

**kuraray**

*Noritake*

# BOND

NEWSLETTER  
FOR  
PROFESSIONALS  
IN DENTISTRY

VOLUME 2 | 04/2017



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Universal  
Bond Quick**

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**New Zirconia  
KATANA™**

Digital Concept

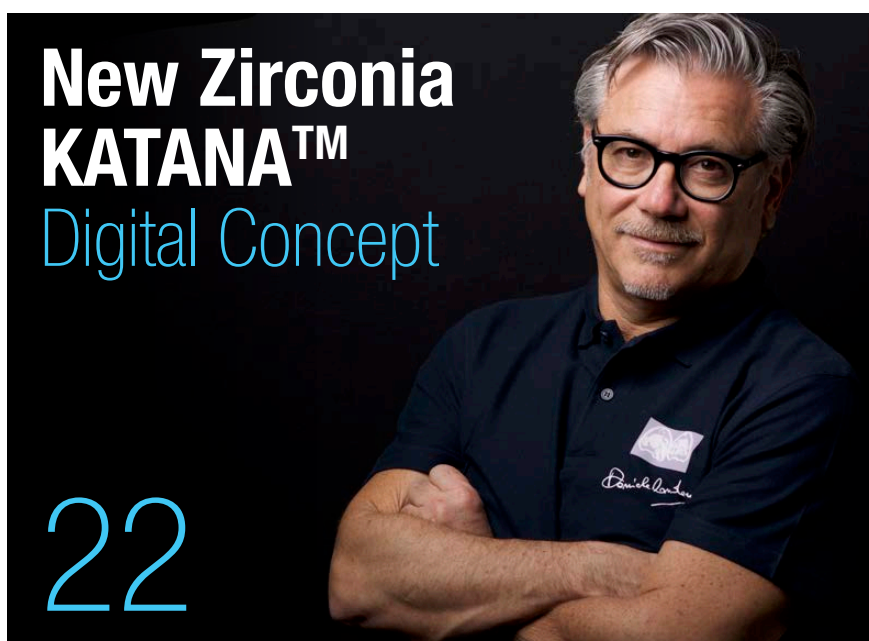
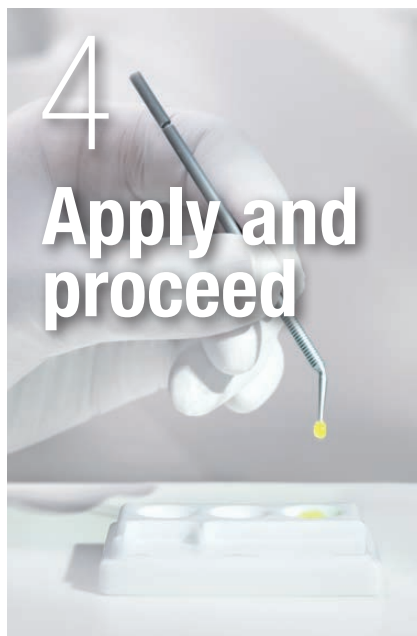
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**Creating  
values**

for customers

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# The perfect world according to Kuraray

**In an ideal world, dental products would be easy to use, less technique-sensitive and deliver a one-hundred-per-cent predictable outcome every time. Although Kuraray Noritake Dental can't offer you the 'perfect world' we can get close by developing innovative, advanced products that are far less technique-sensitive and result in a much more predictable outcome.**

Take our brand new adhesive system CLEARFIL™ Universal Bond Quick, for example. Application is simple and straightforward with no vague instructions like 'apply 2 to 3 layers' or 'wait at least 20 seconds'. With CLEARFIL™ Universal Bond Quick, there is no waiting time and no need for extensive rubbing or multiple layers. Dentists simply apply, dry and light cure – or 'Apply and Proceed' as we like to refer to it. This issue is dedicated to CLEARFIL™ Universal Bond Quick and gives you a full insight into the development of this next generation bond.

Kuraray Noritake Dental has always set great store by the opinion of independent scientists, researchers and universities from across the globe. For us it's important that this is a two-way process in that our R&D division gathers ground-breaking research and then shares it with others. For example the 2016 Kuraray Noritake Expert Symposium in Frankfurt welcomed more than 60 leading experts from across Europe participating in an inspiring full-day session which included presentations and in-depth discussions on the latest advances in adhesive and composite technology. You can read a full report in this newsletter.

A rapidly-growing area of prosthetic dentistry is multi-layered zirconia. Kuraray Noritake Dental introduced multi-layered zirconia under the KATANA™ brand in 2014. Since then KATANA™ has gone from

strength to strength as more and more dental professionals have discovered its benefits. The recently launched UTML (Ultra Translucent Multi Layered) offers a flexural strength of almost 600 MPa together with unsurpassed translucency and aesthetics, and is available in variety of colours and disc sizes. KATANA™ is now the world's leading brand of multi-layered zirconia.

The cementing of zirconia is still a controversial topic in dentistry. Can zirconia be adhesively cemented? Back in the early 1990s Professor Kern of Kiel University demonstrated how, when it comes to adhesion to zirconia, the PANAIA™ which contains MDP monomer delivers outstanding results. The latest version - PANAIA™ V5 - contains the high-purity original MDP monomer with excellent adhesion to a wide range of materials from glass and ceramics to metals, composites and, of course, zirconia.

We highly recommend the combination of KATANA™ with PANAIA™ V5 which has been developed through our R&D philosophy of drawing on world-leading independent research and then putting it into practice. Like all Kuraray Noritake Dental products, PANAIA™ V5 is straightforward to apply, ensuring that dental procedures are carried out to the highest standards and with the most predictable outcomes. The 'ideal world' is getting closer!



**Joost Nederkoorn**  
Head of European Marketing

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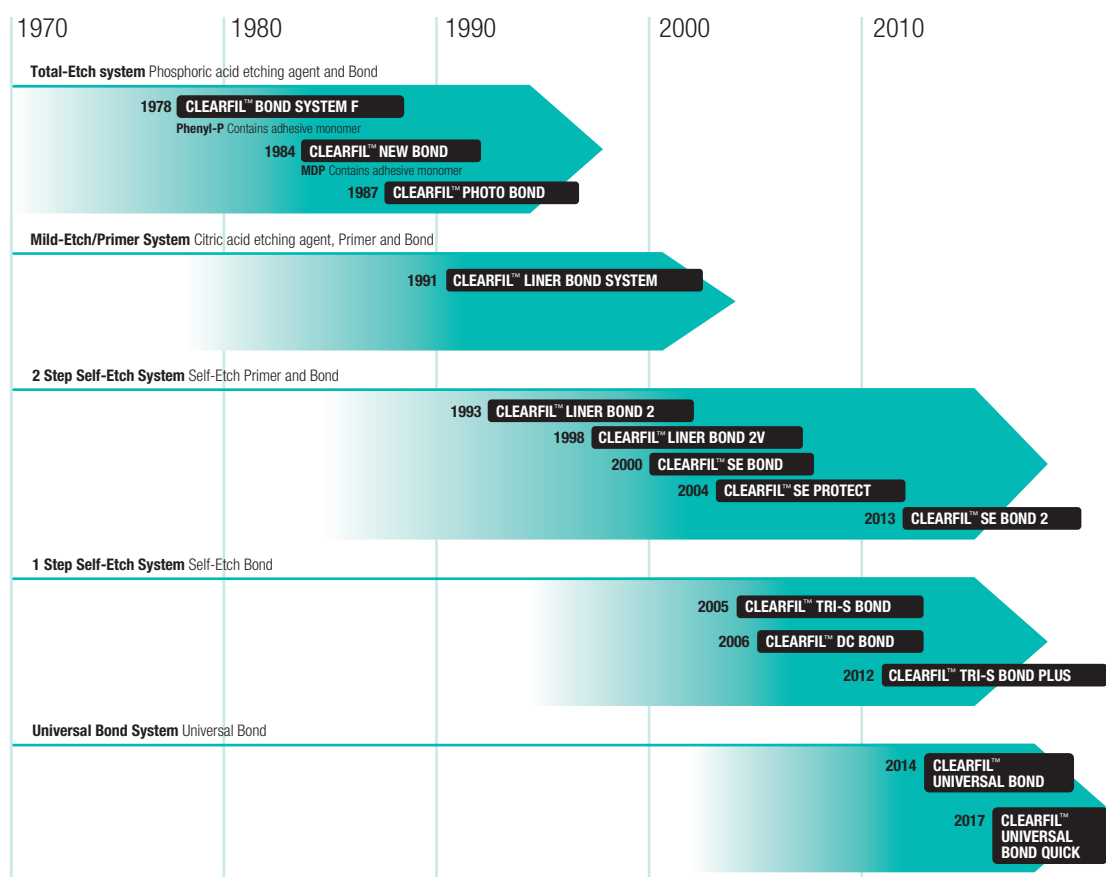




CLEARFIL™ Universal Bond Quick. Apply and proceed

# Development of One Step Self-etch

In 2005 Kuraray developed the first one-step self-etch adhesive CLEARFIL™ TRI-S BOND the aim of which was to deliver ease of use. This simplified adhesive didn't cause phase separation meaning that the adhesive mixture stayed homogenous over time. Thanks to a unique proprietary technology both primer and bonding agent functions of CLEARFIL™ SE BOND were incorporated into one bottle.





The natural successor of CLEARFIL™ TRI-S BOND was the even more advanced CLEARFIL™ TRI-S BOND PLUS which incorporated a new photo-initiator for enhanced curing, along with sodium fluoride for fluoride release. This self-etching adhesive demonstrated improved bond strength and physicochemical quality. Moreover, in addition to direct restorations, it can be used without a separate activator for core build-up restorations in combination with CLEARFIL™ DC CORE PLUS.

### NEXT STEP IN BONDING AGENTS

Advances in modern bonding technology have also led to a reduction in the number of components required in the total-etch and self-etch process. However despite this, the basic handling of adhesives has seen little change. Rubbing or waiting and refreshing liquid or application of multiple layers are still required. Also, in order to avoid sub-standard restorations, dentists still have to follow specific and very precise instructions. In answer to this problem, Kuraray Noritake Dental have come up with a solution: CLEARFIL™ Universal Bond Quick, an adhesive which is:

1. Less technique-sensitive than existing one-step materials on the market.
2. Offers long lasting sealing of the cavity and durability.
3. Has high bond strengths.
4. Offers all the other advantages of a universal bond.

When it comes to simple application and outstanding results, CLEARFIL™ Universal Bond Quick takes bonding agents to an entirely new level.

### A GAME CHANGER

CLEARFIL™ Universal Bond Quick is the latest and most innovative bonding agent from Kuraray. It's a universal bonding agent that works instantly. No waiting, no multiple layers, no extensive rubbing. Instead, CLEARFIL™ Universal Bond Quick uses Kuraray Noritake Dental's unique rapid bond technology to achieve a lasting bond strength in one simple procedure.

CLEARFIL™ Universal Bond Quick produces consistent results with optimum adhesion, reliably bonding all direct restorations, core build-ups and even indirect restorations and repairs.

Unlike other one-bottle universal adhesives which utilize 'slow monomers' that need time to penetrate the dentin, there's no need to wait before you proceed.

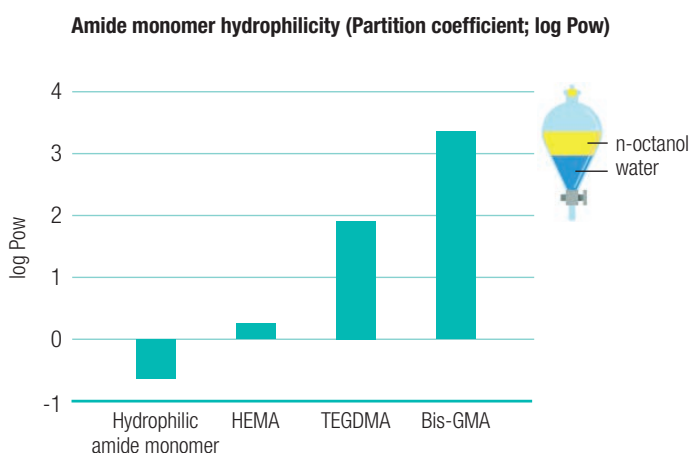
You simply apply, dry and light cure. That's all.

\* APPLY with a rubbing motion and PROCEED

CLEARFIL™ Universal Bond Quick

# Rapid bond technology

In 2005 Kuraray developed the first one-step self-etch adhesive CLEARFIL™ TRI-S BOND the aim of which was to deliver ease of use. This simplified adhesive didn't cause phase separation meaning that the adhesive mixture stayed homogenous over time. Thanks to a unique proprietary technology, both primer and bonding agent functions of CLEARFIL™ SE BOND were incorporated into one bottle. More than a decade on, CLEARFIL™ Universal Bond Quick takes this revolutionary technology to a whole new level.



$$\text{Partition coefficient} = \log_{10} \text{Pow} = \log_{10} \frac{C_{\text{n-octanol}}}{C_{\text{water}}}$$

$C_{\text{n-octanol}}$ : Concentration of the monomer in n-octanol layer (mol/L)

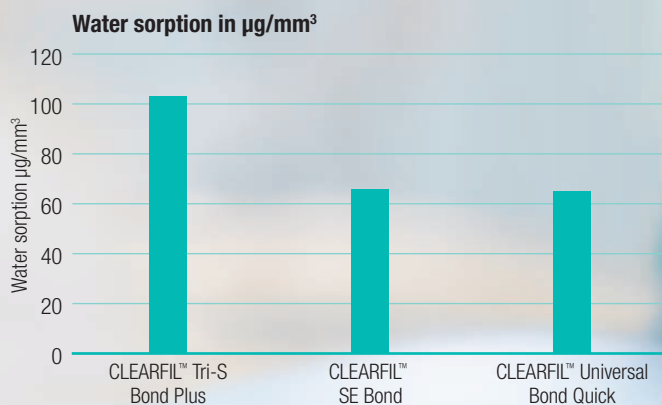
$C_{\text{water}}$ : Concentration of the monomer in water layer (mol/L)

Source: Kuraray Noritake Dental Inc.

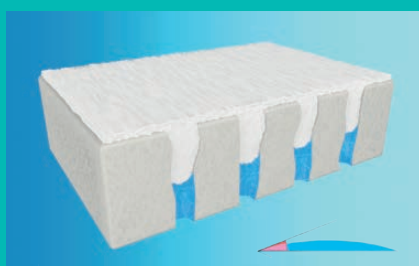
The drive behind the development of CLEARFIL™ Universal Bond Quick was to create a universal adhesive that simplifies the application process and reduces the number of steps required to achieve a lasting and reliable bond.

Unlike other one-bottle universal adhesives which utilize 'slow monomers' that need time to penetrate, there's no need to wait before you proceed. Our rapid bond technology combines our original MDP monomer with revolutionary new hydrophilic amide monomers which work together to deliver optimum stability and resistance to moisture for a lasting result. In fact, our MDP has been trusted by dentists for more than 30 years to deliver outstanding levels of chemical adhesion to hydroxyapatite.

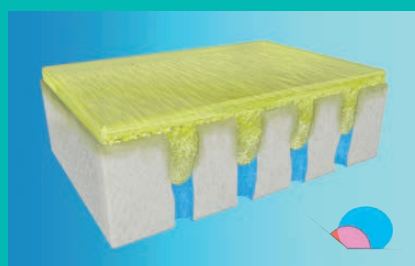
Our new hydrophilic amide monomer is central to this new rapid bond technology. Bonding to dentin isn't easy; the adhesive solution needs to penetrate the wet dentin. CLEARFIL™ Universal Bond Quick utilizes hydrophilic amide monomer technology to penetrate the dentin by exploiting its superior hydrophilicity properties when compared to traditional hydrophilic HEMA-monomer.



Source: Kuraray Noritake Dental



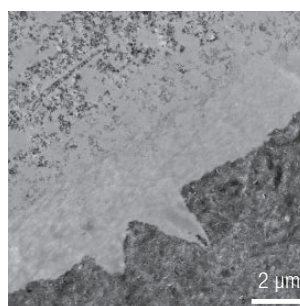
◀ Prepared dentin with smear layer. Due to its hydrophilicity we need a very hydrophilic bonding to be able to optimally penetrate the dentin.



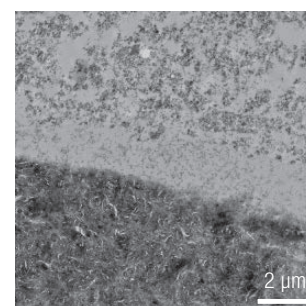
◀ Dentin bonded with CLEARFIL™ Universal Bond Quick. During curing CLEARFIL™ Universal Bond Quick creates a highly cross linked polymer network. As a result of this, the bonding has a very low water absorption which gives a long lasting restoration.

Having low water sorption is one of the most significant characteristics of adhesives. The organic matrix of the adhesive absorbs water in the long term. High water sorption of adhesives is cited as a factor in the deterioration of physical characteristics and secondary caries. CLEARFIL™ Universal Bond Quick showed the lowest water sorption among the tested materials, even though it contains highly hydrophilic amide monomers. It could be attributed to a high cross-linking property of our new hydrophilic amide monomers.

By introducing rapid bond technology we are assured of a quick developing and tight bonding to the materials we want to bond to. Especially to dentin, being the most challenging substrate. Rapid bond technology used in CLEARFIL™ Universal Bond Quick is proven to be very effective. A tight seal of the dentin without any voids is the result. Using either self-etch or total etch a tight interaction zone between the bonding and the dentin is present. No voids were seen.



Etch and rinse mode TEM



Self-etch mode TEM

TEM pictures courtesy of Dr. Kumiko Yoshihara and Dr. Noriyuki Nagaoka, Okayama University, Japan



# Bond strength comparison

## of CLEARFIL™ Universal Bond Quick

M. Cowen, J.M. Powers



### PURPOSE

The purpose of this project was to compare the shear bond strength to ground dentin and enamel of a new bonding agent requiring a shorter application time with two other popular bonding agents.

### EXPERIMENTAL DESIGN

#### Materials and Conditions

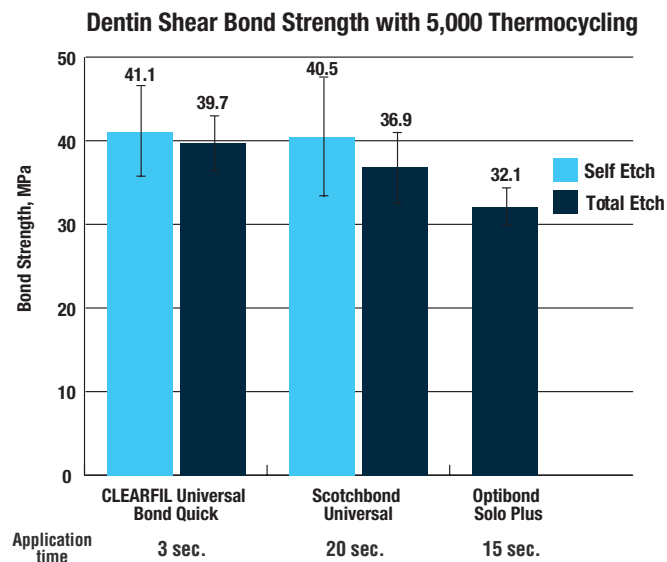
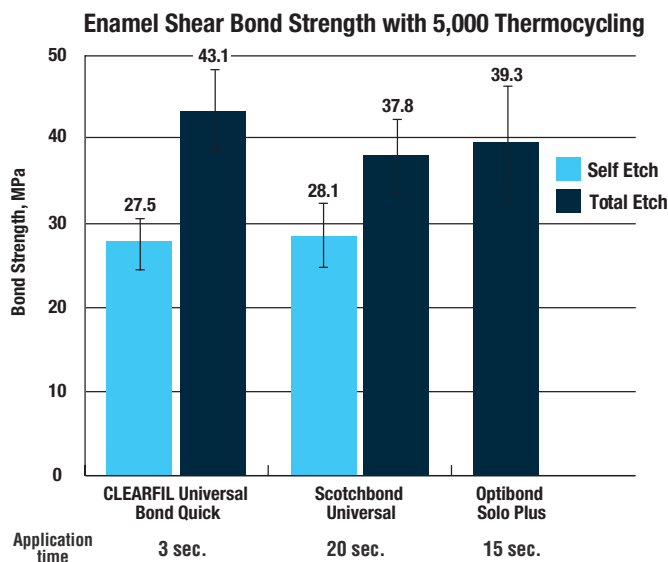
- Composite:** TPH Spectra™ HV (DENTSPLY Caulk)
- Light Curing Unit:** Demi (Kerr Corp.), >1300 mW/cm<sup>2</sup>
- Substrates:** Ground adult human enamel and superficial dentin
- Test:** Ultradent Shear Bond Strength test (n = 5), 2.38 mm diameter cylinder
- Storage Conditions:** 24 h in 37 °C followed by 5000 thermal cycles, 5-55 °C in water
- Etching Mode:**
  - CLEARFIL™ Universal Bond Quick (Kuraray Noritake Dental Inc.): Total-etch and Self-etch
  - OptiBond Solo Plus (Kerr Corp.): Total-etch
  - Scotchbond Universal (3M Oral Care): Total-etch and Self-etch

### Methods:

Human third molars extracted within 3 months of testing, previously stored in sodium azide solution, then in saline and then in water, were embedded in resin and abraded on the facial surface through 600-grit (Carbimet, Buehler, ~15 µm) SiC paper to form a bonding substrate of ground superficial dentin and ground enamel. Each specimen was then ultrasonically cleaned in deionized water for 5 minutes. Each specimen was prepared with the selected etching mode and bonding agent according to manufacturer's instructions, followed by direct placement of the composite material utilizing the Teflon Ultradent shear test mold and set-up jig. The specimens were stored for 24 h in 37 °C water and thermocycled between 5 and 55 °C water with a 20 second dwell time for 5000 cycles. The test specimens were debonded in shear on a universal testing machine (Model 5866 Instron) at a crosshead speed of 1.0 mm/min. Failure mode was determined with a 40x stereomicroscope by classification into categories of adhesive, mixed or cohesive failure. Adhesive failure occurs when greater than 95% of the substrate surface is clear of adhesive, cohesive failure in which there is no debonding and the failure was due to fracturing of the resin or substrate, and mixed failure in which both failure modes are apparent. Shear bond strength means and standard deviations and failure mode are reported.

Product	Company	Lot	Etching Time	Application Time	Air Drying Time	Light Curing Time
CLEARFIL™ Universal Bond Quick	Kuraray Noritake Dental Inc.	T160128	10 s	3 s	5 s	10 s
K-ETCHANT Syringe, 35% Phosphoric Acid		1M0003				
OptiBond™ Solo Plus	Kerr Corp.	5738933	15 s	15 s	3 s	10 s
Kerr Gel Etchant, 37.5 % Phosphoric Acid		5702171				
Scotchbond™ Universal	3M Oral Care	618804	15 s	20 s	5 s	10 s
Scotchbond™ Universal Etchant 32 % Phosphoric Acid		621073				





## 5000 TC Failure mode

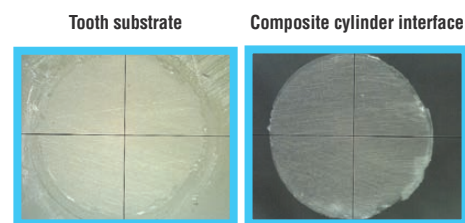
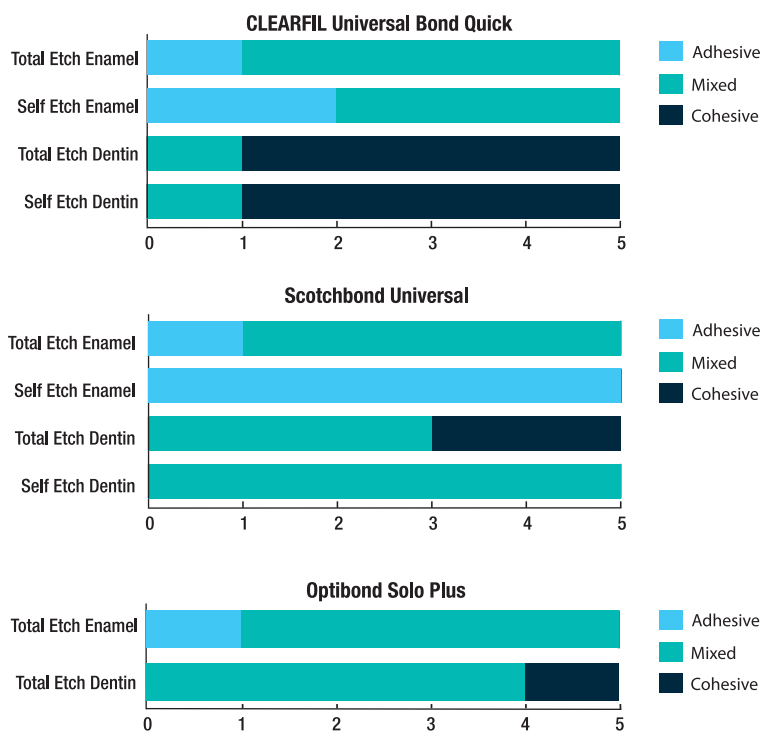


Fig. 1: Adhesive failure

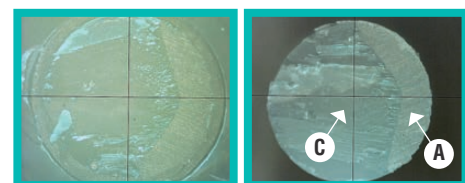


Fig. 2: Mixed failure

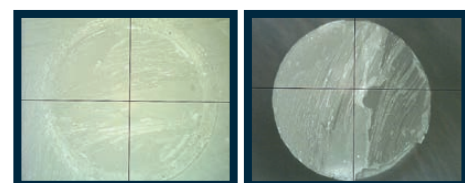


Fig. 3: Cohesive failure

Adhesive failure (green above) indicates the failure occurred due to the bond strength of the bonding agent to the tooth. A cohesive failure (red above) on the other hand, indicates the bond strength was greater than the strength of materials used. A mixed failure (blue above) generally indicates the strength of the bonding agent and supporting materials were close enough to each other to exhibit both failure modes. Cohesive failure generally means the value reported for the bond strength is greater than measured due to early failure of the materials. The large number of cohesive failures in the dentin group for Clearfil™ Universal Bond Quick indicates the bond strength to dentin is even higher than reported.

## CONCLUSION

*CLEARFIL™ Universal Bond Quick* with a reduced application time of 3 seconds showed equivalent, or superior shear bond strengths compared to *Scotchbond Universal* and *OptiBond Solo Plus* after 5000 thermocycles.

# Interview

## The man behind CLEARFIL™ Universal Bond Quick

**Yamato Nojiri is the developer of CLEARFIL™ Universal Bond Quick. After years of research by his team, the European launch took place last February. It's time to interview the man behind CLEARFIL™ Universal Bond Quick.**

**Could you tell us more about your background and responsibilities within the Kuraray Noritake Dental?**

I joined Kuraray in 2006 and I have been working in R&D of dental materials for 11 years. Currently I belong to adhesive group and I'm responsible for the development of new dental adhesives and next medical adhesive technologies.

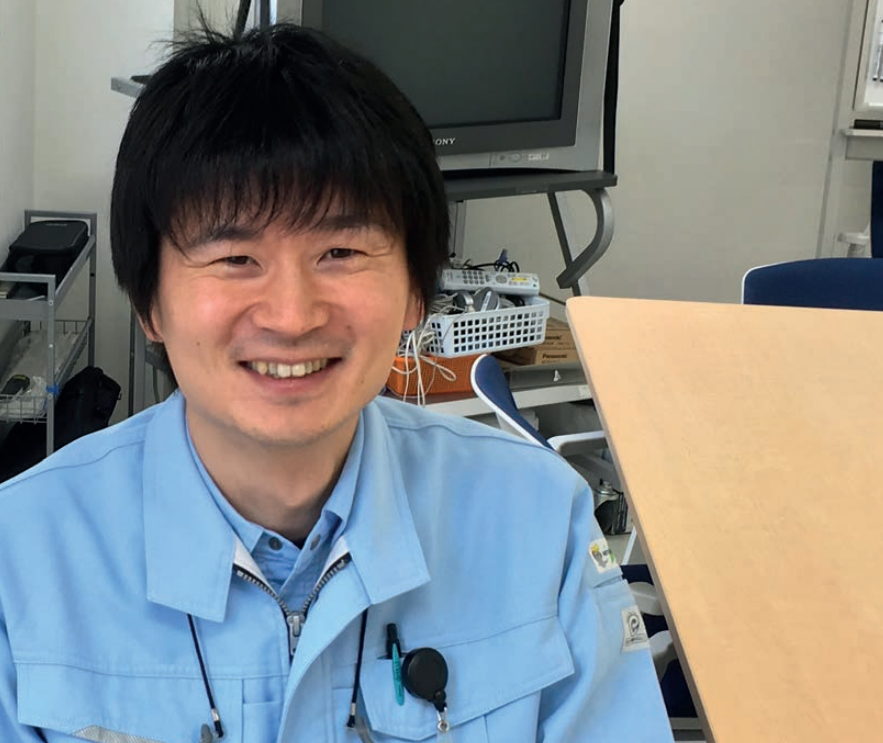
**You spent years in developing CLEARFIL™ Universal Bond Quick. Could you tell us more about the development process ?**

When I started work on the development of the basic technology for future adhesives, I thought that cross-linking hydrophilic monomers would be essential for optimal dentin bonding and durability. Due to research and development dedicated to the studies on hydrophilic monomers, "Rapid Bond Technology" has been successfully achieved, which led to the development of our new adhesive CLEARFIL™ Universal Bond Quick.

**What are the main differences between our other one liquid type of bonding agents and CLEARFIL™ Universal Bond Quick?**

1. Application: There is no waiting time after application of CLEARFIL™ Universal Bond Quick. Just use the applicator brush to apply to the entire cavity wall in a rubbing motion. CLEARFIL™ Universal Bond should be rubbed in for 10 seconds.
2. CLEARFIL™ Universal Bond Quick utilizes a completely new chemistry consisting of new hydrophilic amide monomers which are more stable and resistant to hydrolyses.





**Yamato Nojiri**

Developer of CLEARFIL™ Universal Bond Quick

**What is the most important feature CLEARFIL™ Universal Bond Quick?**

It definitely is the no waiting time feature! Unlike other one-bottle universal adhesives which utilize less hydrophilic monomers and need time to penetrate, with CLEARFIL™ Universal Bond Quick there's no need to wait for it to penetrate the dentin before proceeding. This is due to Rapid Bond Technology.

**What are your expectations of this new bonding and its rapid bond technology?**

To be able to answer this question, I first would like to explain rapid bond technology. Rapid Bond Technology is partly based on new technology and partly on existing. With the aid of the original MDP monomer, we were already able to bond quickly to tooth structure. The rapid penetration part is new. This is achieved by newly developed hydrophilic amide monomers which have been introduced to the new adhesive. The addition of a highly reactive photo initiator system assures fast curing. And once polymerized the hydrolytic stability of the polymerized structure is high. This is due to the high cross-linking of the polymer network. My expectations are that with CLEARFIL™ Universal Bond Quick, an efficient long term bonding can be achieved.

**How important is MDP in CLEARFIL™ Universal Bond Quick?**

The original MDP monomer, developed by Kuraray Noritake Dental, has always been central to our bonding systems. With CLEARFIL™ Universal Bond Quick, nothing has



changed. MDP forms calcium-MDP salt with hydroxyapatite, the stable basis for long-term bonding effectiveness. With the help of the new hydrophilic amide monomers, the bonding penetrates fast into dentin. At the same time, MDP could be brought into the dentinal structure where it reacts with calcium from hydroxyapatite.

**When you are not in the research lab, what do you like to do with your time?**

I usually play with my daughters. Or I run on weekends. I would like to run in the Berlin or Rotterdam marathon someday! For six consecutive years, 2011-2016, Berlin has held the world's record for fastest time. I want to set a new personal best in Berlin!!



# Detailed insights into adhesive technology

The 2016 Expert Symposium held by Kuraray Noritake Dental showcased renowned speakers

By Dr. Gisela Peters

**On 2nd December 2016, the Kuraray Noritake Dental invited guests to its annual Expert Symposium which focused on the topic of adhesive technology. In Frankfurt am Main/Germany, more than 60 leading adhesives and composites experts from universities all over Europe met to discuss new developments and results. Another subject of the studies presented was CLEARFIL™ Universal Bond Quick, the new one-bottle universal adhesive by Kuraray Noritake Dental, launched in Europe in February 2017.**

The following people spoke at the Symposium: Prof. Dr. Bart Van Meerbeek from the KU Leuven - BIOMAT - University Hospitals Leuven/Belgium, who also acted as the Moderator of the conference, Professor Dr. Ivo Krejci from the University of Geneva/Switzerland, Prof. Dr. Amélie Mainjot from the University of Liège/Belgium, Prof. Dr. Mutlu Özcan from the University of Zurich/Switzerland, Luc Randolph, Materials Research Engineer at the University of Louvain-la-Neuve/Belgium, Dr. Nicola Scotti, Assistant Professor at the University of Turin/Italy, and, as the first Speaker, Yusuke Fujimura, Technical Manager and Chief Developer at Kuraray Noritake Dental in Tokyo/Japan.





Yusuke Fujimura

## A UNIVERSAL ADHESIVE FEATURING FURTHER-DEVELOPED CHARACTERISTICS

Yusuke Fujimura initially familiarised the guests in the auditorium with the characteristics of the new CLEARFIL Universal Bond Quick, and linked these with studies and chemical background information. In the new adhesive, two molecules in particular are responsible for the bond strength: the MDP (methacryloyloxydecyl-dihydrogenphosphate) designed by Kuraray Noritake Dental, which has proven its worth over 33 years of use, and a new amide monomer. The TMDU (Tokyo Medical and Dental University) determined the high micro tensile bond strength for the new product on human dentine. In order to help protect against secondary caries, the new version also releases fluoride. The application of CLEARFIL Universal Bond Quick has been improved vs all other bonding agents, by deleting waiting time, extensive rubbing or multiple layer application.

As a truly universal adhesive, CLEARFIL Universal Bond Quick can be used both as a self-etch adhesive through 1-component bonding or in multiple steps in an etch-and-rinse procedure or in a selective etching procedure. In the case of 1-component application, there is no need to wait after application; the next steps for drying and polymerisation also only require minimal treatment time. Regarding the total-etch procedure, data shows: even if the adhesive was only rubbed in for 3 seconds, a shear bond strength of 40 MPa was still retained on the human enamel and on the dentine after 24 hours of water storage or after 5,000 thermocycles. Applied using the self-etching procedure, the values still lay at approx. 25 MPa (enamel) and 40 MPa (dentine) even when the rubbing process was shortened to only 3 seconds.

### Indications

The indications are also universal: CLEARFIL Universal Bond Quick is suitable for bonding procedures with direct composites, for core build-ups, for laboratory-produced prosthesis and more. Headed by Prof. Dr. Yasuko Momoi, the Tsurumi University in Yokohama has conducted

studies of shear bond strength using various prosthodontic materials in combination with the new adhesive. For all tested indirect materials the use of CLEARFIL Universal Bond Quick only gave good results in means of shear bond strength. For VITA Mark II (feldspathic porcelain) it was recommended to use in combination with a separate silane.

### The chemical composition

The highly-adhesive monomer MDP is worked into CLEARFIL Universal Bond Quick and other adhesives and adhesive cements by Kuraray Noritake Dental. The special purity of the monomer substantially influences the bond strength and the longevity of the adhesive bond.

The patented high purity of the monomer substantially influences the bond strength and the longevity of the adhesive bond. The original MDP is still only used in products by Kuraray. MDP manufactured by others have a lower purity grade and are more prone to dimer forming. This making these MDP's less effective.

In the new adhesive, a second monomer is used; a special amide which is not dissimilar in structure to HEMA (hydroxyethyl methacrylate). However, it provides the molecule with very different chemical properties - which has a positive effect on the bonding efficacy. This amide is much more hydrophilic than HEMA, and therefore penetrates especially well into the dentine. Contrary to HEMA the amide monomer has crosslinking properties. This ensuring, once cured, a stable cross link network what is not sensitive to hydrolysis, trough the bonding layer.

In addition, the polymerisation and therefore the curing takes place more quickly, which is advantageous for application in the dentist's practice. Tests at the Osaka Dental University have also revealed that the new universal adhesive is very tolerant of mistakes in practical application: whether the layer applied to the dentine was subjected to a strong or weak air flow, the bond strength measured in the test hardly differed.

### Overall evaluation

Yusuke Fujimura has estimated the sensitivity to technology and therefore the susceptibility to errors of the new universal adhesive CLEARFIL Universal Bond Quick as being low. The important steps of the application duration (rubbing in, no waiting time) and the air-drying (strength of the air flow) permit a wide range of individual processing options. The procedure is short, at max. 10 seconds per step. Depending on the dentist's preference or indication, all bonding techniques are applied, with and without a separate etching step. In this way, the new adhesive represents a further-developed product for the dentist's practice. At the same time, based on the composition with the new amide monomer and The Original MDP, an extended clinical longevity of appropriately bonded restorations is expected. The fluoride release realised for the first time in a universal adhesive could also contribute towards this longevity.

## UNDERSTANDING ADHESIVES: WHAT CAN TOTAL-ETCH AND SELF-ETCH PRODUCTS DO?

At the Expert Symposium, Prof. Dr. Bart Van Meerbeek provided general insights into the etch-and-rinse and self-etch procedures, and made a statement on the chemical properties, supported by the results of studies. Faced with a wide variety of bonding systems, it is possible to perceive a trend amongst dentists for the selection of universal adhesives. The multi-step procedure with etch and rinse is the bonding technique that has been on the market for the longest. These systems mainly rely on mechanical bonding. When bonded to dentin, these early adhesive systems are characterised by the formation of a thick hybrid layer and (long) resin tags in the dentinal tubules. On enamel, a highly uneven etching pattern is created by etching, resulting in an effective mechanical bond produced through total-etch adhesives. These systems have been in part proven clinically successful for a number of decades.

### Subject of discussion: the separate etch step

However, Prof. Van Meerbeek stated three primary reasons which contradict roughening and conditioning when using strong phosphoric acid on dentin. The natural tooth protector, hydroxyapatite, is dissolved thus exposing the collagen matrix. Secondly, it has been revealed that the formation of retentions lies below expectations, as the infiltration of the tooth is usually only partially successful. In addition, the bonding layer deteriorates gradually (hydrolysis) and develops microgaps along with all the consequences. Although advancements have been made, no true breakthrough has been achieved in adhesive technology. We may ask ourselves the following fundamental question regarding the

conventional total-etch procedure: Why first demineralise the tooth with strong acids, only to remineralise it again?

### The self-etching procedure brings the chemical bond into play

The self-etch method provides a new solution. If a weaker acid is contained in the appropriate adhesive systems (e.g. with a pH value of 2), this results in only a slight dissolution of hydroxyapatite, thus, the collagen is not completely exposed. The hybrid layer need not be strongly characterised by self-etching bonding agents. A major characteristic of these products is the functional groups contained in them which adhere chemically to hydroxyapatite, notably the MDP monomer.

### How does the MDP functional monomer work?

When compared with other functional phosphoric acid monomers on the market, the MDP functional monomer possesses a higher bonding property to hydroxyapatite. It contains a functional phosphoric-acid ester group, which provides in particular a strong chemical affinity with the calcium in teeth (ionic bond). The MDP developed and produced by Kuraray Noritake Dental is, as studies show, highly pure. This represents a unique proposition, and the high level of purity provides an important basis for the long-term stability of the chemical bond between the tooth and the restoration. The fact that the calcium MDP salt is also extremely hard to dissolve, also contributes towards longevity, thus significantly increasing hydrolysis stability. However, when it comes to adhesive bonds on restorations, there is still room for improvement. Research



Dr. Nicola Scotti

## MAJOR STEP INTO CLINICAL STUDIES ON WHAT ADHESIVES CAN ACHIEVE

In addition to treating patients, Dr. Nicola Scotti, Assistant Professor at the University of Turin, Italy, spends his days in research. He is therefore no stranger when it comes to in-vitro tests and clinical application and results. At the Expert Symposium, he reflected on the two worlds of laboratory research and clinical studies with regard to the success of bonding agents, in particular universal adhesives.

Regarding the practical application of bonds, the question repeatedly arises as to the acid etching and self-etch procedure, as well as, the bonding of the adhesive onto enamel and dentine. Here, it is necessary to differentiate according to tooth regions – whether this concerns, for example, the bonding on crown and root dentines, or prismatic/aprismatic enamel



Prof. Dr. Bart Van Meerbeek

*“When using a self-etching 2-step adhesive (CLEARFIL™ SE BOND), 96-per-cent longevity success rate was the result.”*

is currently being conducted to determine the potential of other monomer classes.

## Study results

In the second part of his lecture, Prof. Dr. Bart Van Meerbeek presented literary studies on the bond strength (meta-analysis) and in-vitro tests, for example, shear and fracture toughness tests. The results are not uniform; the respective test procedures generate major differences. Readers have to look closely at details in order to benefit from the study's findings. However, a trend was indicated in an in-vitro study on the marginal integrity. Under the management of Prof. Dr. Uwe Blunck, Charité – University of Medicine, Berlin,

five adhesive categories were put to the test: 3-step and 2-step adhesives with acid-etch procedure, self-etch adhesive with 1-step or 2-step procedures and universal adhesives. 3-step adhesives with etching and rinsing achieved the most convincing results along with self-adhesive 2-step adhesives. In these two groups, a 100-per-cent marginal integrity with low standard deviations was determined for many products after tests had been conducted, with and without 2,000 thermocycles.

Prof. Van Meerbeek also provided Expert Symposium participants with the results of some clinical 13-year studies: a 96-per-cent longevity success rate when using a self-etching 2-step adhesive (CLEARFIL™ SE BOND).

areas. This extends right up to the differentiation according to vertically cut, or laterally executed, enamel prisms.

Taking the available findings into consideration, Dr. Nicola Scotti determined, as had Prof. Dr. Bart Van Meerbeek before him, that the numerous facets of bonding make it hard to establish

a correlation between in-vitro and clinical results. He made his statement based on analyses on marginal integrity, and on clinical assessments according to Ryge criteria, such as marginal discolouration, marginal adaptation etc. However, if the clinical study observation period is extended, for example to 5 years, and if these results are compared with studies on the bond strength of artificially aged samples, things look very different.

*“The numerous facets of bonding make it hard to establish a correlation between in-vitro and clinical results.”*

Overall, clinical studies have shown that secondary caries represents a decisive influencing factor for long-term stability rates. In clinical 6 to 17-year studies, the annual failure rates of composite restorations were approximately 4-per-cent, but there are also studies which did not record any failures. This also comprises studies on details, for example, on the preliminary treatment of tooth surfaces, classified according to region.

# Adhesives on the test bench

## four individual studies

**The fact is: The longevity prognosis for bonded restoration is absolutely dependent on the quality of the adhesives and the effect of procedural steps. Kuraray Noritake Dental has links to many scientists involved in the investigation of adhesives. Here, the scope of testing rises far over and above the legally-required ISO-standards. At the Expert Symposium, a scientific short program provided insights into this scope, in addition to the main lectures sketched out above. Four speakers presented their findings to the participants on interesting individual questions.**



Prof. Dr. Amélie Mainjot

### Bonding effectiveness of the novel bonding SKB-100\* to various dental substrates

Prof. Dr. Amélie Mainjot from the University of Liège/Belgium went one step further. By investigating the interface between the adhesive and the restoration material, she wanted to obtain targeted knowledge regarding questions on the success of the treatment. For her tests, she produced prism-shaped test objects; these consisted of different CAD/CAM-prosthetic materials – feldspar ceramic (Vita Mark II, Vita Zahnfabrik/Bad Säckingen, Germany), lithium disilicate (IPS e.max CAD, Ivoclar Vivadent/Schaan, Liechtenstein) and zirconia (KATANA™, Kuraray Noritake Dental) as well as direct composite (CLEARFIL™ AP-X, Kuraray Noritake Dental) – each with and without CLEARFIL™ Universal Bond Quick applications. A small precise notch was made at the interface which should serve as a crack initiation in the fracture toughness test – and therefore, trigger a fracture exactly at this interface. The results for the bond were very positive for the zirconia material, which showed a similar bond strength as Vita Mark II glass-ceramic, even after thermocycling, instead of pre-test failures when not treated with CLEARFIL™ Universal Bond Quick. The results were slightly positive for Vita Mark II, and neutral for CLEARFIL™ AP-X and e.max CAD, while CLEARFIL™ AP-X showed the best bond strength and e.max CAD the lowest.

\*CLEARFIL Universal Bond Quick





Luc Randolph

## Bonding effectiveness of a novel bonding SKB-100 to dentin

Luc Randolph, Materials Research Engineer at the University of Louvain-la-Neuve/Belgium, reported on his shear bond strength tests using the new universal adhesive CLEARFIL™ Universal Bond Quick. Tests were performed on human dentine slabs. Composite was bonded with several bonding systems to the dentin slabs. The fractured samples were then divided into 3 groups: adhesive fractures, composite fractures and mixed fractures. In the “single step bonding” test objects, the fractures were mainly only registered in the adhesive; however in CLEARFIL™ Universal Bond Quick mixed failure occurred in less than one quarter of the tests. The bond strengths lay within the range of standard 1-step adhesives. Luc Randolph's final judgement was as follows: “Among the all-in-one universal alternatives, the new CUBQ technology appears equally efficient despite the absence of waiting time after application, making it a more user-friendly and more convenient option than its competitors.”



Prof. Dr. Mutlu Özcan

## Effect of contemporary universal primers and SKB-100 on resin composite repairs

Owing to the frequent need in dental practice to repair composite fillings with composite, it would be helpful to ask specific questions regarding measures for increasing the bonding strength to the adhesive. Prof. Dr. Mutlu Özcan from the University of Zurich/Switzerland prepared composite test objects, with and without air abrasion (50 µm aluminium oxide with 2.5 bar), to receive the adhesive. Her result: Whereas an enlargement of the surface is always advantageous, the effect of the air abrasion step (measured through shear tests) differs depending on the adhesive used; no cohesive failures were observed in any of the groups. The described method of air-abrasion increased the adhesion results for the majority of the adhesives. Air-abrasion may not be needed for CLEARFIL™ Universal Bond and CLEARFIL™ Universal Bond Quick. The conclusion for use in a dental practice: Dentists must inform themselves on their respective products.



Prof. Dr. Ivo Krejci

## Evaluation of adhesives

Prof. Dr. Ivo Krejci from the University of Geneva/Switzerland, who has long concerned himself with restorations in mixed-class V cavities, in particular with marginal integrity, also recommended that dentists familiarise themselves with the specific adhesive used. He repeatedly revealed – and thus concurred with other speakers on that day - that the quality evaluation of adhesives based on in-vitro tests cannot simply be reflected in clinical results. Too many factors play a role; this starts with the different adhesions on enamel and dentine alone. More recently, the consideration of laser preparations are also to be taken into account. General quality statements on adhesive categories, according to total-etch or self-etch, or 1-step and multi-step procedures, and according to universal formulas, are also difficult to filter out. The individual product counts ... and not least the technological sensitivity and the user themselves, as the Moderator, Prof. Dr. Bart Van Meerbeek, added at the end of these interesting explanations.



**The speakers had produced many enlightening research results which Symposium participants were able to take away with them. However, before they left, Prof. Van Meerbeek asked the panel to hold a questions-and-answer session with the audience, filtering out requests for future development and finding answers.**

#### **QUESTION:**

*There are many adhesive systems available with different procedures: acid-etch procedures with strong phosphoric acid, wet bonding, 1-bottle formulations ... – what is important and expedient for the application?*

#### **Response from the panel:**

The products are as diverse as the respective dental situation: only enamel - with and without preparation, crown and root dentine, small and large cavities... there are many options available in order to restore them appropriately: an adhesive system and a procedure can be selected for every situation and indication. The application can profit from this. There is no single, expedient response for everything.

#### **QUESTION:**

*Approx. 20 years of application lie behind us. What can we dentists improve?*

#### **Response from the panel:**

One must look at the composition and the chemism of the respective products and acquire basic knowledge of the bonding mechanism. This also means knowing about the functional monomers involved and their effectiveness. And then a final decision has to be made depending on the individual tooth involved. Our knowledge status keeps changing; researchers are also learning and asking an increasing number of more differentiated questions.

# Panel discussion

## How might developments in adhesive technology continue?

By Dr. Gisela Peters

### QUESTION:

*Doesn't that leave us dissatisfied? So when will we have a solution for all bonding cases? With regard to this, isn't the designation "universal" adhesive rather confusing?*

### Response from the panel:

There is no medication which acts as a miracle cure for all patients and all illnesses. And it is the same for adhesives, too. "Universal" adhesive means that all procedures are thus covered: the application with the etch & rinse procedure, the selective etching procedure and the self-etching procedure. "Universal" doesn't mean one procedure for all situations. The universal adhesive provides a compromise if a dentist only wishes to concern themselves with one product in their practice. The application thus possible without a separate acid etching procedure also provides protection against application errors, respectively excessive drying out and collagen collapse.

### QUESTION:

*On the other hand, isn't the simplicity of the bonding procedure a major requirement for users?*

### Response from the panel:

... and possibly also the low price. Unbranded adhesives are available on the market for which the background effort taken in studying the product is not known. The most important factors to be observed by dentists are the clinical success and the stability of the bond. Other criteria are to be regarded as less important. Responsible manufacturers launch their products onto the market only after a lot of internal and university testing. At the same time, they drive the search for improved bonding agents. In addition, they also develop their adhesive systems with a view to creating reliable application.

### QUESTION:

*After this Symposium, what quintessence should I take back with me to my workplace?*

### Response from the panel:

A firm understanding of the procedures and effects of the products. This knowledge should be mediated far more than previously, during dental training. Let's admit it: many dentists don't truly understand the science behind bonding. However, further work is being conducted on the simplification, acceleration of procedures, technical durability, clinical error tolerance - and above all, on the "ingredients" - in order to expand the longevity of the bond still further.



# Adhesive cementation

## of a KATANA™ Zirconia HT 3-unit



### After preparing the abutments

An anterior bridge made of crown and bridge resin has become dislodged. The abutments are vital teeth.



### Prosthesis

A PFZ bridge with a frame fabricated using KATANA™ Zirconia HT12.



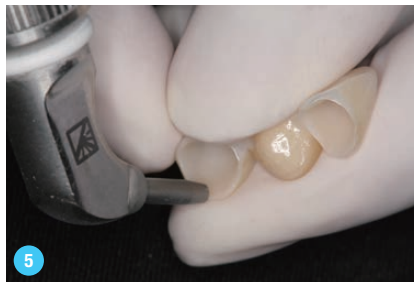
### Application of Try-in Paste

Evaluate the shade of the cement before cementation.



### Try-in

After checking the cement's shade, rinse the prosthesis and tooth surface with water to remove Try-in Paste.



### Pretreatment of the prosthesis (A)

Sandblast the prosthesis (at 0.3 to 0.4 MPa), clean with an ultrasonic cleaner for 2 minutes, then dry.



### Pretreatment of the prosthesis (B)

Apply CLEARFIL™ CERAMIC PRIMER PLUS and blow dry with air.

## PRODUCTS USED IN THIS CLINICAL CASE

### KATANA™ Zirconia Multi-Layered Series

Our KATANA™ Zirconia series brings naturalness to all prosthetics. Make natural veneers and natural full contour prosthetics out of zirconia. Plus large dentin-like frameworks.

KATANA™ Zirconia UTML is a high translucent disc, which meets the requirements of highest translucency level for anterior crowns and veneers. All layers are highly translucent, whereby the color saturation is reduced in the incisal area. The transparency of the natural enamel is copied and the abutment shade is absorbed.

KATANA™ Zirconia STML is a multi-layered zirconia disc where light is transmitted in the incisal area and blocked in the cervical area. Due to its color and translucency gradient,

more opacity in the cervical area and more translucency in the incisal area are achieved.

KATANA™ Zirconia ML, the pioneer of zirconia with a natural color gradient, is made for large dentinal frameworks. Its natural opacity makes it the ideal base to cover it with hand-made ceramics.



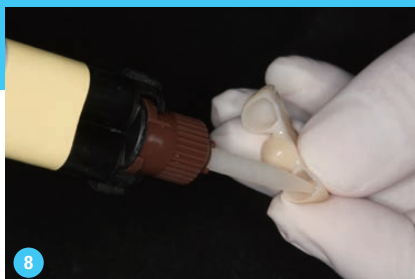


# bridge with PANAVIA™ V5



## Pretreatment of the abutments (C)

Apply Tooth Primer, allow it to react for 20 seconds, then blow dry with air.



## Application of Paste

Use Universal.



## Placement of the prosthesis

After placement, remove excess cement using a piece of gauze, a small brush, etc.



## Light-curing

Light-cure the entire surface of the prosthesis, including the margins.



## Final polymerization

Make sure the prosthesis is left in place, unmoved, for 3 minutes.

More information?  
[kuraraynoritake.eu](http://kuraraynoritake.eu)

## PANAVIA™ V5

One Cement. All cement indications. One prime procedure. Start with priming the tooth using PANAVIA™ V5 Tooth Primer. Then prime and roughen the prosthetic using CLEARFIL™ CERAMIC PRIMER PLUS and apply the pre-mixed cement. PANAVIA™ V5 comes in five aesthetic shades and the original MDP assures a durable bond. On the tooth and the prosthetic.

## CLEARFIL™ CERAMIC PRIMER PLUS

The universal prosthetic primer for almost all prosthetic surfaces. It durably bond to ceramics (lithium disilicate, zirconia), hybrid ceramics, composite resins and metals. The original MDP monomer bonds to metals and metal-oxides such as zirconia. Silane coupling agent  $\gamma$  MPS guarantees a strong adhesion to composites, glass-ceramics and hybrid ceramics. This perfect mixture of ingredients will give you long lasting adhesion to virtually all dental materials.



# New Zirconia KATANA™ Digital Concept

Since 2010, thanks to its increased translucency, KATANA™ HT has become paramount in fully meeting the ever more demanding aesthetics in restorations where a zirconia frame is used in combination with new generation ceramics CZR. Such ceramics feature an enhanced leucite balancing, which makes them stronger and more durable. 1 2 3 4



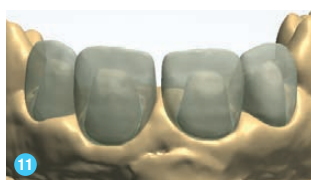
Since 2013, ML-Multi Layer technology has made it possible to skip the infiltration phase through multi-layered dentine/enamel millable discs. Such Multi-layered discs allow CUT-BACK solutions that definitely improve the function-related result as the palatal part of the restoration can be manufactured by using KATANA™ ML Zirconia only. Thus, without limiting the aesthetic results (which are reached by enamel-ceramic LUSTER porcelain with “MICRO LAYERING technique”, the restoration benefits of the low abrasiveness of the functional-occlusal areas which is reached through simple and effective mechanical polishing without either surface staining or glasuring. 5 6 7 8 9





## DANIELE RONDONI

- Graduating in 1979, Daniele Rondoni opened a laboratory in 1982, which is also the home of the AAT Community College he founded.
- Teacher and counsellor for the "Italian School for Dental Technicians" at the University of Chieti, University of Sienna and University of Rome Tor Vergata.
- EAED and IAED Active Member and a SICED Associate and O.L.
- International Instructor for Kuraray Noritake Dental products.
- Author of "Tecnica della Multistratificazione in ceramica" (Ceramic Multilayering Technique) and a lab manual about the use of composite materials, introducing his own method – the "Inverted Hardness Layering System".



New generation KATANA™ UTML and STML introduced in 2015 can be used for anterior restoration thanks to the cubic zirconia based products that have been made available to make it possible to conceive a bi-layer to mono-layer transition in most clinical situations.



Cubic zirconia features superior optical behavior. Although mechanically inferior in performance to conventional zirconia, KATANA™ UTML and STML are aging-resistant, while UTML offers the same translucency as lithium disilicate based solution.

"ZERO-CUTBACK technique" is one of the ideal techniques that can be achieved with cubic zirconia solution. They can perfectly replicate digital projects without any need for subsequent layering and can be easily painted and mechanically polished in the palatal area. [10](#) [11](#) [12](#) [13](#) [14](#) [15](#)

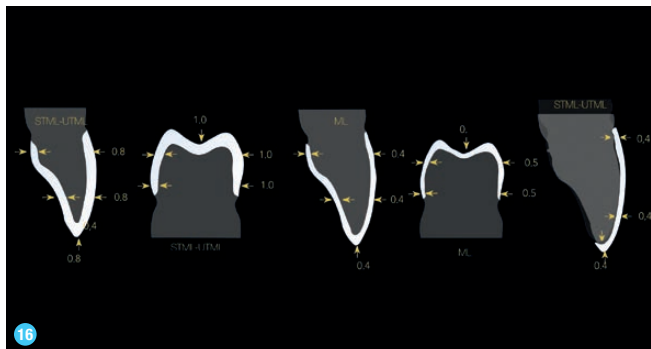


Kuraray Noritake Dental has also developed CZR FC Paste Stain with a wide range of coloring pastes specially designed for full-anatomical solution of multi-layered zirconia. Their effectiveness is proven to be enhanced when used with "ULTRA MICRO LAYERING technique" on thin glasure or thin transparent ceramic mass.

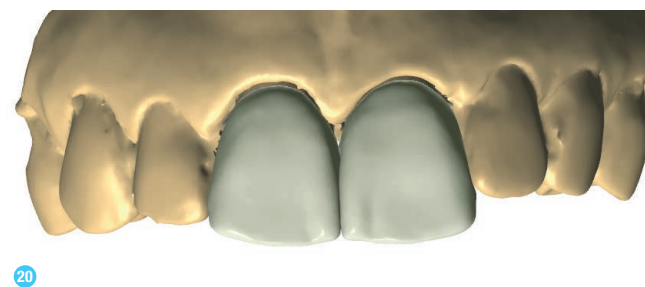
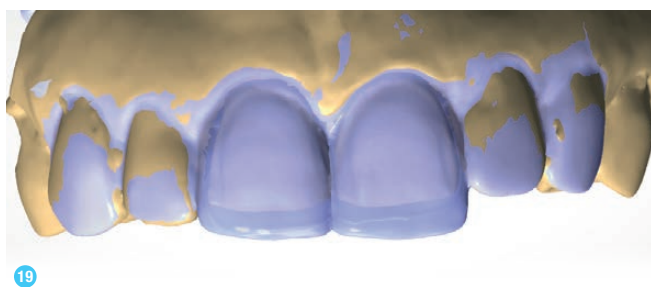
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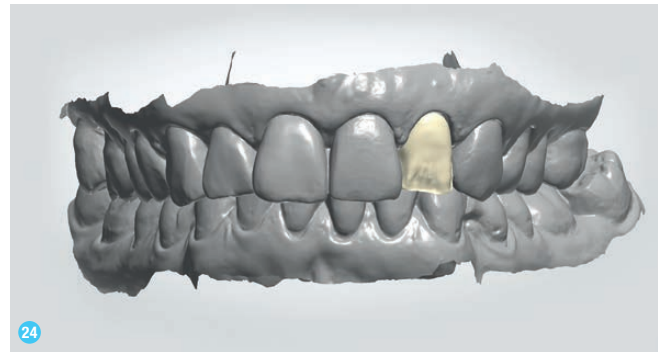
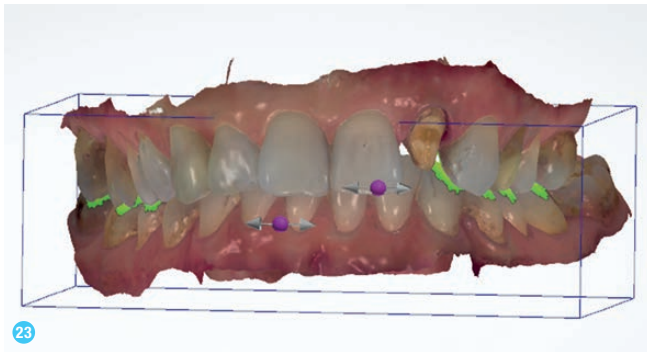
Another advantage with STML and UTML products is the lower thickness, respectful of the latest micro-invasive dentistry standards and current market requests. 16



Excellent flexural strengths higher than 550/750 MPa allow restoration to feature micro-invasive thicknesses from 0.4 mm on, p.e. on laminates. Unlike PFZ, zirconia lower thicknesses ensure better results. 17 18 19 20 21 22

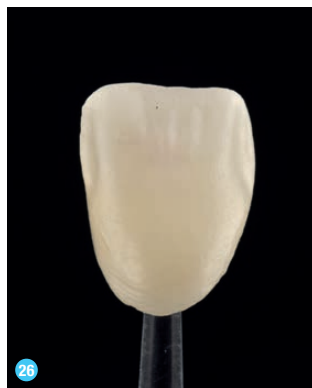
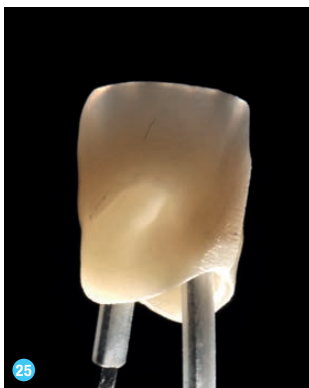




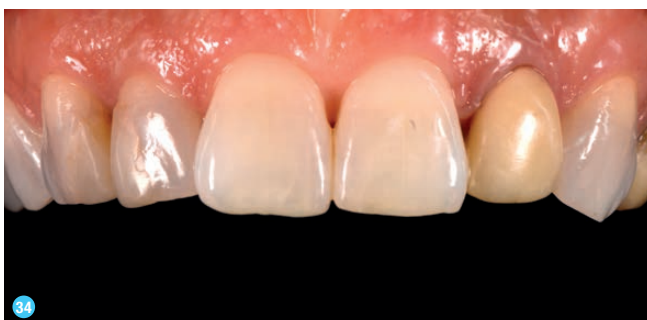
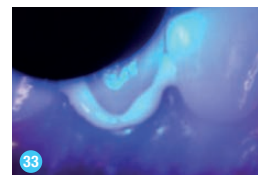
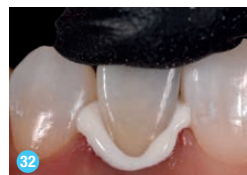


Above all, new generation zirconia makes the digital work-flow more efficient and performing, from the intra-oral impression to the final product which can be manufactured “model-free”.

23 24 25 26 27 28



Thus a new procedure standard is introduced, where simplified adhesive cementation through composite cements opens the the way to zirconia-based adhesive restoration techniques. Regarding adhesion, unlike glass-ceramic, zirconia is not etchable, yet it can be fixed through phosphate monomer MDP, i.e. Panavia™ V5 29 30 31 32 33 34 35





# Creating values for customers

Kuraray material was used for the Louis Vuitton building in France

Small components or constituents can have a major effect on the quality of products. Frequently, substantially lesser-known companies are concealed behind successful brands, and these companies ensure the performance capability of products through their solutions. Kuraray Europe GmbH, with headquarter in Hattersheim am Main, is such a manufacturer, creating real added value for its customers with its chemical components. Whether in paints, trainers, glass panes or dental products; the materials made by this subsidiary of the Kuraray Group from Japan contribute, thanks to their innovative physical and chemical properties, towards the further optimisation of everyday objects.

*"We constantly keep our ear to the ground in the marketplace and are extremely fast and flexible."*

Dr. Matthias Gutweiler,  
Managing Director of Kuraray  
Europe GmbH

Manufacturers of paints and lacquers, clothing, vehicles and dental products along with large paper groups, architects and many more have come to depend on the competence of the special chemicals manufacturer. "We feature an innovative product portfolio, are market leaders in many areas and occupy attractive niches", says Managing Director Dr. Matthias Gutweiler on the success factors for Kuraray Europe. "We collaborate very closely with our customers, and this proximity gives us a big market advantage. We constantly keep our ear to the ground in the marketplace and are extremely fast and flexible".

## LARGE PORTFOLIO

Kuraray Europe is the leading manufacturer of polyvinyl alcohol in Europe which is used amongst other things for water-soluble dispersion paints and wood primers, and polyvinyl butyral (PVB), which is a plastic used for example as a film in composite safety glass. In addition, the company has a wide range of



other products to offer, from thermoplastic elastomers and liquid rubber via activated carbon filters and synthetic fibres, right up to artificial leather and dental products. The SEPTONTMQ elastomer, for example, combines the elastic characteristics of rubber with those of thermoplastic resins, and is used by well-known sports shoe manufacturers in the manufacture of shoe soles

With TROSIFOL® Sound Control, Kuraray has developed a new PVB film with outstanding sound insulation properties. Tirrenina™ is an artificial leather which is produced without solvents and is therefore the preferred solution for environmentally-conscious companies.

“Using TROSIFOL® Sound Control, we have developed a new PVB film with outstanding sound insulation properties”, explains Dr. Matthias Gutweiler. “In comparison to a glass construction with standard PVB film, it is possible in the same structure to achieve an improvement in the sound insulation values of up to 3 dB using TROSIFOL® Sound Control”. TROSIFOL® films are used for the production of composite safety glass in vehicles, buildings or solar systems. TROSIFOL® can be found in the glass cupola of the Berlin Reichstags building, in the YAS Hotel in Abu Dhabi and in the glass gondolas of the London Eye big wheel.

## FAMOUS BUILDINGS

The takeover of DuPont has further expanded our product portfolio with yet more innovative solutions. With SentryGlas® the company now has a composite film as part of its product range. One hundred times more rigid than PVB yet comparatively slim in design, it meets the stringent safety requirements demanded in modern building work. SentryGlas® thus offers all manner of new possibilities and freedom of design along with good aesthetics and functionality, for example in façades, parapets, glass floors or staircases. The product has for



With TROSIFOL® Sound Control, Kuraray has developed a new PVB film with outstanding sound insulation properties.

example been used in the renovation of the glass first floor of the Eiffel tower. In combination with silicons by Dow Corning, SentryGlas® has also been used for the Louis Vuitton building in France, the curving glass surfaces of which extend like the sails of a ship over the treetops of the Paris Bois de Boulogne.

## NEW PROJECTS

Research and Development Division plays a major role at Kuraray, and the company is constantly working on new projects in order to develop new solutions for its customers. “Today, chemicals companies are solution providers who assist customers in generating values”, says the Managing Director. “This is no longer about merely selling products, but rather about efficiency enhancement and collaborative innovations. Here we focus on direct customer contact in order to find out through dialogue how we can help”. Kuraray is committed to a permanent investment in its R&D Division in order to develop technologies which generate competitive advantage while at the same time delivering value to the customer. Today the Group has become an international market leader for innovative high-performance materials.

## UNIQUE PRODUCTS

Now with an active worldwide presence, Kuraray was founded in 1926 in Japan while Kuraray Europe GmbH has been in existence since 1991. “We want to grow further, and to manufacture products which are so unique that they cannot be copied”, says Dr. Matthias Gutweiler. “Our solutions should continue to contribute towards making everyday life that little bit better”.



Mowiflex C 30 is a water-soluble support material, for example for 3D printing

**kuraray** *Noritake*

# APPLY AND PROCEED



**RECEIVE 5  
UNIT DOSES**

Sufficient for 5 treatments with  
CLEARFIL™ Universal Bond Quick

## **CLEARFIL™ Universal Bond Quick**

The new CLEARFIL™ Universal Bond Quick works instantly. Just apply, dry and light cure. That's all. It requires no waiting, no multiple layers and no extensive rubbing. All direct restorations, core build-ups and even indirect restorations and repairs, are reliably bonded. Simply use it the way you want. Total-etch, selective-etch or self-etch. You decide.

**Order your Trial Pack of CLEARFIL™ Universal Bond Quick on [KurarayNoritake.eu/CUBQ](https://www.kuraraynoritake.eu/CUBQ)**