## GC get connected 9 Your product and innovation update



## Get Connected, Together towards the best solutions for your patients.



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#### Welcome to GC 'get connected', GC Europe's newsletter that showcases our latest product innovations, techniques and trends in restorative dentistry.



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## GC get connected Your product and innovation update



## **Dear readers** Welcome to the 9<sup>th</sup> edition of GC's Get Connected newsletter.

Dear reader,

Glad you decided to 'get connected' with GC once again and now find yourself reading this latest edition. Needless to say, we have lots to say & share again.

Looking back to the latest edition of the International Dental show, we can say it has once more been a record breaking edition, in terms of visitors and sales. We're convinced that this is due to our dedicated team of professionals, the special relationship we have developed with our customers, as well as a series of strong new product introductions, such as GC Initial LiSi Press and D-Light Pro.

April also marks the closing of our (Japanese) fiscal year 2016-2017, also here on a positive note. Thanks to our dealers and customers we closed with another strong year, growing more than twice market rates. To further secure this growth we keep up with the most recent evolutions in digital dentistry. We have the Aadva Lab Scan and our Intra Oral Scanner, which are further optimised in terms of software and support to be able to compete among the best in class.

This never ending pursuit of quality was also reflected when GC was awarded a first place in the 2016 Quality Management Level Research. This is a survey conducted by the Japanese Union of Scientists and Engineers (JUSE), sponsored by Nikkei Inc. The JUSE is an independent group that conducts a survey at about 650 companies in industry such as manufacturing, construction, IT service, etc., on six factors of quality management.

GC is proud of the recognition and will continue improve the health of our society through high-quality products and services that enhance satisfaction of dental professionals and patients Last but not least, I'd like to wish you all a very good summer, some well-deserved rest and excellent holidays. Take some time off to charge your batteries, but as always, we'll be more than happy to meet up with you afterwards: on a congress, when one of our sales reps visits you or during a GC course in one our Campus facilities.

Wishing you all the best,

Michele Puttini

President, GC Europe

## Let's get social

As part of our service to customers to keep them up to date about our products and to help them use our products in a correct way, GC has an extensive presence across the social media channels. Be sure to connect with us here:





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# Discover all GC's apps

#### **Luting Guide**

All of GC's cementation materials are showcased in the Luting Guide. Ranging from the cementation of simple metal crowns with Fuji I, up to the adhesive bonding of veneers with G-CEM LinkForce, the latest composite-based addition to GC's range of luting materials. Looking for the optimal luting procedure? All parameters are accessible in one screen: select your type of prosthetic restoration, choose between a range of modern materials, (including lithium disilicate), indicate the circumstances like whether the environment is dry or not, low or high retentive preparations and discover our suggestions from our portfolio of luting materials. The 3D step-by-step will guide you through the process to achieve the most optimal results for all your cementation challenges. These configurators can be used as a treatment planning tool, but also to enhance patient communication, as dentists can show the procedure of the cementation in an easy and understandable way.



#### **Restorative Dentistry Guides**

The configurator gives you a 3D representation of any restorative class on any tooth using GC's advanced composite restoratives GC G-ænial Anterior & Posterior and GC Kalore as well as the flowables G-ænial Universal Flo & Flo, supported by the 7<sup>th</sup> generation selective etch bonding G-ænial Bond.

The app shows how aspects such as colour and thickness can be used. Up till now, with the limitations of 2D, this has been impossible to do. Technique



tips are also given for the use of these materials when repair of different types of dental restorations is required. The latest addition is a step-by-step series on the revolutionary posterior filling concept GC EQUIA.

#### **Initial Layering Guides**

To allow you to achieve optimal results with our range of ceramics, we have developed for you a unique tool that will guide you in a 3D presentation through the different application steps of Initial.

The configurator gives you a 3D representation of any restorative class on any tooth using GC's advanced composite restoratives GC G-ænial Anterior & Posterior and GC Kalore as well as the flowables G-ænial Universal Flo & Flo, supported by the 7<sup>th</sup> generation selective etch bonding G-ænial Bond.

The GC Initial Layering Guides will guide you in easy to understand way through the process of building up the various layers of the restoration. During the



step-by-step you can at any times turn the restoration to get a perfect view on how to build-up the different powders. The images can be changed into standard view, transparent view or outline view for optimal visualisation. Furthermore you will find the perfect firing instructions, the corresponding shade guide and many more features that help you to get the maximum out of the Initial ceramics.



## $GRADIA^{\texttt{R}} \ PLUS \ {\rm from} \ GC$

## when innovation meets indication...







Dr. Rafał Mędzin is a lecturer and trainer in cosmetic dentistry, aesthetic restorative techniques and dental photography, as well as a consultant in product development and clinical research. He obtained his dental degree in 1996 at the Pomeranian Medical Academy, Faculty of Dentistry, in Szczecin, Poland. In 1999 he earned Postgraduate Specialisation in General Dentistry and in 2012 graduated Postgraduate Curriculum of Oral Implantology at the JW Goethe University in Frankfurt, Germany.

Together with his wife and father, Dr Mędzin runs the Dentura Clinic and Lab in the city of Gryfino, Poland.

Dr Medzin is specialised in aesthetics and prosthetic rehabilitation on natural teeth and implants, as well as minimally invasive dentistry, CAD/CAM technologies and dental macro photography. In 2011 he achieved a world first when he gave a dental presentation in real 3D in Warsaw, on the biggest 3D 4K cinema screen in Europe.

His main interests outside of dentistry are martial arts and shooting. He holds a 1<sup>st</sup> dan black belt in aikido and is a certified ISSF sport-shooting instructor.

# Indirect composite

restorations in the posterior zone: probably **one of the best options** 

## Clinical step-by-step with GRADIA<sup>®</sup> PLUS composite, luted with G-CEM LinkForce<sup>™</sup>

#### By Dr. Rafał Mędzin, Poland

In spite of the many advantages that ceramic restorations have to offer, they have some drawbacks as well, such as wear of the antagonist and brittle catastrophic failures. That is why, for some particular cases, indirect composite restorations are preferred. High-strength indirect composites have the advantage of inducing less marginal chipping of the enamel around the margins of the restoration and they have better long-term stability on margins. According to available studies, indirect overlay composite restorations also exhibit better fatigue resistance and fracture propagation of posterior endodontically treated teeth<sup>1,2</sup>.

With indirect composite restorations, the enamel wear rate and total wear rate are more favourable than with ceramic restorations<sup>3</sup>. Moreover, composite restorations on implants present similar dynamic responses to load (damping behaviour) when compared to natural teeth using a simulated periodontal ligament<sup>4</sup> and they showed significant higher survival rate when compared to ceramic onlays and crowns in clinical trials<sup>5</sup>. We have been using composites for those cases more than 10 years long with really satisfactory results.

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#### Indirect Onlay & Hybrid Restoration on implant with GRADIA<sup>®</sup> PLUS

The following article describes the use of a new indirect composite, GRADIA® PLUS (GC) and the intra-oral luting procedure.

#### **Case Report**

A 38-year-old female who had received no significant dental health care for approximately five years was referred to our practice. She complained of unsatisfactory tooth function caused by missing teeth and defective restorations in the posterior area. She had no significant medical problems and claimed she did not use alcohol or tobacco. After a detailed examination we prepared a treatment plan, placing high importance on achieving good periodontal health and the active treatment of carious disease. Due to insufficient endodontics, our next step was non-surgical root canal treatment (NSRCT) revision of tooth 46, while the missing tooth 47 was replaced by an implant following cone beam computed tomography (CBCT) planning.

Successful osseointegration was achieved after three months, at which time we started restorative procedures. Using the GRADIA® PLUS, a nanohybrid lightcured composite system from GC in both cases, we prepared a composite overlay for tooth 46 and a screw-retained restoration for implant 47. To optimize the long-term stability of the material, we advise to carry out an additional thermal polymerisation of the restorations in a nitrogen atmosphere in the furnace to increase the conversion level up to 90-95 %<sup>6</sup>.

A first implant reconstruction was placed and the access hole was closed with wit a laboratory-prepared composite "cork" cemented with G-CEM LinkForce™ (GC) luting cement. We recommend to sandblast the restoration freshly just before the cementation. The same material was used for the final adhesive cementation of the 46 overlay.



**Figure 1:** Working model with gingival mask and straight abutment



**Figure 2:** Straight abutment mounted on the lab analog



**Figure 3:** Sandblasted abutment treated with GC Metal Primer II. A universal primer like GC Multi PRIMER can also be used. Functional phosphate-based monomers (MDP) will promote a strong bond between the metal surface and the composite luting



Figure 4: Isolation was placed on the onlay preparation



Figure 5: The abutment was covered with Gradia Plus Opaquer (A3 combination). A first layer of GRADIA® PLUS was placed on the onlay preparation



Figure 6: Final restorations on the model - screw access hole visible



#### Innovative shade concept of Gradia Plus indirect composite allowing multiple layering combination.





**Figure 7:** Final restorations on the model - screw access hole visible

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Figure 8: Composite "cork" within the implant access hole



**Figure 9:** Final restorations with gingival mask - lateral view



Figure 10: Final restorations with gingival mask - occlusal view



**Figure 11:** Final restorations with the access hole "cork" and clinical screw



## Indirect Onlay & Hybrid Restoration on implant with GRADIA® PLUS



**Figure 12:** Intra-oral view of the onlay preparation and the healing screw. Note that the onlay prep design presents low mechanical retention, therefore requiring the use of an adhesive resin cement to assure a strong bonding and last-longing retention



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Figure 13: Soft tissue contour - close-up view



**Figure 14:** The hybrid (titanium-resin) implant restoration was screwed directly onto the implant. Rubber dam isolation with the clamp covered with teflon's tape was used to preserve the restoration surface against saliva contamination



**Figure 15:** Refreshing of the sandblasted surface of the access hole. Screw head was protected earlier with hot gutta percha

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Figure 16: GC Multi PRIMER application



Figure 19: Light curing - 20s





**Figure 18:** G-CEM LinkForce was dispensed directly into the access hole and composite "cork" was bonded. Due to the precise adaptation of the composite "cork", it is important that a luting cement with low film thickness is used. G-CEM LinkForce presents a film thickness of around 4 microns, which is ideal in this situation

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#### Indirect Onlay & Hybrid Restoration on implant with GRADIA® PLUS



**Figure 20:** Selective etching of enamel for 15s. Research has shown that Universal adhesives reach their best performance when enamel is etched selectively. By avoiding etching of dentin, chemical bond is assured and the possibility of post operative sensitivity is reduced.



**Figure 21:** G-Premio BOND application. For optimal adhesion, the tooth surface should be clean and any water excess should be removed. A practical way to dry the preparation without overdrying it is to use a cotton pellet instead of air syringe. For this bonding agent, the application of one single layer is enough.



**Figure 22:** Air drying of the bonding agent should be done with high pressure air for 5 seconds. This will assure a rather thin film thickness, and efficient elimination of the solvent, and therefore a strong bonding layer. G-Premio BOND can be light cured before cementation to assure high polymerization. This should not influence the adaptation of the restoration as G-Premio BOND can be used in a very thin film thickness.



Figure 25: Application of G-Premio Bond.

Always air blow G-Premio Bond with strong

for a separate bonding step.

pressure for 5 s. Note that this step is optional.

The intention is to let the bonding agent deeply penetrate into the microporosities of the sandblasted composite surface. A luting cement with high wetablity like G-CEM LinkForce may fulfill this objective perfectly without the need

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Figure 23: Pick-up stick for onlay



Figure 26: G-CEM LinkForce applied directly onto the onlay surface from automix syringe



**Figure 24:** Sandblasted composite surface covered with a universal primer, namely GC G-Multi PRIMER. The silane coupling agent in G-Multi Primer will promote a stable chemical adhesion of the resin cement to the filler particles of the highly-filled indirect composite Gradia Plus.

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#### Indirect Onlay & Hybrid Restoration on implant with GRADIA® PLUS



Figure 27: G-CEM LinkForce applied directly onto the onlay surface from automix syringe



Figure 29: G-Cem LinkForce excess was removed before polymerization



**Figure 30:** GRADIA® PLUS AIR BARRIER was applied on the margins before the final polymerization. This step aims to prevent contact of the cement line with air, therefore avoiding the formation of the so-called oxigen-inhibition layer. When present, this layer may lead to future marginal discoloration due to its low level of polymerization.

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**Figure 28:** Onlay stabilized by an instrument while cement excess is removed. It is important that no movement of the restoration is allowed during excess removal. Any movement at this stage may lead air entrapment between the tooth and the restoration or crack formation within the cement layer which is still not completely polymerized. The excess can be tack cured for 1s to facilitate its removal. Alternatively, wait around 2 minutes until the cement feels rubbery. This will make the procedure completely worry-free.

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Figure 31: Restoration after the initial light-curing



**Figure 32:** Final result - occlusal view. Note the natural result that can be achieved with modern composites for indirect restorations such as GC Gradia Plus.

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Figure 33: Natural effect of the final restorations compared to the existing dentition



Clarissa Bonifácio graduated from the University of São Paulo (USP-Brazil) in 2004, concluded her specialisation in Paediatric Dentistry in Brazil in 2006, her Masters in Restorative Dentistry in 2008 (USP-Brazil) and her PhD in Paediatric Dentistry (ACTA-NL) in 2012. In 2014 she concluded her Masters in Paediatric Dentistry in The Netherlands and she is currently working as Assistant Professor in Paediatric Dentistry at ACTA (Academic Centrum for Dentistry Amsterdam).



Daniela Hesse graduated from the University of São Paulo (USP-Brazil) in 2007, concluded her specialisation in Paediatric Dentistry in 2009 (USP-Brazil), her Masters in Paediatric Dentistry in 2012 (USP-Brazil) and her PhD in Paediatric Dentistry (USP-Brazil) in 2015. She is currently working as Assistant Professor in Paediatric Dentistry at ACTA (Academic Centrum for Dentistry Amsterdam).

## Managing severe Hypomineralised Second Primary Molars (HSPM) and Molar Incisor Hypomineralisation (MIH) with preformed metal crowns

#### By **Dr. Clarissa Bonifácio** and **Dr. Daniela Hesse,** The Netherlands

MIH is defined as a qualitative hypomineralisation of enamel of systemic origin appearing as a demarcated opacity in one or more first permanent molars, permanent upper incisors or permanent lower incisors<sup>1</sup>. In the primary dentition, the same type of defects is known as hypomineralised second primary molars (HSPM)<sup>2</sup>. The enamel defects can vary in extent and severity, can present different colours (white, yellow, brown), can lead to post-eruptive breakdown (PEB) and can be associated with extensive atypical caries development<sup>3</sup>. Children with hypomineralisation of their first permanent molars often require more and repeated treatment than children without the condition<sup>4</sup>. Furthermore, children with MIH may experience hypersensitivity of the affected teeth if exposed to temperature changes<sup>1</sup>. The treatment strategies are similar for primary and permanent molars, being focused on preventive strategies when there is no PEB, in

Managing severe Hypomineralised Second Primary Molars (HSPM) and Molar Incisor Hypomineralisation (MIH) with preformed metal crowns

an attempt to protect and reinforce the dental structures. In these mild cases, the application of fluoride varnishes such as GC MI Varnish and applications of GC Tooth Mousse or GC MI Paste Plus<sup>®</sup> at home are advisable<sup>5</sup>. When there is already some loss of structure, in cases where the patient reports sensitivity or when the affected element is not fully erupted, the advice is to protect the dental structure by placing a high-fluoride glass ionomer sealant<sup>6</sup>, such as GC Fuji TRIAGE<sup>®</sup>. None of these products requires the use of anaesthesia, or enamel etching, and they are easy to apply, being suitable for the primary and the permanent dentition.

In the primary dentition, in the case of severe structure loss due to HSPM or the combination of HSPM and caries. we tend to avoid extractions of the second primary molar, to safeguard the place for the subsequent premolar and prevent the mesialisation of the first permanent molar. When it comes to the first permanent molars severely affected by MIH, extraction can be

indicated but the stage of development of the second permanent molars is crucial to determine the ideal moment for the extraction<sup>7</sup>. Normally, the second permanent molar should have one- to two-thirds of its root formed at the moment of extraction of the affected first permanent molar. In case the affected molar needs to stay in the mouth, it must be protected to prevent

more structure loss or pain. In these cases, the placement of a preformed metal crown (PMC) is the most indicated temporary treatment, while waiting for the ideal moment for extraction.

The conventional method of placing these PMCs preconizes tooth preparation, lowering the occlusal surface and adapting the approximal

Table 1. Classification, Signs & Symptoms and Suggested Treatment			
Classification	Mild	Moderate	Severe
Signs and Symptoms	<ul> <li>Visual change (opaque or yellowish enamel)</li> <li>No post-eruptive enamel breakdown</li> <li>No caries involvement</li> </ul>	<ul> <li>Limited post-eruptive enamel breakdown</li> <li>Patient occasionally reports hypersensitivity</li> </ul>	<ul> <li>Severe post-eruptive enamel breakdown</li> <li>Hypersensitivity becomes a limiting factor for hygiene and quality of life</li> <li>High risk of caries involvement</li> </ul>
Suggested Treatment	• Preventive treatment with remineralising agents such as professional application of CPP-ACP*/high-concentration fluoride varnish or domestic application of CPP-ACP/ fluoride-containing paste	<ul> <li>Preventive treatment with remineralising agents and;</li> <li>Protection of the broken enamel areas with a glass ionomer-based sealant or composite</li> </ul>	<ul> <li>Preformed metal crowns cemented with a glass ionomer luting cement in case of HSPM (Hall technique).</li> <li>Extraction of 1st permanent molar in case of MIH can be an option**.</li> </ul>
Material	GC MI Varnish GC Tooth Mousse GC MI Paste Plus	GC Fuji Triage GC MI Varnish GC Tooth Mousse GC MI Paste Plus	Preformed metal crowns GC Fuji I

By the moment of extraction of the affected 1st permanent molar, 2<sup>rd</sup> permanent molar should have from 1/3 to 2/3 of its root formed. The affected molar should be protected with a metal crown until the moment of its extraction.

#### Managing severe Hypomineralised Second Primary Molars (HSPM) and Molar Incisor Hypomineralisation (MIH) with preformed metal crowns

surfaces. This can guarantee adaption of the PMC to the tooth; however, the tooth preparation might lead to extended chair time, and HSPM/MIH molars are known to be more difficult to get anaesthetised<sup>4</sup>. In the case of primary molars, a less invasive technique that cements a PMC over the tooth without any tooth preparation - the so-called Hall technique<sup>8</sup> – can be indicated for the management of affected teeth. PMCs offer physical protection to teeth affected by enamel hypomineralisation, through complete tooth coverage as well as arresting eventual progression of any caries lesions. In fact, treatment with PMCs presents encouraging results, once their longevity has been found to be equal to or superior to restorations<sup>9</sup>. Particularly for the placement of PMCs using the Hall technique, where no tooth preparation is required, the assessment of the contact areas and the occlusion prior to the treatment is necessary. In cases where there is no space between the treated tooth and its adjacents, placing orthodontic elastic separators in the contact points is advised. The elastics are placed in the approximal surfaces of the tooth to be treated, with the help of dental floss. After three to five days the patient returns, the separators are removed and the appropriate crown size is selected. The smallest size possible is recommended; however, the clinician should select a crown that covers all cusps with a perfect adaptation in the approximal areas. After that, the PMC is filled with a GIC for cementation and the crown can be positioned<sup>8</sup>. The crown is seated by finger pressure and, in some cases, the child helps with the crown adaptation by biting it

#### Case 1

Girl, four years old. HSPM molars were previously treated with GIC but the material seems to break and the extent of the enamel loss increases over time, resulting in severe sensitivity for the little girl.





Figures 1a & 1b: Occlusal view of upper and lower jaw before treatment, respectively. Previous direct restorative treatment failed due to the extension and location of the enamel breakdown. Remaining restorative material can still be observed in specific areas.

Figure 1c: Occlusion before treatment



Figures 1d & 1e: Occlusal view of upper and lower jaw after treatment with the Hall technique, respectively.



**Figure 1f:** Occlusion after treatment. Note the increase in the occluso-vertical dimension (OVD) which seems to progress to self-resolution after 15 to 30 days<sup>10</sup>

into place. Then the excess cement is wiped away and, after the first setting reaction (2-3 minutes), dental floss is used to clean the interproximal areas<sup>8</sup>. Because there is no tooth preparation or caries removal, the occluso-vertical dimension (OVD) tends to be increased after placement of a crown using the Hall Technique<sup>8,10</sup>, a factor that seems to present a self-resolution after 15 to 30 days<sup>10</sup>.

The GIC for cementation, GC Fuji I, is a well-established material for the cementation of crown and bridge restorations. This material has the property to chemically bond to the Managing severe Hypomineralised Second Primary Molars (HSPM) and Molar Incisor Hypomineralisation (MIH) with preformed metal crowns

#### Case 2

Boy, three years old, complaining of pain when brushing the upper second primary molars. Enamel loss is located in the distal cusp of the occlusal surface, an area of difficult retention for restorative materials.



Figure 2a: Occlusal view of upper jaw before treatment. Enamel breakdown is located in an area of difficult retention for direct restorative materials.



Figure 2b: Use of orthodontic elastic separators for three to five days is advised to create interproximal space for the preformed metal crowns.



**Figure 2c:** Occlusal view of upper jaw after treatment with the Hall technique.







Figures 2d & 2e: Occlusion before treatment.



**Figures 2f and 2g:** Occlusion after treatment with the Hall technique. Note the increase in the occluso-vertical dimension (OVD), which seems to progress to self-resolution after 15 to 30 days<sup>10</sup>

tooth structure and the metal in PMCs. Studies show that this material presents excellent strength, good marginal integrity<sup>11</sup> and has good biocompatibility<sup>12</sup>. Additionally, it is easy to handle and is fast-setting, therefore the time necessary for the cementation of preformed metal crowns can be decreased, a factor essential to the treatment of paediatric patients. Excess cement can be easily removed when the cement feels rubbery.

As said before, patients who present severe HSPM/MIH have an increased need for dental treatment<sup>4</sup> due to the higher treatment needs and failure rates of conventional treatment when compared to non-affected teeth. Also, sensibility is often present, and these factors can lead to the development of dental anxiety and fear<sup>4</sup>. Therefore, the treatment decision of HSPM should be based on severity and sensitivity. In cases with high severity, the placement of a PMC following the Hall technique premise seems to be a suitable option, as the crown offers physical protection to the tooth, preventing its further loss of structure and reducing or even eliminating sensitivity from these molars. Also, as anaesthetics and tooth preparation are not required, this procedure can be considered a friendly approach for the patient, accepted by patients, parents and dentists. However, future research in this field is advisable to expand the body of knowledge around the treatment of HSPM with the Hall technique, and to benefit patients and parents, as well as guide clinicians and public health policy decisions.

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# Press for perfection!

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### Initial<sup>TM</sup> LiSi Press From GC



The revolutionary new pressable ceramic that combines strength, aesthetics and ease of use!







#### Toshio Morimoto

- 1982 Graduated from Osaka Dental University School of Dental Technology
- 1982 Joined the Dental Clinic Komuro Group
- 1989 Graduated from IDA
- 1991 Opened M Dental Laboratory



# Key points to the successful laboratory processing of **PRESS**

# On the occasion of the release of GC Initial™ LiSi Press/LiSi PressVest

#### By **Toshio Morimoto,** Dental Technician, M Dental Laboratory, Osaka Introduction - two major problems in laboratory processing of press ceramics

Press ceramics have many advantages over zirconia when placed in the mouth because they are more esthetic and have less of an impact on opposing teeth. The fact is, however, the laboratory processing accompanies substantial difficulties. The possible problems can be classified into two major types.

Unlike metal casting, these problems cost more due to non-reusable press ceramics, relatively expensive investment materials, and other factors. Furthermore, the re-fabrication takes substantially more time than metal casting.

With all these factors of the current situation of the dental laboratory market taken into account, it is quite understandable that one would shift to materials other than press ceramics after having failed more than once. No matter how hard you try, you cannot overcome failures without

#### Two major problems in the laboratory processing of press ceramics

**Problem 1:** Investment failure during pressing. Even when no external breakage is observed, internal cracks cause fins and a fractured abutment part results in restorations with filled inner cavities.

Problem 2: Incomplete margins and rough surfaces of press objects.

knowing the causes. Even well intended actions to prevent failures may sometimes lead to unexpected problems, which make finding the causes more difficult. On the occasion that GC releases the press ceramic Initial LiSi Press/LiSi

PressVest, I present how to manage such problems based on my experience and results from experiments.

#### Press ceramics or zirconia?

For all ceramic restorations, we currently choose either press ceramics such as Initial LiSi Press or zirconia. We consider various selection criteria for individual cases as we actually and clinically choose materials. In the cases of the splinted multiple unit restoration, zirconia is advantageous for its mechanical strength, whereas press ceramics have superior esthetics.

From a functional viewpoint of (wear) compatibility with opposing teeth, it is not always true to say "hard materials = less wear". One may assume "hard = more resistant to abrasion", but in fact, the same material presents dramatically different outcomes depending on "conditions of the polished surface", "characteristics of wear surfaces", and "lubrication conditions". Here, I focus on the "conditions of the polished surface", and for more detailed explanations, you can look for in "Tribology".<sup>\*1</sup>



Figure 1-1: The SEM image of Initial LiSi Press.

You can polish the functional cupids of full-contoured zirconia restorations to a high luster. Highly polished zirconia has been reported to be less-wearing than press ceramics.\*

However, it should be difficult to polish the triangular ridges on the occlusal surface to a high luster when considering all the current technical factors and materials used in dental laboratory work together. Polishing is still more difficult during the adjustment in the patient's month. Therefore, inadequately polished zirconia restorations can cause more severe two-body abrasive wear. \*2 In contrast, we can polish press ceramics relatively easily and so the ridges on the occlusal surface have a high luster. In addition, refined crystals of lithium disilicate included in LiSi Press allow mechanical polishing to provide a smooth and lustrous surface texture featuring a surface property of less

abrasion of opposing teeth if any wear occurs (Fig. 1-1). With all things considered, press ceramics now seem to be advantageous.

## How to Prevent Cracks in Investments.

Even materials with advantageous features cannot be useful if they fail frequently. LiSi PressVest is phosphatebonded; therefore, you need to observe general precautions for phosphatebonded investment materials. Now, I will discuss the troubleshooting.

Small cracks that develop during burnout of rings (Fig. 2-1 left) may play a role in breaking the investment on pressing (Fig. 2-1 right). Additionally, even in the absence of cracks on the surface, internally developed cracks may lead to fracturing the abutment



**Figure 2-1:** Left: Cracks after burnout. When the ring is placed in the ring furnace at 500°C and then the temperature is raised to 900°C, the ring may crack as shown in the figure. Right: As shown in the figure, the investment having a decreased compressive strength may fail when pressed.

\*1 Tribology

Tribology is the science and engineering that deal with what happens at the interacting surfaces in relative motion and studies all the phenomena, including "wear", "seizure", and "rolling contact fatigue" caused by friction to prevent and reduce the damage of friction surfaces or to utilize them.

For example, the load causing seizure between highly polished ceramics and metals is far greater than that at the metal-to-metal or ceramic-to-ceramic rubbing surfaces. Thus, one cannot simply assume "hard = less wear" or "soft = more wear", and friction involves a wide variety of factors, including the quality of materials, states of motions, surface conditions, contact conditions, and small particle inclusion between friction surfaces.

The branch of engineering comprehensively studying these factors is called Tribology

\*2 Abrasive wear

Abrasive wear takes place when a rough, hard surface glides across a relatively softer surface or any hard foreign bodies are included between friction surfaces. Two-body abrasive wear takes place when hard projections on one surface eliminate material from the opposing surface. Three-body wear occurs when the hard inclusions between friction surfaces exist. \*) Seiji BAN: "Polishing and Finishing of Full-contoured Zirconia Crowns and Wears of Opposing Teeth." QD" Vol. 37 2012. portion. These cracks are attributable to less compressive strength of the investment materials than that intended to be attained (Fig. 2-2).

To prevent cracks, the following precautions should be followed.

Compressive strength of LiSi PressVest (MPa)			
After solidification (after 120 minutes)	Burnout at 900°C	After cooling following burnout	
4.0	20.3	6.3	

Figure 2-2: Compressive strength of LiSi PressVest (MPa)

#### How to Prevent Cracks in Investments

- (i) The ring should be placed in the ring furnace between 20 minutes to 3 hours after investing. After 3 hours, the rings have higher risks of causing cracks.
- (ii) To avoid the dangerous
  temperature zone causing cracks
  as much as possible, the
  temperature of the ring furnace
  must be set to 900°C, and it should
  be completely heated before the
  ring is placed (never placed if the
  furnace is not heated to 900°C).

Once the ring is placed in the ring furnace, the temperature setting should be lowered to 850°C.

- (iii) Do not place rings in the ring
  furnace with any investment rings
  for metal casting. (The metal rings
  excessively lower the temperature
  of the ring furnace. At maximum,
  four 100 g rings or two 200 g
  rings can be placed at the same
  time in the furnace, but you need
  to check the capacity of your ring
  furnace.)
- (iv) The holding time should be not less than 45 minutes. (The holding time up to about 5 hours will not significantly decrease the strength.)
- (v) Avoid lowering the temperature
  by opening the ring furnace
  during the holding time for
  burnout. In placing the ring in the
  press furnace, the ingot should
  be inserted as quickly as possible
  to prevent the ring from cooling
  down as much as possible.

- Place the ring into the ring furnace heated to 900°C.
- Do not place the ring together with those for metal casting.
- The holding time should be not less than 45 minutes.
- Evenly distribute rings in the ring furnace.

**Reasons for (ii), (iii), and (v):** As shown in the graph (Fig. 2-4), if the phosphate-bonded investment material is "slowly heated", it once expands at around 250 °C during cristobalite transformation and then shrinks from around 350°C in association with decomposition of ammonium phosphate. Repeated thermal expansion and shrinkage promote the formation of fine cracks. Therefore, as shown in the graph of "rapidly heated" in Fig. 2-4, heating up at the maximum possible rate in this temperature zone results in a relatively constant expansion of the investment. Accordingly, we can preserve the strength of the investment material and avoid the formation of cracks. Additional elevation and lowering of the temperature during the holding time may cause additional destruction of crystal structures, leading to reduced compressive strength. So the ring should be transferred to the press furnace as quickly as possible to avoid heat loss of the ring.

Reasons for (iv): The more heated the phosphate-bonded investment materials, the greater the compressive strength. The short holding time in the furnace as well as larger investments such as 200 g rings may prevent the middle part of the investment to be heated up completely, which result in the incomplete compressive strength causing problems (Fig. 2-2).

#### Causes of investment failure besides insufficient strength of investments

The investments may fail due to causes other than those discussed above. Such causes include too high temperature for melting the press ceramics or too long holding time in the press furnace. If the press ceramics are melted more than necessary, it would infiltrate into the investment. Thereby the press ceramics exert wedge effects to generate cracks in the investment, leading to the formation of fins and the investment failure.

When troubleshooting such problems, you certainly need to use an appropriate press temperature and an



Figure 2-4: Variation in thermal expansion coefficient by different heat-up protocols.

adequate holding time for the press ceramics whereas you can also routinely attach longer sprues to be prepared for unexpected problems. Longer sprues can prevent investment failure. Completely different from metal casting, sufficient pressing can be done with longer sprues. The longer distance between the base part and the wax pattern even favors preventing the wedge effect and thus reduces the risk of investment failure.

## Sprues of different length result in different press results even when the pressing is performed with other conditions being the same.





**Figure 3-1:** The length of each sprue in the left and right figures is 3 mm and 5 mm, respectively. The Ready Casting Wax R25 was used for both sprues and 0.46 mm-thick sheet waxes for press molding.



Figure 3-2: Press ceramics infiltrate into the investment when the melting temperature is too high.

## Processing and handling of the investment material.

First, the mixing ratio should strictly be adhered to. The colloidal silica designed for each product of phosphate-bonded investment material has different concentrations and in turn, different specific gravities. Colloidal silica should be measured with graduated cylinders or syringes because it has a different specific gravity from that of water, which disables the accurate measurement with scales (Fig. 4-1) (What is important here is to measure the volume rather than the weight).

The second most important point is the temperature control of the investment material. Especially in

- Adhere to the mixing ratio.
- Closely control the temperature.
- Mix thoroughly.

**Figure 4-1:** You can quickly and accurately measure using a syringe rather than a graduated cylinder.

phosphate-bonded investment materials, the lower temperature retards the intended hardening reaction, resulting in decreased strength and setting expansion.



To prevent any problems, powders and liquids should essentially be stored at 23°C. Especially in January and February, powders and liquids stored in a cold room should be handled with due care. It may take 3 to 4 hours to allow the powder that once became cold to reach room temperature. Therefore, in winter, when the investment material is stored at cold room temperature, you need to wait until around noon to confirm its having been warmed to 23°C to start the investing procedures.

On the contrary, in summer, the temperatures of powders and liquids are elevated, which only shorten the hardening time and does not significantly influence physical properties such as setting and thermal expansion.

#### Melting conditions of ingots

Problems of "incomplete margin" and "rough surface" can occur depending on the melting conditions of the press LiSi PressVest normally has a working time of about 7 minutes. It is reduced to about 5 minutes when the temperatures of the powder and the liquid are raised to 30°C.

However, it inherently has high flowability, which ensures enough time for investing (Fig. 4-2). In addition, thorough mixing is important to obtain the intended physical properties. The mixing program



of the Twister Evolution from Renfert
tested in my experiment is listed
below (Fig. 4-3).

1 minute after mixing 5 minutes after mixing

Figure 4-2: Flowability of LiSi PressVest.

Premixing	15 seconds
Revolution speed	300 rpm
Mixing time	1 minute
Inverse rotation	30 seconds

Figure 4-3: Twister Evolution from Renfert and the mixing program time I use.

ceramics. To prevent such problems, we need to slightly adjust the holding time and temperature from those specified by the manufacturers. The variation in temperature by each



furnace requires such adjustment. The next is about melting of press ceramics.

We, dental technicians, are apt to compare the melting of press ceramics to those of metals that transform from a solid to a liquid state. However, unlike metals transforming from a solid to a liquid state at solid and liquid phase points, ceramics and rubber convert at the glass transition point (Fig. 5-1). Even when the temperatures exceed the glass transition points, they show no such significant changes as those observed in metals. For example, if rubber is soft enough to be bent easily, its temperature is beyond the glass transition point, and it remains soft over a wide range of temperatures despite the variation in softness.



Ceramics and rubber, when they are melted, feature plasticity over a wider range of temperatures while they maintain an appearance like solids. Thus, they never convert into liquids when they are melted. So, press ceramics are simply softened to be pressed (the glass transition point of LiSi PressVest is 520°C, which is lower than the pressing temperature). Furthermore, glass has substantially lower thermal conductivity than metal (Fig. 5-3), which results in substantially different melting rates between the surface and middle areas even in small-sized ingots; therefore, it takes a few hours to be uniformly melted (Fig. 5-2, Fig. 5-3). Because it is clinically impractical to take several hours to uniformly soften ceramics, the program shown in Fig. 5-4 is developed to obtain the intended softness in a shorter time.

Thermal conductivity (W/mK)		
Gold	295	
Silber	418	
Palladium	70	
Glass	0,76	
Quarts glass	1,35	

Figure 5-2: State of a melted ingot in cross

section

Figure 5-3: Thermal conductivity (W/mK)

Panamat Press / Austromat 644 (GC / DEKEMA)				
Ingot type	HT, MT, LT		MO	
Ring size	100g	200g	100g	200g
Start temperature	700°C		700°C	
Temperature rise rate	60°C / min		60°C / min	
End (holding) temperature	893℃	913℃	907°C	923°C
Holding time	25min		25min	
Pressing time	5min		5min	
Pressing pressure level	ressure level 5		5	

Figure 5-4: Recommended programs of Initial LiSi Press by GC.

In light of these properties, attention should be given to the following.

#### Things to be considered in view of the characteristics of press ceramics:

(i) The surface conditions of pressed objects may differ depending on the size of the sprue patterns even if the ingots are similarly melted. Especially in the case of smaller patterns, the well-melted outer part of the ingot (Fig. 5-2) is readily pressed into it, leading to the increased risk of a rough surface. For troubleshooting it, a second (dummy) sprue can be placed to obtain consistent press results, as shown in Fig. 5-5. (ii) As shown in Fig. 5-6, the space within the mold is filled as the ingot is pressed. During this process, the pressure is applied in a certain direction as the melted ingot is not a true liquid (Fig. 5-7, Fig. 5-8). Therefore, the sprue press objects and the second sprue should be attached at an angle of 60° or less between them (Fig. 5-5).









**Figure 5-5:** Attach to have an angle of 60° (30° or less from the center on both sides).

Figure 5-6: Press molding in an investment mold.



**Figure 5-7:** Schema of the press pressure. Pressure is more applied in the vertical direction. Therefore, press objects should be sprued so that the margins are in such a direction.



Figure 5-8: When sprued as shown in this figure, pressure cannot completely be applied to the deepest part of the object, leading to failure.

#### Troubleshooting incomplete/short margins of press objects.

Here I discuss incomplete margins of press objects as classified into two categories.

#### Two patterns of the incomplete margin of press objects to be discussed are as follows:

(i) Large marginal discrepancy with an extensively incomplete margin (Fig. 6-1).





(ii) Generally good marginal fit with some gaps in part (Fig. 6-2).





Figure 6-3: Schema of residual air. Air incompletely vented is entrapped around the margin to cause a short margin. This defect can mislead us to have an impression of a crown being seated incompletely as the shortened margin presents a similar shape to that of the real margin.

The cause of (i) may be insufficient melting of ingots and can thus be solved by extending the holding time in the press furnace. If it is not effective, you need to raise the press temperature or extend the pressing time. The optimal softening conditions can be explored by pressing with mesh



**Figure 6-4:** Ideally pressed condition into mesh pattern. (The wax pattern of GEO retention grid, fine from Renfert and the sprue of R25 are used.)

patterns. In such a case, the result as shown in Fig. 6-4 should be qualified as good.

If you have any incomplete margins, you first extend the holding time by about 5 minutes. If it is not effective, you can raise the softening temperature by 5°C.



**Figure 6-5:** Ready casting wax R07 is used to place the open vent.

As shown in Fig. 6-3, the air incompletely vented causes the defect such as (ii). So, this type of problem can be solved by placing open vents to the pattern to eliminate the entrapped air in the mold (Fig. 6-5).





• Adjust the holding time and temperature to heat ingots adequately

**Figure 6-6:** When the pattern is sprued in such a direction as shown in the figure, the air is likely to be entrapped in the area indicated by the arrow leading to locally incomplete margins.



#### **Open vents**

The press furnace is vacuumed during pressing by a vacuum pump but still contains enough air to cause defects. As shown in Fig. 5-6, while the space in the mold is filled as the ingot is pressed, the air remaining in the mold may escape through the sprue during the pressing process (Fig. 7-1) or pushed around the sprue to be entrapped (Fig. 7-2).

Because the air pushed to the margin also causes incomplete pressing, such

as short margins (Fig. 6-3), open vents should be placed to promote the elimination of air from the mold (Fig. 7-3).

The length of pressed open vents can also serve as an indicator of appropriate conditions including melting temperature and holding time (Fig. 7-4).

Especially when using a furnace utilizing air pressure to press ceramics, you should have difficulties in eliminating such air and must place open vents (because the remaining air is to be pushed by the air pressure).

Open vents should be placed at the last parts where press ceramics reach while they are press-filled, and multiple vents may be required depending on the shapes of the patterns. I hope you enjoy laboratory work as you pay attention to the key points discussed here to eliminate any difficulties.



Figure 7-1: Left: with vents. Right: without vents. The open vents, which are placed at the last point where the pressed ceramics reach as shown in Fig. 6-5, help eliminate the residual air and can make a difference in pressing results as shown above even with other conditions being the same.

#### Press-fitting plunger of the press furnace (when an aluminum plunger is used)

Repeated pressing increasingly causes the attachment of press ceramics on the press-fitting plunger that comes down from the ceiling part of the press furnace. The attached ceramics work to stick the press-fitting plunger to the plunger, and thus the plunger placed on the investment will be lifted up as the press-fitting plunger is elevated at the end of pressing program (Fig. 8-2). Accordingly, the



Figure 7-2: Trace of the escaping air through the sprue.



Figure 7-3: Many random crater-like air bubbles are shown.

Figure 7-4: The length of pressed vent under appropriate pressing conditions. The pressed vent becomes shorter when ceramics are insufficiently softened, and in contrast, it becomes longer when softened too much. The parameters of the press furnace should be adjusted depending on the conditions of pressed vents.

ceramics once pressed into are sucked back, which may lead to the incomplete margins.

Therefore, the press-fitting plunger should periodically be scraped and cleaned.





Figure 8-1: As shown in the figure, press ceramics are increasingly accumulated on the surface of the press-fitting plunger if the attached press ceramics are left unremoved. Therefore, press ceramics attached to this part should periodically be scraped off.





Figure 8-2: When pressing is completed, the press-fitting plunger lifts the plunger to cause the suck-back of press ceramics.

#### Conclusion

I have shared techniques for the successful laboratory processing of press ceramics. As a matter of fact, I have learned how to avoid failures only after I had taken supposedly

well-intended actions based on my experience and assumption that only led to poor results, and I realized it through repeated experiments and the continuing process of trial and error.

For example, I previously thought

that I could get good results if I placed the ring in the furnace at a lower temperature before it was completely heated to 900°C, which in fact, caused problems.



# Two modes, one device, no double standards.

CU

Labolinghe DAXO

# Labolight DUO from GC

LED Dual Mode Light Curing Unit for indirect composite techniques





#### Francisco Troyano Aller Technical specialist in prosthetic dentistry since 1979. Founder of MAPIDENT, S.L. laboratory in 1987 Honorary member of ACADEN Founding member of Dental Technological Club Founding member of Gerber Meeting Internacional. Courses of balanced complete prostheses since 1997. Specialist in complete prostheses, according Dr. Gerber's philosophy. Courses of aesthetic prostheses and gum customization, since 2001 Lecturer in the conferences of Spanish Aesthetic Dentistry Association, October 2000. Lecturer in the 8th Scientific Workshop of ACADEN, March, 2002 and November, 2007. Lecturer in Mediterranean Dental Forum, January 2003. Lecturer in Andalusian Prosthetic College (Sevilla, Granada and Jaén) Contributor for GC in aesthetic coatings with Gradia (laboratory) and Gradia Direc

with Gradia (laboratory) and Gradia Direct Author of many scientific articles, national and international.

# Restorations with **composite in ceramic** rehabilitation

By F. Troyano, Spain

For many years, many professionals, both technician and clinicians, found it stressful to deal with a case of a ceramic fracture which had been in mouth for a long period.

It is well known that when a fracture occurs in any ceramic rehabilitation in mouth, it is reckless to put the restoration back in the furnace. The most probable consequence is the crash of the ceramic, with the subsequent inconvenience of having to repair it, plus the cost.

Nowadays, these fractures can be repaired in an easy and quick way, without the high cost of doing the restoration all over again from the start.

#### **Initial situation**

Case of a patient with a metal ceramic bridge: in a three-part bridge from 12 to 21, a fracture has occurred in piece n° 11. (Figures n° 1 and n°2)



Figure 1 & 2: Initial situation, fracture of piece 11



Preparation and bonding

Before beginning, it is very important to get the shade, the saturation and the value of the restoration. Once we have these data, we can start with a medium grain, diamond bur, milling the surface five tenth of a millimeter on the vestibular and palatine part, scrupe the rest of the piece. Sandblast the area to be repaired, protecting the rest of the pieces of the bridge.





**Figure 3 & 4:** Scruping and sandblasting of the surface to be repaired. Vestibular and palatine view

Clean and dry the surface. Etch with hydrofluoric acid during two minutes and then rinse with plenty of water to remove any excess of the acid.

Then, allow the whole restoration to dry. Make sure that there are not any excess of water so the retentive surface, which we have created by roughening and etching, is not damaged.

Once the surface is clean and dry, apply the bonding agent for ceramics CERAMIC PRIMER II (GC) and allow it to dry for a few minutes. There is no need for light-cure.



Figure 5: Etching with hydrofluoric acid



Figure 6: Application of CERAMIC PRIMER II from GC

#### Layering

We will use different pastes but the protocol for layering will be the same as when we do a new restoration. We will use on the fractured part, opaque dentin, in this case, HB-ODA. In order to create the desired mamelon structure, it is necessary to do little incisions in incisal-cervical direction, which will ease the masking of the fracture line.



**Figure 7:** Application of opaque dentin HB-ODA

By applying opaque dentin the fracture line will be absorbed and thus enhances the integration within the final colour.

Apply HB-DA3 on top to continue the mamelons and overlap in wedge shape from the middle to the incisal edge.

Pre-cure for 10 seconds.

HB-DA3, apply dentin on its color to continue the mamelons and overlap in wedge shape from the middle third to the incisal edge.



Figure 8: Dentin on its color, in this case, HB-DA3



**Figure 9:** Detail of the dentin. The integration of color and the same saturation can be appreciated

In the next step, we create the dentinenamel junction with the paste HB-CLF, which will allow the light to scatter when it penetrates the tooth, bringing a luminosity similar to natural teeth. (Fig. n° 10 & n° 11). Pre-cure for 10 seconds



**Figure 10 :** Application of a thin layer of Clear Fluorescence (HB-CLF ) over the entire surface.



**Figure 11 :** Detail of the dentine-enamel junction, where you can see the incisal edge and its transparency

We finish by applying enamel pastes, HB-PE, in order to create the line angles of the tooth and with HB-ED to create the vestibular and palatine part of the tooth. When modelling, MODELING LIQUID from GC will be very useful.

Pre-cure for 10 seconds.



**Figure 12:** Aspect of the bridge once modelling is done

.....



**Figure 13:** With Modeling Liquid, it is easier to place the different pastes and to model with a brush.

#### **Finish And Polishing**

Once modelling is done, we must light cure the restoration and remove the inhibition layer. Cover the composite crown with GRADIA® PLUS AIR BARRIER and light cure with Labolight DUO 3 minutes. It is very important to cover all the restoration in order not to allow it to make contact with oxygen during the light curing. At the end, take out of the lamp and rinse with cold water (do not use steam) and mill with a tungsten carbide bur at low speed.



**Figure 14:** Application of GRADIA® PLUS AIR BARRIER



**Figure 15:** complete cover with Gradia Plus Air Barrier, making sure that it has no contact with oxygen

.....

Once you get the anatomy of the tooth, polish with GC DiaPolisher Paste, using dedicated polishing tools, finish with a mop in order to brighten it.



Figure 16: Aspect of the finished restoration



Figure 17 & 18: Application of DiaPolisher Paste

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Final Result: Restoration of a fracture in piece 22 in a metal-ceramic rehabilitation. Similar case protocol.



Figure 19 & 20: Final result





Figure 21: Initial situation, fracture of piece 22. 



.....

Figure 22: Final case.



Figure 23: Detail

Made to fit all your adhesive challenges Designed to last



## G-CEM LinkForce<sup>™</sup> from GC

Dual-cure adhesive luting cement for all indications, all substrates

**One system, three base elements** that's all it takes to create strong adhesion in all situations

G-Premio BOND bonds with no compromises to ALL preparations

G-CEM LinkForce provides a strong link in ALL indications G-Multi Primer ensures a stable adhesion to ALL restorations







#### Dr. Joachim Beck-Mußotter

Following his degree at Heidelberg University, Dr. Joachim Beck-Mußotter was a research associate from 2003 to 2010 at Heidelberg University's Oral, Dental and Maxillofacial Clinic, polyclinic for dental he was also the head of the HeiCuDent Referats für Studium und Lehre at the same place. Furthermore, he was the head of the ambulant clinic and of the headquarters of the polyclinic for dental prosthetics at the university's Oral, Dental and Maxillofacial clinic. After brief employment at Dr. Graf's dental practice in Weinheim, he established himself there in 2011 and founded the Joint Practice for Dentistry: Das Zahnkonzept in Weinheim. Since 2011, he has had a university teaching position at Heidelberg University's Clinic for Guided Surgery and is an expert in the areas of conservative and prosthetic dentistry, as well as implantology and 3D processes. Furthermore, his reputation is backed up by countless prizes and qualifications, including the title of implantologist (DGI) and Master of Science in dental prosthetics and oral implantology.

## Universal bonding solution with G-CEM LinkForce: **Strong adhesion** for a diversity of materials and indications By Dr. Joachim Beck-Mußotter

Modern cements need to meet high demands due to the diversity of indications and materials available today, for example with respect to long-term adhesion and convincing aesthetics. That's why, several months ago, Dr. Joachim Beck-Mußotter chose to use the universal adhesive composite cement G-CEM LinkForce™ from GC, among other products. What convinced him about the material was its high adhesive strength both in self-cure and light cure mode, as well as the availability of different shades and try-in pastes.

#### Universal bonding solution with G-CEM LinkForce™: Strong adhesion for a diversity of materials and indications

Alongside preparation and quality of care, cementing a restoration is one of the deciding factors in determining the long-term success of a dental rehabilitation.<sup>1,2</sup> Since modern dentistry is characterised by a huge diversity of materials and uses highly diverse restoration types, it is not surprising that manufacturers are always looking for universal solutions. That's why, for several months now, I've been supplying our practice, which is specialised in restorative dentistry and implantology, with G-CEM LinkForce (GC) and other cements.

#### **Material Characteristics**

G-CEM LinkForce is a dual-cure, adhesive composite cement for definitive cementation of all types of ceramic, composite and metal-based inlays, onlays, crowns and bridges, as well as pre-assembled metal and ceramic posts teeth, fibre glass posts, cast posts and cores. It is also indicated for the bonding of ceramic and composite veneers, table tops and crowns and bridges on implant abutments.

The proven high wear resistance of the cement gives assurance when cementing CAD/CAM and metal-free restorations, which is very important to me personally as a a regular user of modern restorative materials such as zirconium, lithium disilicate and hybrid ceramics.<sup>3</sup>

G-CEM LinkForce is a system consisting of three basic elements: the bonding agents G-Premio BOND, G-Multi Primer (both GC) and the composite element itself, which can be used in self-cure or light cure mode. Alongside efficient autopolymerisation, which is especially practical when cementing opaque restorations and restorations with strong coatings, I appreciate optimal light curing of the composite cement e.g. when cementing veneers. The possibility of using the bonding agent with or without light curing makes the system highly versatile and interesting, e.g. when bonding post. In this later case, G-Premio BOND DCA will be mixed to G-Premio BOND in order to make the bonding dual cure.

#### **Practical Experience**

I see the advantages of G-CEM LinkForce to be the exceptionally good flowability of the material in combination with its good stability. This is a great advantage for the margins and for simple removal of excess following initial light polymerisation.

For full-ceramic and CAD/CAM restorations, the colour stability and therefore aesthetics are an essential prerequisite for the long-term success of the restoration. Even though I don't have any long-term experience with the product, the first recalls showed no visible shade variation. The material also meets up to aesthetic demands by being available in four different shades (translucent, A2, opague and bleach), which are also available as try-in pastes. I see further advantages in the material's low linear expansion, its good radiopacity and the fact that it is associated with very low to no postoperative sensitivity. Another positive is the fact that the thin film thickness (3 µm according to the manufacturer) does not affect crown seating.

I use G-CEM LinkForce as a cement for all indications with the exception of cementing temporary restorations. Also when cementing subgingival restorations and crowns supported by non-screwed implants, I avoid using it. In this case, I resort to G-CEM LinkAce or FujiCEM 2 SL (both GC). Apart from this, I usually work with initial light polymerisation when using G-CEM LinkForce in order to remove excess cement simply and time-effectively. When inserting crowns and bridges, I use the material in self-curing format when light polymerisation alone does not lead to reliable results. The many usage options make material management and practical processes much easier, even if G-CEM LinkForce has to be stored in the fridge.

#### **Case Study**

The following clinical case illustrates the use of G-CEM LinkForce when cementing a complex restorative treatment. The 20-year-old patient came to the practice with the desire to improve his functional and aesthetic dental situation. Medical history, X-rays and clinical diagnosis revealed agenesis of teeth 15, 22, 24, 25, 37, 35 and 45 (as well as all third molars with the exception of 28), the remaining deciduous teeth 55, 62, 65, 75 and 85 and aesthetic problems with a posterior open bite (Fig. 1 & 2a-2d). The frontal diastema was considered too narrow for two implants but too wide for one. The problems with chewing food could be traced back to a suboptimal occlusion. No tooth mobility was diagnosed. At the time the patient visited the practice, orthodontic treatment elsewhere as well as at the

#### Universal bonding solution with G-CEM LinkForce™: Strong adhesion for a diversity of materials and indications

dental clinic of Heidelberg University had already been completed.

After clarifying the various treatment options we decided together with the patient to extract tooth 62 and make a full ceramic bridge from 21 to 23, to reshape 23 and 24 and pontics 22 and 23 (zirconium bridge frame-work and veneer, cara Zirconium Dioxide translucent and HeraCeram Zirkonia, both from Heraeus Kulzer). Once further orthodontic treatment was not possible, modified table tops on teeth 55, 14, 65, 36, 75, 34, 44, 85 and 46 were planned next as well as veneers on 13, 12 and 11 (each made from lithium disilicate, IPS e.max press, Ivoclar Vivadent). We recommended against an implant at the position of 22 due to space concerns.

An adhesive bridge between 21 and 23 was not desired by the patient. A direct composite build-up to balance the occlusion was also turned down. Before treatment began, shade A2 was selected. The first treatment step involved making a wax-up of the treatment area (Fig. 3) and discussing it with the patient. The wax-up model was later duplicated and a moulded part (deep-draw foil) was made which could be used to make the temporary restorations. Next, UDS forte (Sanofi-Aventis) was used as an anaesthetic and the teeth were prepared. For the bridge preparation, the preparation rules for full ceramic reconstructions according to Prof. Edelhoff were applied using the full ceramic preparation set from the company Komet/Brasseler.<sup>4</sup>

While an appropriate preparation for sufficient layer thickness of the lithium disilicate restoration had to be ensured. for the table tops it is necessary to take into consideration that the adhesive bond with the enamel is stronger than with the dentin. Preparation was therefore only carried out in the heavily structured areas to the benefit of an enlargement of the adhesive surface in the enamel. The peripheral preparation line was located juxtagingivally for the veneers and bridge abutments and supragingivally for the table tops; with a shoulder preparation in the lingual and vestibular side (Fig. 4a-4b). For the impression taking (double mix technique with customised tray and Identium®/ Kettenbach) retraction cords were applied in the sulcus using the









2a







**Figure 1:** OPG showing the initial starting situation: Agenesis of teeth 18, 15, 22, 24, 25, 38, 37, 35, 45 and 48, remaining deciduous teeth 55, 62, 65, 75 and 85

**Figures 2a-2f:** Clinical situation before treatment with posterior open bite and abnormal aesthetics. Poor aesthetics in the maxillary front.

#### Figure 3: Wax-up

Figures 4a & 4b: Preparations for the table tops

#### Universal bonding solution with G-CEM LinkForce™: Strong adhesion for a diversity of materials and indications























#### Figure 5: Provisional restoration

Figures 6a & 6b: The completed restorations on the models

**Figure 7:** The System Kit includes everything necessary for cementation: G-CEM LinkForce A2, G-CEM LinkForce Translucent, G-Premio BOND, G-Premio BOND DCA, G-Multi Primer, G-CEM LinkForce try-in pastes (A2 & Translucent), GC etchant & accessories

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**Figure 8:** Intra-oral preparation for the cementation procedure: placement of OptraGate and Wedjets.

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Figures 9a-9f:;Final images from the same session

double-cord technique (Ultradent Products) and an aluminium chloride gel was applied as a haemostatic agent (ViscoStat Clear, Ultradent Products). The temporary restorations (see above) made from Luxatemp Solar (DMG) and IPS Empress Direct Trans 20 (Ivoclar Vivadent) were cemented using a temporary, eugenol-free zinc oxide cement (RelyXTM Temp NE/3M Espe) (Fig. 5).

The restorations were then manufactured in the lab (Fig. 6a-6b). All restorations were then tested in intra-orally using the corresponding try-in paste. Possible corrections and adaptations were performed on the internal surface of the restoration using a yellow diamond bur. After checking the occlusion, the restorations are ready to be luted in the same session using G-CEM LinkForce Translucent shade.. Following this, the teeth were cleaned with polishing paste after the temporary restorations were removed. The patient refused rubber dam due to feelings of claustrophobia and insufficient nasal breathing, so we just used OptraGate (Ivoclar Vivadent) and Wedjets (Fig. 8). To prepare the restorations for cementation, they were sandblasted, cleaned and dried. G-Multi Primer was then applied to the adhesive surfaces of the restorations and they were dried. The teeth were then etched slightly using GC Etchant for 15 seconds, cleaned with water and carefully dried. The G-Premio BOND which was then used (in this case it was not light cured before cementing), was mixed with G-Premio BOND DCA, the activator for dual cure, in a ratio of 1:1. This mixture takes effect within 20 seconds following application, and is then dried with maximum air pressure for 5 seconds. In accordance with the instructions, the DC activator was of course avoided when cementing the veneers, and light curing was used. G-CEM LinkForce was then directly applied to the restorations from an automix, and the restorations were cemented to the prepared teeth. Light curing was then briefly employed for around 2 seconds, since this gives the excess cement a rubbery consistency. The excess was then removed with a miniscaler, minicurette and a foam pellet. In our practice we foresee 5-10 seconds for this, after which final polymerisation is carried out - for 30 seconds per side of the tooth (Bluephase 10; Ivoclar Vivadent). The restorations were cemented step by step in this way. After another occlusion check, local fluoridation and scheduling an appointment for a subsequent check-up on the next day, the patient left the practice and was satisfied (Fig. 9a-9f).

G-CEM LinkForce is for me an ideal cementation solution to achieve high adhesive strength with a universal adhesive. Its versatility with regard to curing techniques, colours and restoration types has been proven, as the clinical case report shows, even in complex treatment cases. Initial light polymerisation for simple removal of excess cement is one of the advantages of the material that I benefit from every time I use G-CEM LinkForce for cementation.

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GC Aadva Lab Scan open Scanner with a patented implant recognition system

The greatest precision at the speed of light



,'GC.'





#### Marco Ferrari

Prof. Marco Ferrari graduated from the School of Medicine and Surgery at the University of Pisa in July 1983 before obtaining his degree in General Dentistry at the University of Siena in 1987. He obtained his Postgraduate in Prosthodontics at Tufts University of Boston in 1988 and his PhD at the University of Amsterdam (ACTA) in 1995.

He started teaching at the School of Dental Medicine at the University of Siena in 1990 and is currently appointed as a professor at various universities, among which the Tufts University in Boston and the University of Leeds. Since 2003, he is the dean of the School of Dental Medicine of University of Siena. As a dean, he combines research, clinical activities and teaching to create a multidisciplinary academic dental centre with a dedicated focus on both students and patients.

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# Aadva Lab Scan – high accuracy for the perfect fit

#### By Prof. Marco Ferrari

Computer-aided design and computer-aided manufacturing (CAD/CAM) have revolutionized the daily practice of dentistry and this trend will probably evolve even further in the future. The CAD/CAM digital workflow consists of three phases<sup>1</sup>:

1. Scanning the involved surfaces. The digital model can be obtained indirectly by scanning a cast model with an extraoral scanner or directly by capturing the oral environment with an intraoral scanner. While the latter eliminates the need of conventional impression taking and producing a tangible object, the scanning possibilities are more restricted than with an extraoral scanner: the restricted space in the oral cavity, presence of oral fluids and patient movement may impede intraoral scanning. Mainly in those cases where capturing larger areas is necessary, some accuracy might be lost when multiple scans have to be matched<sup>2</sup>.

#### Aadva Lab Scan – high accuracy for the perfect fit

- 2. Designing the restoration on the reconstructed virtual model (CAD). Construction software is continuously being improved and nowadays packages exist for the design of various types of restorations, such as inlays, onlays, crowns, bridges, and structures on implants. The design is then stored in a virtual 3D format, such as .stl (standard tessellation format).
- 3. Automated manufacturing of the restoration (CAM). Computer-aided manufacturing has clearly increased the scala of materials for indirect restorations by enabling the use of new high-strength materials, such as zirconium oxide<sup>3</sup>. Moreover, it has opened the pathway to new manufacturing techniques: nowadays, subtractive techniques, where the restoration is milled from a block are most known, but additive processes (3D printing) can be used as well. While in the past, only closed systems existed, open systems now offer the benefit of providing access to multiple CAM techniques so that the most appropriate material and manufacturing process can be selected for each indication.

Automation of the workflow can lead to many advantages, like a predictable, standardized and cost-effective production of restorations. However, this requires a valid and reliable performance of the devices in each of the three phases of the workflow, starting with the scanning procedure: any potential errors in following steps will add up to errors in this first step and finally the proper fit of the restoration, which is one of the main factors that determine clinical success<sup>4</sup>.

In a recent study at the University of Milan<sup>5</sup>, we tested the trueness and precision of seven extraoral laboratory scanners (Table 1). Trueness concerns the agreement between the created digital model and the true object and is affected by systematic errors. Precision, on the other hand, refers to the agreement between different scans from the same scanner and indicates random errors.

Both values together determine the accuracy of the device. Trueness was evaluated by comparing with a highly accuracte industrial scanner, while the precision was evaluated by comparing ten scans from each device with each other. The discrepancy with the true model (trueness) varied between 7,7-31,1  $\mu$ m, with the lowest error measured with Aadva Lab Scan. The deviation between different scans from the same scanner varied between 4,0-19,5  $\mu$ m, the lowest discrepancy again belonging to Aadva Lab Scan.

(Figure 1). For both parameters, Aadva Lab Scan scored significantly better than 5 out of 7 tested laboratory scanners.

#### Table 1. Scanners tested

Scanner	Manufacturer
Aadva Lab Scan	GC Europe, Belgium
Zfx	Zfx Evolution, Germany
D700	3Shape, Denmark
DScan3	Enhanced Geometry Solutions, Italy
D640	3Shape, Denmark
Con Sc Top	Open Technologies, Italy
Sinergia	Nobil Metal, Italy



Figure 1: Accuracy of the tested laboratory scanners. Lower values indicate less error and higher accuracy (Adapted from Mandelli et al., J Prosthodont Res, 2016).

Given the high speed of Aadva Lab Scan, digitizing the workflow becomes even more interesting, not only in terms of predictability, but also in terms of speed and efficiency. The system is very versatile and can be used for a lot of different indicationituations. First, because the software comprises a wide range of indications; second, because it is an open system and can be used with other .stl-compatible systems, which gives the freedom to choose between different CAM-systems and softwares. A peculiarity of the Aadva Lab Scan is the use of patented scan flags when implants need to be scanned. These scans flags have a unique 5-dotted coding system, by which the exact position and implant type and diameter are immediately transferred to the virtual model. Because this occurs automatically, the user cannot make mistakes, in contrast to the manual selection necessary with traditional scan bodies. We had the opportunity to test this new methodology on a clinical case. It illustrates how the scan flags allow the fast production of an accurately fitting restoration, supported by two implants.



#### Aadva Lab Scan – high accuracy for the perfect fit



Figure 2a: Initial situation after implant surgery.



**Figure 2b:** X-ray showing the placed implant fixtures.



**Figure 3:** Pickup impression copings are screwed onto the implants fixtures intraorally. Impression with the double mix technique is taken and implant analogues are positioned.



**Figure 4:** Cast model with the scan flags positioned on each analogue. Note the dotted pattern, which is unique for each scan flag and determines the recognition of the implant type and its exact position.



Figure 5: Scanning procedure. Due to the closeness of the fixtures, each scan flag was scanned separately.



Figure 6: The software automatically merges both scans and recognizes the implant type and position.



Figure 7: It can be clearly seen on the model how close the fixtures are from each other.



Figure 8a: Scanning procedure. Due to the closeness of the fixtures, each scan flag was scanned separately.

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Figure 8a: Scanning procedure. Due to the closeness of the fixtures, each scan flag was scanned separately.





9b

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#### Aadva Lab Scan – high accuracy for the perfect fit



Figure 10: Temporary restoration.



**Figure 11:** The soft tissue is properly conditioned by the temporary restoration.



**Figure 12:** The metal framework is positioned onto the cast model before veneering.



**Figure 13:** The final restoration with porcelain veneering.

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Figure 14: The final restoration on positon.



Figure 15: X-ray of the placed final restoration.

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