multi-mode or universal adhesives were the result. The latter category, introduced in the early 2010s, nowadays comprises numerous products offered by many different manufacturers.

In general, universal adhesives offer more procedural freedom and simplicity than multi-step, multi-bottle systems as well as good adhesion. According to a recent review[1], adhesive properties have improved and manufacturers have also succeeded in reducing the technique sensitivity of the adhesive systems. However, hybrid layer degradation still seems to be a relevant issue for many modern products available on the market. Moreover, feedback from clinicians reveals that there are several areas of concern where bonding systems in general can be improved. These include the risk of contamination due to a lengthy procedure or the need for rubbing, pooling of the adhesive in corners and accumulation along margins. Moreover, some adhesives are challenging to introduce into narrow cavities, while their curability may be limited.

That is why Kuraray Noritake Dental Inc. decided to develop a new-generation universal adhesive that addresses these areas of concern: CLEARFIL™ Universal Bond Quick 2. This latest evolution in dental bonding technology is based on decades of knowledge in the development of clinically successful dental adhesives at Kuraray Noritake Dental Inc. It retains all the benefits of its predecessor – the current extensively tested and clinically proven CLEARFIL™ Universal Bond Quick – adding higher strength and improved handling.[2-5]



THE ESSENTIAL BENEFITS OF CLEARFIL™ Universal Bond Quick 2

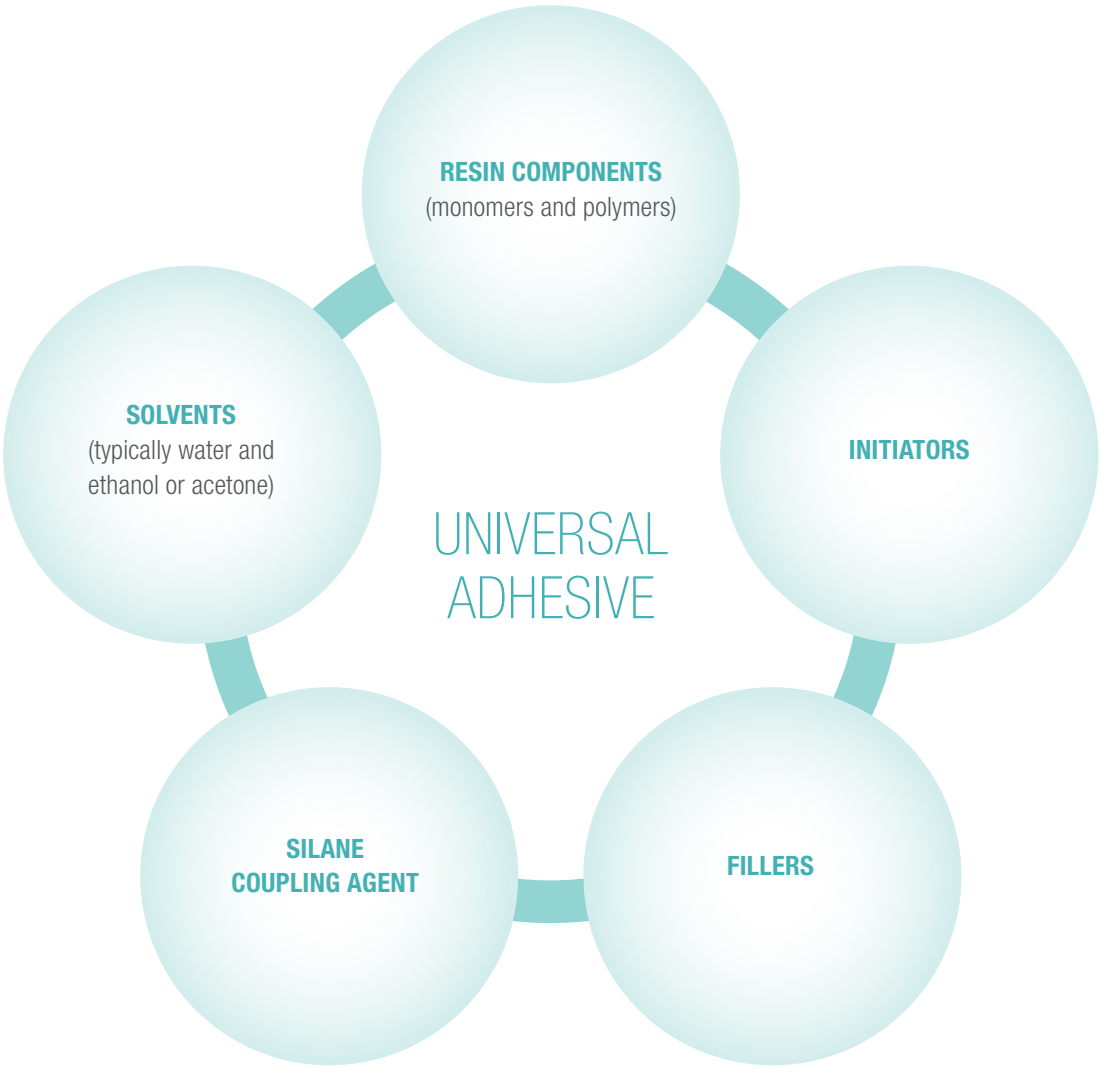
CLEARFIL™ Universal Bond Quick 2 offers the following essential benefits:

- Quick and straightforward application procedure
- High-strength bonding layer
- Consistently durable bond
- Ease of application
- Minimised risk of pooling
- Procedural freedom
- Immediate availability for clinical use

For all those who wonder how the improvements were implemented, which technologies are responsible for them and whether there is scientific proof, the following paragraphs are worth reading. They summarize essential general knowledge about adhesive formulations, explain potential issues and their causes, and address every benefit featured by CLEARFIL™ Universal Bond Quick 2, explaining all the important details around it.

KEY COMPONENTS OF UNIVERSAL ADHESIVES

Universal adhesives are based on highly complex formulations with many different constituents and technologies combined in a single bottle. The most essential parts found in virtually every universal adhesive are:



RESIN COMPONENTS

Just like composite restorative materials, **dental adhesives are resin-based materials. This means that different kinds of cross-linking and functional monomers are the beating heart of the formulation.** Functional monomers are initially hydrophilic and form linear polymers upon curing, while cross-linking polymers are hydrophobic and form stronger, highly cross-linked polymer networks.[6] They are added to adhesive formulations to fulfil different tasks: some monomers are used to promote adhesion to tooth structure or composite resin, while others are used as etching or demineralising agents, wetting enablers, and agents promoting penetration into the tooth structure. Hence, they have an impact on application properties, bond strength to various substrates including enamel and dentin, strength, hydrolytic stability and overall durability of the bonding layer, and more.

INITIATORS

To provide for a high strength of the adhesive layer and a favourable degree of conversion, dental adhesives are typically cured before the composite is applied. **Universal adhesives contain a photo initiator that sets off the radical polymerisation reaction when light of a specific wavelength is absorbed.** Chemical initiators are found in self- or dual-cure resin cements, but not in single-bottle adhesives. Studies have revealed that the initiator concentration has an impact on the mechanical properties of the materials they are part of [6,7].

FILLERS

Unlike composite restorative materials, which are always filled, dental adhesives may or may not contain fillers. **Fillers are usually added for two main reasons: to increase the viscosity of the adhesive and to strengthen the adhesive layer. The viscosity has a direct impact on the thickness and quality of the adhesive layer.** If the viscosity is too low, the risk increased of some areas of the tooth structure remaining uncovered resulting in an incomplete adhesive layer. In addition, an overly thin adhesive layer may be weak due to the inhibition of oxygen, which prevents proper curing of the contained resin[6]. If the viscosity is too high, however, application into the root canal and deep Class II cavities is often difficult thus increasing the risk of pooling or adhesive accumulation along margins. Moreover, air-blowing and complete solvent evaporation may also prove challenging.

SILANE COUPLING AGENT

A silane coupling agent is usually part of the formulation as well. They are the link between the resin matrix and the filler particles in the formulation and offer protection against degradation.

SOLVENTS

Solvents – typically water and ethanol or acetone – are essential parts of adhesive formulations. This is because dentin only bonds well to hydrophilic materials. **Together with the hydrophilic monomers found in the formulation, the solvents provide for an environment favourable for dentin bonding[6].** Moreover, their task is to re-expand the collapsed collagen fibrils on the demineralized dentin surface. Most modern dental adhesives contain water and ethanol as solvents. However, ethanol cannot be used in combination with certain types of monomers.

CHEMISTRY IMPROVEMENTS ENABLING THE ESSENTIAL BENEFITS

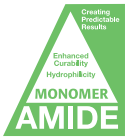
There are certain components and technologies, like monomers and monomer combinations, which are used by various dental industry manufacturers in their universal adhesives. While some certainly offer advantages, potential drawbacks lie in their toxicity in the uncured state, possible unwanted interactions with other components and the like.

Many of the essential benefits of CLEARFIL™ Universal Bond Quick 2 are due to improvements or changes in those key components. Specifically, the resin formulation and the filler technology have been altered to provide for higher strength and an improved handling. The following paragraphs will describe the changes, the key components used and the benefits arising from them.

1. RESIN TECHNOLOGY: QUICK AND STRAIGHTFORWARD APPLICATION PROCEDURE

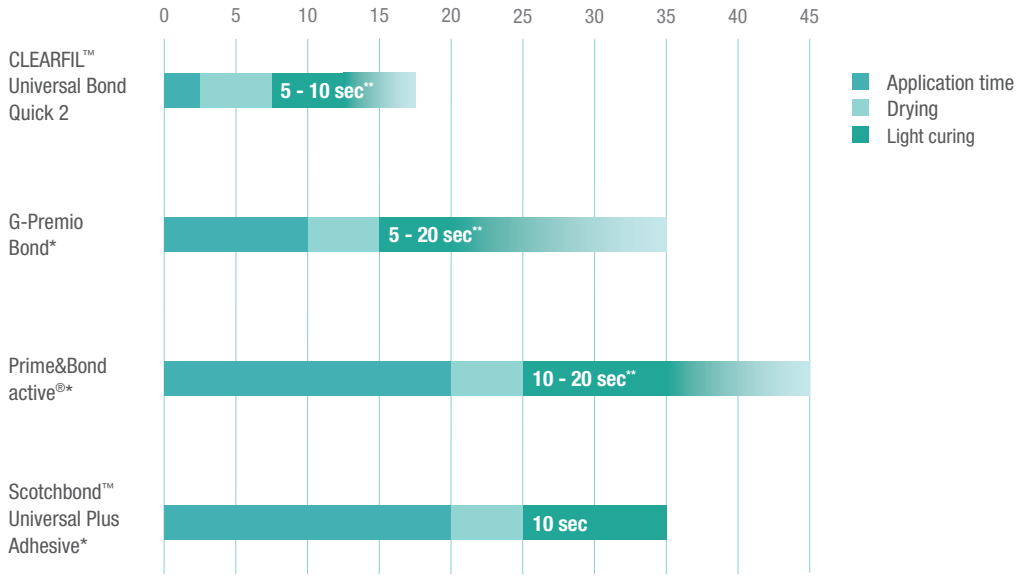
Adhesive penetration into the tooth structure is strongly influenced by monomers contained in the formulation. A monomer commonly used for this purpose is the highly hydrophilic hydroxyethylmethacrylate (HEMA)[6]. Although HEMA provides important benefits such as supporting homogeneous integration of components within the adhesive, its hydrophilic character – even after polymerization – may lead to water sorption, which can negatively influence the long-term mechanical properties of adhesive systems[8]. According to the results of an in-vitro study, high concentrations of HEMA in adhesive formulations may not only lead to poor mechanical properties (including bond strength), but also to a higher risk of bond degradation[9]. For these reasons, reducing the dependency on high levels of HEMA in universal adhesives and complementing it with alternative monomers is considered advantageous. However, this measure requires careful selection of the alternative monomer and precise alignment with the existing ingredients to prevent negative effects. In some cases, manufacturers have selected alternative monomers that lead to a lower bond strength or (unlike HEMA) lead to cytotoxic effects even after polymerisation[10].

In CLEARFIL™ Universal Bond Quick and the brand-new universal adhesive CLEARFIL™ Universal Bond Quick 2, Kuraray Noritake Dental Inc. have incorporated an amide monomer that significantly decreases the need for HEMA. In in-vitro tests, this monomer did not show any cytotoxic effects[10], while it is responsible for one of the essential benefits – the extremely quick and straightforward application procedure. It gives the adhesive its hydrophilicity in the initial, uncured state. During polymerisation, a stable, hydrophobic cross-linked network is formed. The network contributes to the durability of the bond, also thanks to its water-resistant property.



CLEARFIL™ Universal Bond Quick 2 takes just seconds to apply as there is no need to wait for the adhesive to penetrate the tooth structure. This feature was originally developed for its predecessor CLEARFIL™ Universal Bond Quick and was carried over as it turned out to work well[11] and has been very well received by clinicians from all over the world. Eliminating the need to wait after application speeds up the procedure, saves time and minimises the risk of contamination. This is particularly useful in situations where moisture control is a challenge or where a patient is impatient – e.g. in paediatric dentistry.

TREATMENT TIME COMPARISON (SEC.)



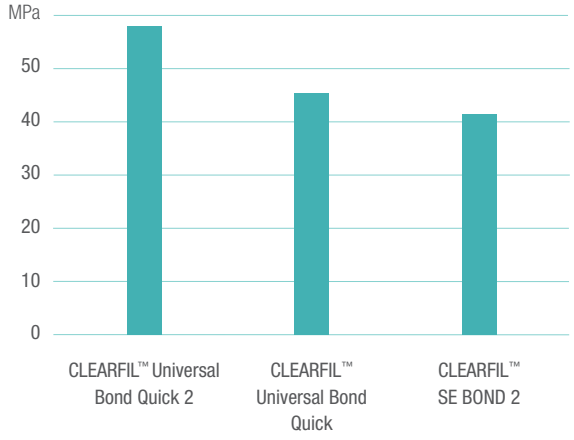
* Not a trademark of Kuraray Noritake Dental
** The indicated curing times are according to the respective manufacturer's recommendations and depend on the output of the curing light.
Source: Kuraray Noritake Dental

2. RESIN TECHNOLOGY: HIGH-STRENGTH BONDING LAYER

The stronger the bonding layer, the higher its resistance to shrinkage forces. Hence, it seems worth striving for a strong bonding layer to enhance the longevity of both bond and restoration. A popular strategy is the adding of cross-linking bi-or multi-functional monomers to the formulation[6,12]. While the most frequently used monomers added for this purpose are UDMA, Bis-GMA and TEGDMA, Kuraray Noritake Dental Inc. added the Urethane Tetra Methacrylate Monomer (UTMA) to add mechanical strength to the adhesive system.

UTMA is a functional monomer that, due to its multiple curable sites, provides for an increased strength of the bonding layer. Both nano-hardness and ultimate tensile strength are extraordinarily high. Consequently, the adhesive offers the desired increased resistance to shrinkage forces. Moreover, it forms a highly curable, thin bonding layer.

ULTIMATE TENSILE STRENGTH



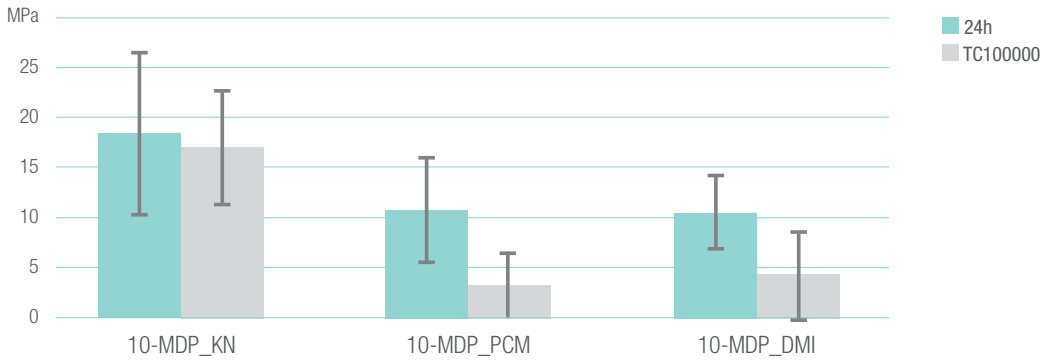
Test conditions:
Silicone mold beam-shape 1.0×1.0×10.0 mm
Light curing Of bonding materials
24 hours dry storage
Source: Dr. Hosaka (Tokushima University)

3. RESIN TECHNOLOGY: CONSISTENTLY DURABLE BOND

The third monomer forming the advanced rapid layer technology found in CLEARFIL™ Universal Bond Quick 2 is the proven functional acidic monomer invented by Kuraray Noritake Dental Inc.: **the Original MDP Monomer. MDP is not only well-known for its high affinity to hydroxyapatite, but also several other materials, including metals and zirconium oxide. In various studies, it has been proven to deliver an outstanding bonding performance over time**[13,14].

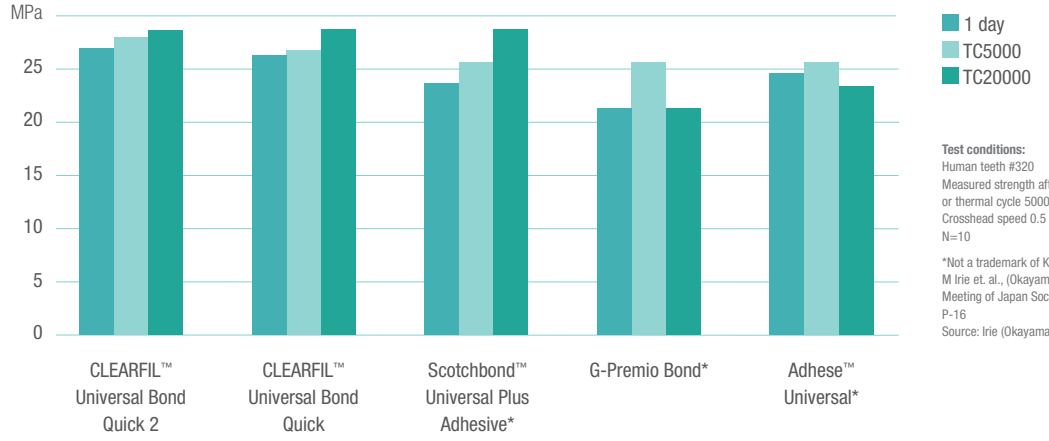
This applies specifically to the original MDP monomer produced by Kuraray Noritake Dental Inc. In a study, it was shown that the quality and performance of the functional monomer may be different depending on how it is produced: MDP from other manufacturers contained impurities and dimer, which had a negative effect on the bonding performance of the respective adhesives[15]. Only the original MDP monomer exhibited a high purity and contained no dimer, with better bonding outcomes.

MICRO-TENSILE BOND STRENGTH TO DENTIN [1]



1. Three experimental self-etch primers were prepared consisting of 15 wt.% 10-MDP provided by different sources: KN (Kuraray Noritake Dental), PCM (Germany) or DMI (Designer molecules Inc., USA). Data source: Yoshihara K, Nagaoka N, Okihara T, Kuroboshi M, Hayakawa S, Maruo Y, Nishigawa G, De Munck J, Yoshida Y, Van Meerbeek B. Functional monomer impurity affects adhesive performance. Dent Mater. 2015 Dec;31(12):1493-501.

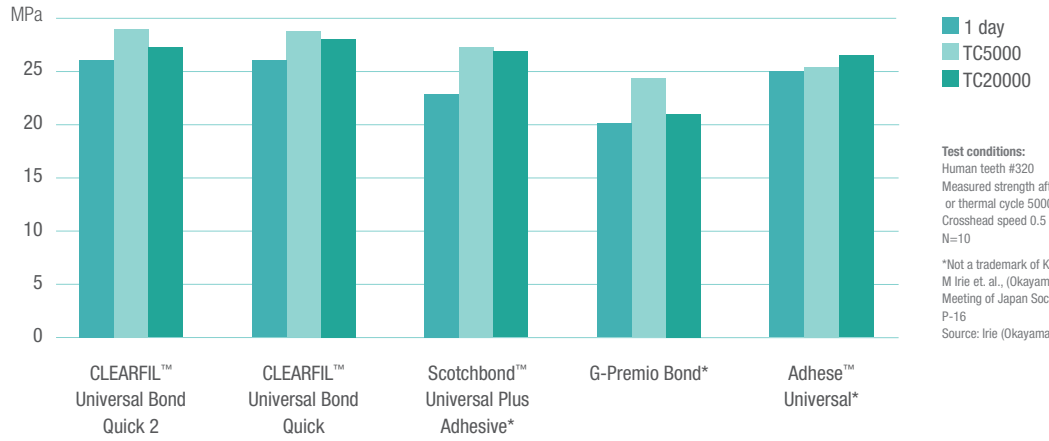
SHEAR BOND STRENGTH TO HUMAN ENAMEL



Test conditions:
Human teeth #320
Measured strength after 1 day of storage in 37°C water, or thermal cycle 5000 or 20000 times (5°C ⟷ 55°C).
Crosshead speed 0.5 mm/min
N=10

*Not a trademark of Kuraray Noritake Dental Inc.
M Irie et. al., (Okayama University.) The 42nd Annual Meeting of Japan Society for Adhesive Dentistry Poster P-16
Source: Irie (Okayama university)

SHEAR BOND STRENGTH TO HUMAN DENTIN



Test conditions:
Human teeth #320
Measured strength after 1 day of storage in 37°C water, or thermal cycle 5000 or 20000 times (5°C ⟷ 55°C).
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Source: Irie (Okayama university)

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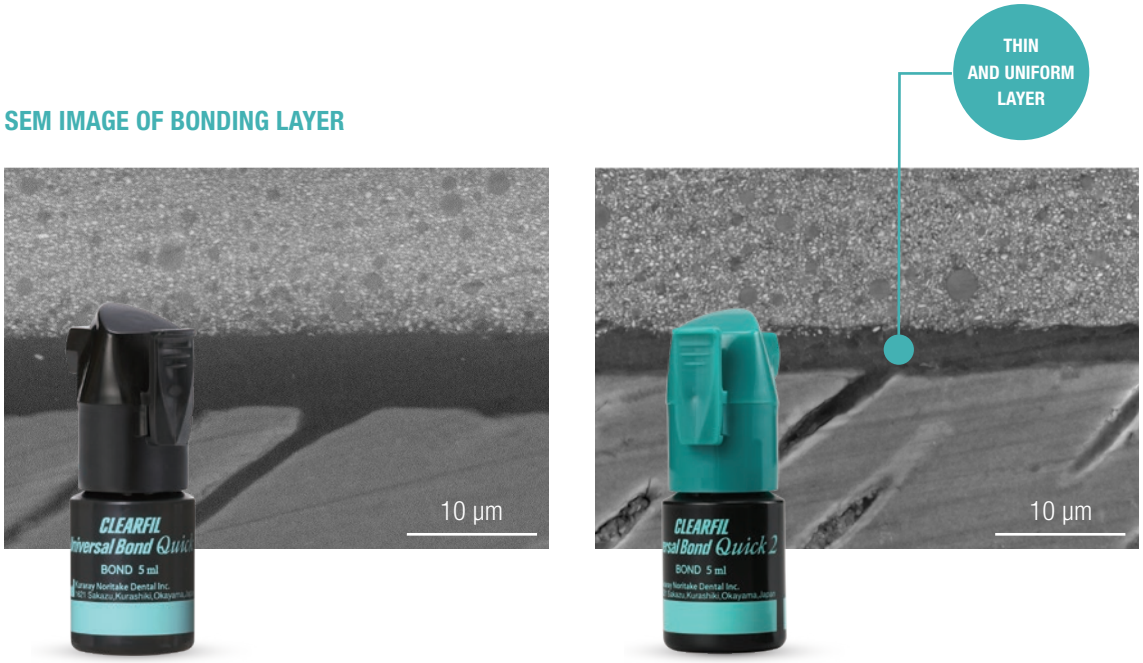
4. FILLER TECHNOLOGY: EASE OF APPLICATION

The flow properties of an adhesive are a critical factor: as mentioned earlier, **achieving an optimally formed and uniformly distributed adhesive film is essential for reliable clinical performance**. Moreover, the right flow properties improve the application procedure. To realize improved flow properties without altering the filler content (which might negatively influence the mechanical strength), Kuraray Noritake Dental Inc. has redesigned the filler dispersion method originally employed by the company. The new way of adding fillers and different monomers to the formulation leads to low filler agglomeration.

Consequently, CLEARFIL™ Universal Bond Quick 2 is very easy to apply. Its low viscosity allows the adhesive to flow effortlessly even into narrow or hard-to-reach areas, supporting precise placement and uniform coverage.

SEM IMAGE OF BONDING LAYER



Finally, air-blowing is easier to perform on a thin layer than when the layer is highly viscous and thick: The adhesive is evenly distributed and thinned out with a gentle stream of air. If performed correctly, this measure has a positive impact on bond stability and longevity according to scientific studies[8,16]. Despite an increased flowability, the filler content in CLEARFIL™ Universal Bond Quick 2 is similar to that of its predecessor CLEARFIL™ Universal Bond Quick in supporting the formation of a strong bond.

The low viscosity of CLEARFIL™ Universal Bond Quick 2 allows the adhesive to flow effortlessly even into narrow or hard-to-reach areas, supporting precise placement and uniform coverage.

5. FILLER TECHNOLOGY: MINIMISED RISK OF POOLING

The new filler dispersion method also enables the formation of a thin, uniform layer independent of the cavity shape. The formation of an undesirably thick bonding layer along the margins and adhesive pooling at the bottom of the cavity are clearly a thing of the past. This is particularly advantageous in the context of creating restorations in the aesthetic zone or cementation procedures employing Immediate Dentine Sealing (IDS).

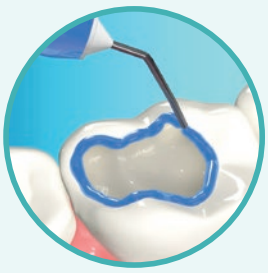
6. PROCEDURAL FREEDOM

CLEARFIL™ Universal Bond Quick 2 is universally applicable: It can be used in self-etch, selective etch and total-etch techniques and is thus suitable for many clinical situations and for all types of users independent of their personal preferences.

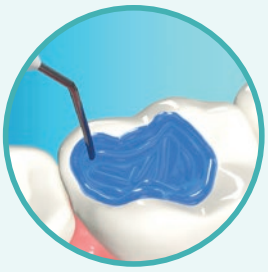
Moreover, it is approved for an extremely wide range of indications. Procedures are simplified as fewer bottles and fewer steps are required: The need for etching is eliminated, as is the need for a separate dual-cure activator when the product is used with other manufacturers' self-adhesive cements.

ALL ETCHING TECHNIQUES

Self-etch
(no phosphoric acid)



Selective-etch
(phosphoric acid on enamel)



Total-etch
(phosphoric acid on enamel and dentin)

CLEARFIL™ Universal Bond Quick 2 forms the connection between several universal resin-based products of Kuraray Noritake Dental Inc.'s portfolio:

SCAN FOR MORE INFORMATION ABOUT
CLEARFIL MAJESTY™ ES-2 Universal

SCAN FOR MORE INFORMATION ABOUT
CLEARFIL MAJESTY™ ES Flow Universal

SCAN FOR MORE INFORMATION ABOUT
PANAVIA™ SA Cement Universal

7. IMMEDIATE AVAILABILITY FOR CLINICAL USE

Due to the carefully selected components and their precise alignment, the chemistry found in CLEARFIL™ Universal Bond Quick 2 is highly stable. Filler particles are extremely unlikely to agglomerate, and the novel formulation allows for storage at room temperature. This is a big advantage, as it provides for the fact that the product is always ready for use and readily available. **The formulation of CLEARFIL™ Universal Bond Quick 2 is optimised so that it may be stored at temperatures between 2 and 25° C (36-77°F).**

CLINICAL WORKFLOWS

Explore the clinical videos demonstrating how CLEARFIL™ Universal Bond Quick 2 can be seamlessly integrated into different workflows.

DIRECT RESTORATION WORKFLOW

CLEARFIL™ Universal Bond Quick 2 +
CLEARFIL MAJESTY™ ES-2 Universal

DIRECT RESTORATION WORKFLOW

CLEARFIL™ Universal Bond Quick 2 +
CLEARFIL MAJESTY™ ES Flow Universal (Super Low)

DIRECT RESTORATION WORKFLOW

CLEARFIL™ Universal Bond Quick 2 +
CLEARFIL MAJESTY™ ES Flow Universal (Low)

POST CEMENTATION & CORE BUILD-UP WORKFLOW

CLEARFIL™ Universal Bond Quick 2 +
CLEARFIL™ DC CORE PLUS

HOW TO CEMENT INDIRECT RESTORATIONS

CLEARFIL™ Universal Bond Quick 2 +
PANAVIA™ SA Cement Universal

HOW TO SEAL A PREPARED ABUTMENT TOOTH

CLEARFIL™ Universal Bond Quick 2

SCAN FOR MORE INFORMATION

CONCLUSION

Kuraray Noritake Dental Inc. is committed to continuous improvement in dentistry. With the ultimate goal of making dental professionals' lives easier and patients happier, the company combines research, development and innovation with Japanese perfection to introduce products that make all the difference.

Decades of experience and access to highly developed adhesive technologies enable the team of researchers to develop new adhesive formulations with well-balanced properties like CLEARFIL™ Universal Bond Quick 2. The product handles well, is based on proven components and adds decisive innovative technologies to provide for an even better bonding performance and straightforward application.

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- Before using this product, be sure to read the Instructions for Use supplied with the product.
- The specifications and appearance of the product are subject to change without notice.
- Printed color can be slightly different from actual color.

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