



Changing the paradigm of composite placement

Tetric EvoCeram® Bulk Fill

Dr Eduardo Mahn
Santiago, Chile



Bulk Fill Composites:

Changing the paradigm of composite placement

In many areas of our life, we are guided by paradigms. Dentistry is not the exception. For example, for many years we were placing implants and waiting for several months before loading them. Then implants were developed that could tolerate immediate loading. We were sceptical about them at first, but they worked.

The same holds true for direct fillings. When we were dental students, we were all told that due to polymerization shrinkage, the composite needed to be applied in several layers in order to control it. Over the years, new composite materials were launched on the market, which claimed to be revolutionary. However, this did not apply to most of them and they failed to fulfill the expectations raised. Only recently, things changed and now we are finally ready to change the paradigm of composite layering.

The development of dental composites

One of the first dental composite resin groups was known as “microfilled composites”. They demonstrated excellent polishing properties and minimal surface roughness. However, today, they are no longer considered to be adequate for heavily loaded posterior teeth. Due to their inferior mechanical properties (Hickel, 1997), their fracture rate was high, especially in Class II cavities. A study by Hickel showed the fracture rate to be significantly higher than that of hybrid composites. The “heavy body” composites or packables followed in a later development step in the late 1990s. These restoratives were designed for Class I and II lesions in posterior teeth. They were particularly aimed at meeting the requirements of private practitioners: for example, heightened cost-effectiveness (Leinfelder et al., 1999).



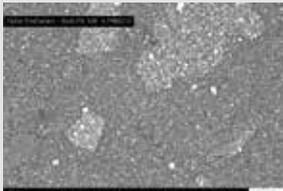
Many attempts have been made to develop a material that is tooth coloured, but can be placed in one bulk increment like amalgam.

However, these materials could not fulfil the great expectations associated with them, because their handling and material properties (Chen et al., 2001) were like those of the established hybrid composites (Manhart et al., 2001, Cobb et al., 2000). No improvements were shown in terms of increased polymerization depth, sculptability or the achievement of tight physiological contacts (Choi et al., 2000). A few years later, “nano-hybrid composites” were introduced to the market. They contained extremely small fillers, which were supposed to be responsible for the excellent physical properties, such as enhanced wear resistance and polishability (Palaniappan et al., 2010). In a recent study, these modern nano-hybrid composites showed a significant decrease in polymerization shrinkage: Tetric EvoCeram® (Ivoclar Vivadent) and Grandio (Voco) were found to be the best products in this group (Sideridou et al., 2011). Nevertheless, the handling properties and the time used for the placement of fillings remained unchanged, until the “bulk fill composites” arrived on the market.

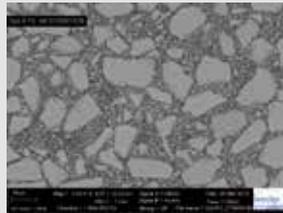
Bulk Fill Composites

Bulk fill materials are available in sculptable and flowable form. The flowable composites are mainly used to replace dentin. Manufacturers recommend covering this layer with a universal composite. However, this is not completely possible in Class II cavities, because the material is in contact with the matrix on one or two aspects and cannot be covered at a later stage. As a result, the material is unprotected in the interproximal area. However, most of these materials should not be applied without a covering layer, because they contain large fillers, which limit their polishability and increase their wear and surface roughness to clinically unacceptable levels. It should be pointed out that there are large variations in the filler sizes used in this type of materials. In contrast, sculptable bulk fill composites can be applied in one layer. Nevertheless, this group of materials also shows major differences in terms of the different properties, e.g. Tetric EvoCeram® Bulk Fill contains considerably smaller filler particles than QuiXfil® and x-tra fil®.

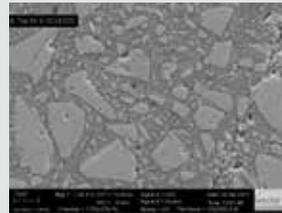
Sculptable



Tetric EvoCeram Bulk Fill / Ivoclar Vivadent

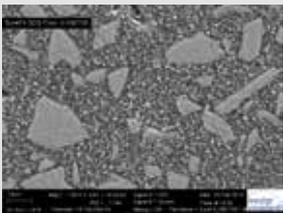


QuiXfil / Dentsply

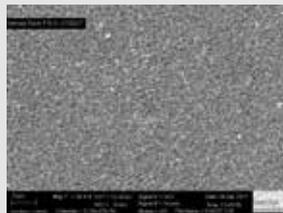


x-tra fil / Voco

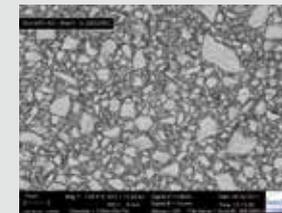
Flowable



SDR Flow / Dentsply



Venus Bulk Fill / Heraeus Kulzer



SonicFill / Kerr

The different filler sizes used in bulk fill materials (Ivoclar Vivadent 2011)

What has to be taken into account?

The development of an appropriate material is challenging and time-consuming. As a result, many of the described problems have been overcome only recently.

A close look at the properties of conventional composites and curing lights reveals several areas that should be improved in order to make bulk filling possible:

- 1) Polymerization shrinkage (especially shrinkage stress) should be considerably reduced, because the amount of composite to be cured in one step will be higher.
- 2) The depth of cure and light penetration should be at least 4 mm to allow the placement of a real bulk filling.
- 3) The working time should be longer in order to enable the clinician to adapt the composite properly to the cavity walls and avoid leaving any excess.
- 4) Fast, easy and reliable accessibility to all surfaces needing to be cured is a must, especially in the treatment of pediatric patients and patients with restricted mouth opening or TMJ problems. In these cases one-step curing must be ensured even in large cavities.

Polymerization shrinkage and stress

Composite resins shrink during polymerization. And many problems are related to this phenomenon: for example, pulp irritation; post-operative sensitivity when chewing (Carvahlo et al., 1996); cusp deflection when the “C” factor is high (McCulloch and Smith, 1986, Alomari et al., 2001) and gap formation causing secondary caries due to bacteria colonization (Leinfelder, 1995, Davidson et al., 1984). Major efforts have been undertaken to reduce polymerization shrinkage and improve the dental adhesives at the same time. Furthermore, attempts have been made to relieve the shrinkage stress (Ilie et al., 2006), since this force can overload the adhesive layer between the composite and the tooth structure and lead to premature failure of the filling (Versluis et al., 2004, Feilzer et al., 1987, Moorthy et al., 2012).

Conventional low-shrinkage composites

Low-shrinkage composites are not new. Quite some time ago, 3M Espe launched a composite called Filtek Silorane® on the market, which was claimed to show volumetric shrinkage of less than 1%. Even though this composite resin showed less shrinkage than methacrylate-based materials, it could not fulfil the expectations of clinicians. The following features were considered to be drawbacks: for example, the necessity of using a special adhesive; incompatibility with methacrylate-based composites; the lack of a flowable and the limited indication range. In a study conducted in 2007, Ilie et al. confirmed that shrinkage could be reduced if various curing regimes were used. Finally, following a completely different path, advanced chemistry enabled Dentsply to reduce the shrinkage stress by adding a shrinkage modulator with a high molecular weight to the centre of the polymerizable resin backbone. The central modulator relaxes the surrounding network of the SDR™ resin (see Dentsply brochure).

The first composite featuring this type of technology was SureFil® SDR™ (Dentsply DeTrey, Constance, Germany). Investigations on resin-based composites (RBCs) with SDR™ technology showed significantly lower shrinkage stress values (Burgees and Cakir, 2010) compared with regular flowable RBCs as well as nano-hybrid and hybrid RBCs and even silorane composites (Ilie and Hickel, 2011).

Although this flowable material showed reduced stress, it remained a flowable material, which showed a volumetric shrinkage between 3.5% and 5% and a low modulus of elasticity. Moreover, the low modulus of elasticity of microfilled composites was responsible for their high failure rate in posterior restorations (Braem et al., 1986, Willems et al., 1992). Lambrechts et al. (1982) reported cohesive and adhesive chip fractures at enamel cavosurfaces three or four times more often in conjunction with microfilled resin composites than with conventional resin composites. But at the same time, Heintze and Rousson (2012) discovered in a meta-analysis that the survival rate of microhybrid composites was much better than that of compomers and composites featuring larger filler particles.



Polymerization shrinkage had to be reduced in order to obtain good marginal quality in the long term.



The shrinkage stress reliever attenuates shrinkage-induced stress in Tetric EvoCeram Bulk Fill. This special filler, which is partially functionalized with silanes, adheres to the cavity walls together with the monomer matrix and the adhesive and resists the shrinkage force.

State-of-the-art bulk fill composite

These results allow us to conclude that an ideal posterior bulk fill material should combine stress modulators with the properties of modern nano-hybrid composites featuring a well-balanced mix of small- and medium-sized filler particles. This is the case in **Tetric EvoCeram Bulk Fill** (Ivoclar Vivadent, Schaan, Liechtenstein). Tetric EvoCeram Bulk Fill is a nano-hybrid composite for the fabrication of direct restorations in posterior teeth. According to the manufacturer, patented shrinkage stress relievers or modulators, which are integrated into the filler composition, reduce polymerization shrinkage and shrinkage stress. The filler content is 60% (by volume) with particles in the 40-nm to 3000-nm range.

Depth of cure

Before the arrival of bulk fill composites, the maximum increment thickness of a filling was generally defined as 2 mm (Pilo et al., 1999, Sakaguchi et al., 1992). However, restoring cavities, especially deep ones, with composite increments of 2-mm thickness can be time-consuming and entails the risk of incorporating air bubbles or contaminants between the increments (Flury et al., 2012).

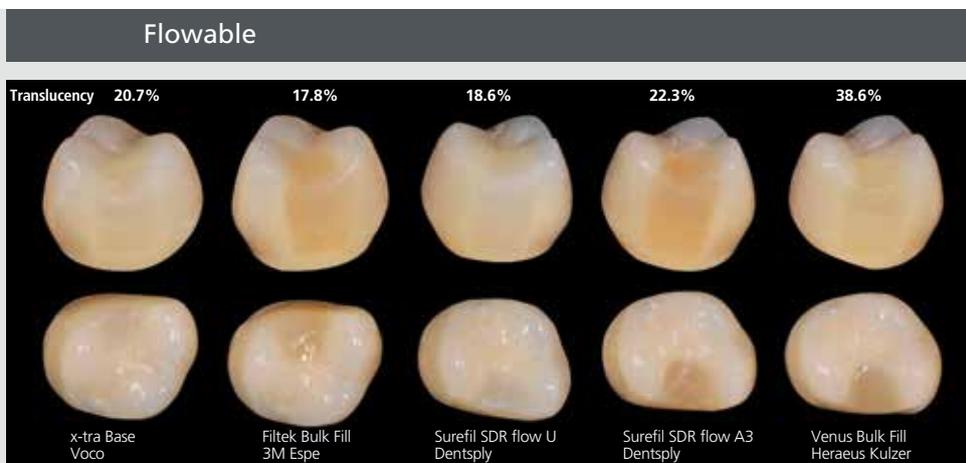
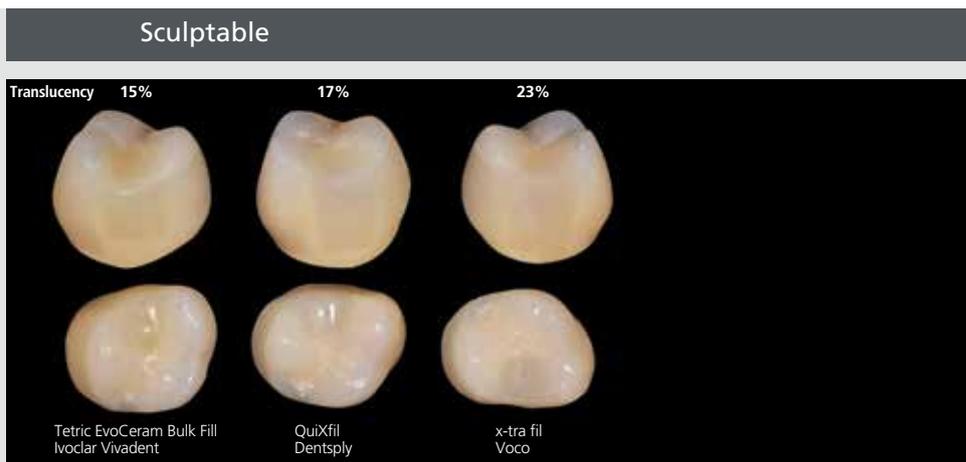
Composites with improved depth of cure and reduced shrinkage properties, which allow the placement of bulk fillings are also not really new. As early as 2008, Polydorou et al. published an in vitro study in which the curing depth of two translucent composite materials was evaluated. The study proved that a sufficient degree of polymerization for QuiXfil® samples in depths of 3.5 mm to 5.5 mm could be achieved, depending on the curing unit used. The maximum curing depth of microfilled composites which was achieved with the same method was only 2.5 mm.

In a controlled clinical trial, Manhard et al. (2010) found better success rates for a microhybrid composite (Tetric Ceram®, Ivoclar Vivadent, Schaan, Liechtenstein) placed in 2 layers of 2 mm than for a so-called bulk fill composite (QuiXfil®, Dentsply DeTrey, Constance, Germany). The survival rate after four years was 89.2% for QuiXfil® and 97.8% for Tetric Ceram. These values correspond to an annual failure rate of 2.7% and 0.6% respectively. Even though Tetric Ceram seemed to achieve the better results, the performance of both products was in an acceptable range if compared with reports from other longitudinal studies of Class II restorations, where a range of 0% to 7% with a mean value of 2.2% was recorded (Manhard et al., 2004). The study concluded that both composites represent a safe and predictable treatment option.

Three ways of increasing the curing depth of composites

- The first is to **increase the filler particle size**. Li et al. (1985) claimed that a reduction of the filler size decreases the depth of cure and the compressive strength. However, this effect could not be confirmed by Czasch and Ilie (2012). In their study, they compared SureFil® SDR™ flow (Dentsply) with Venus Bulk Fill (Heraeus). Despite the different filler sizes used in the two composites, both showed similar curing depths.

- The second approach is to **increase the translucency of the composite**. The consequence is obvious: More photons will penetrate into deeper areas of the composite, where they will activate initiator molecules. This is the tactic most often used in the products available. For example, x-tra® fil (Voco) has a translucency of 23%, Venus Bulk Fill (Heraeus) of 38.6 % and SDR™ flow (Dentsply) of 18.6%. As a reference, universal composites exhibit around 10% to 12% translucency and enamel shades of esthetic composites around 15%, which is also the range of Tetric EvoCeram Bulk Fill (Reference values measured by Ivoclar Vivadent AG).



Comparison between different bulk fill composites. Some are too translucent and are therefore incapable of matching natural tooth colours.



Comparison of composites in terms of translucency and flow properties



Before (left) and after (right) the treatment. TetricEvoCeram Bulk Fill blends in seamlessly with the natural tooth structure due to its enamel-like translucency of 15%.

- The third approach is to **improve the absorption spectrum and the initiator's reactivity to light**. Although the number of photons that reach the cavity floor is significantly smaller than those on the restoration surface, there should still be sufficient initiator molecules available to trigger the polymerization reaction even in layers that are 4 mm deep or even deeper. Moszner et al. (2008) and Durmaz et al. (2008) described novel initiators with significantly higher photocuring activity in comparison to that of camphorquinone (CQ) and ethyl 4-(N,N-dimethylamino) benzoate (EMBO) in composites with a filler load of about 60 wt%. They also concluded that composites based on these new initiators showed improved UV stability. Furthermore, the storage stability was comparable to that of CQ/EMBO-based composites. In the same year, Ilie and Hickel (2008)

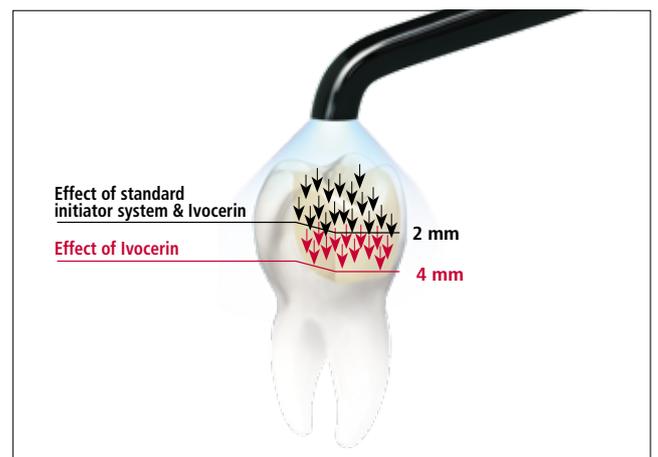
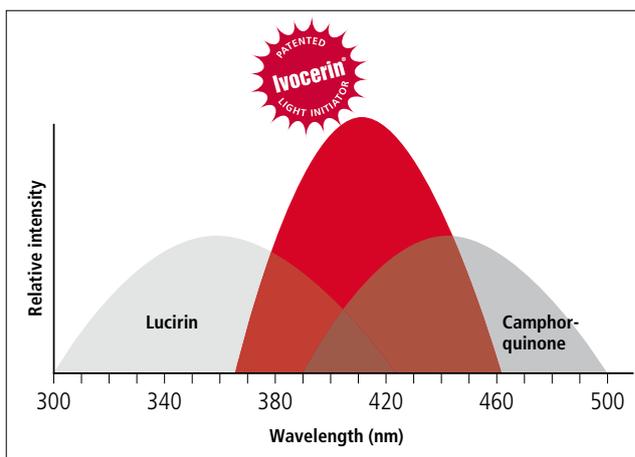
also proved that a total replacement of CQ was possible, without negatively affecting the mechanical properties of the material, if the right curing unit (with a broad emission spectrum like that of Polywave®) was used. Another group of researchers (Burtscher 2008) achieved similar results with regard to the mechanical properties with germanium-based initiators, without using CQ.

Synthesized germanium compounds show significantly higher blue light absorption than camphorquinone (Moszner et al., 2009). During irradiation, the dibenzoyl germanium derivatives undergo photodecomposition with the formation of radicals. Therefore, amine-free photoinitiators in the visible light range are used in dental cements and composites (Moszner et al., 2009). Experimental composites based on dibenzoyl germanium

derivatives are stable in storage and show significantly improved bleaching behaviour over composites with CQ/amine photoinitiators (Moszner et al., 2009).

A smart combination of initiators is exactly what is needed in the case of bulk fill composites. To accelerate the polymerization process, a patented new initiator called Ivocerin® has been added to the standard initiator system (Lucirin and camphorquinone).

As a result, the material features an absorption maximum in the blue light spectrum between 370 nm and 460 nm. When exposed to the light of a powerful polymerization unit (for example, Bluephase® Style, Ivoclar Vivadent) the bulk fill material cures rapidly (10 seconds) to a consistent depth of cure. By contrast, other commercially available materials contain conventional initiators, which are not capable of starting the polymerization process with a reduced amount of light in the deeper areas of the filling.



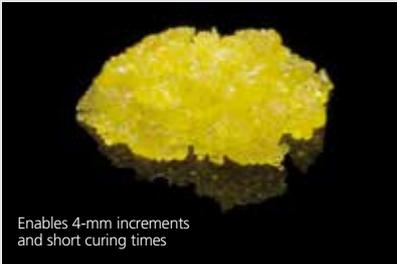
The initiator system boosts the polymerization process and is responsible for the enamel-like translucency of 15% of **Tetric EvoCeram Bulk Fill**. This is not possible with conventional composites that do not contain such initiators.



Natural-looking restorations made of Tetric EvoCeram Bulk Fill. The translucency of the material is 15%. As a result, the restorations blend seamlessly into their natural surroundings.

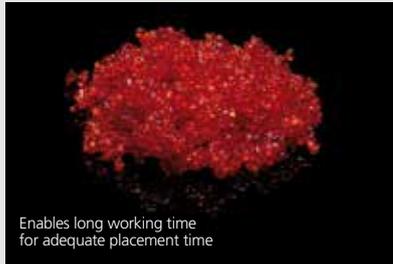
Working time

Light initiator Ivocerin



Enables 4-mm increments
and short curing times

Light sensitivity filter



Enables long working time
for adequate placement time

Shrinkage stress reliever

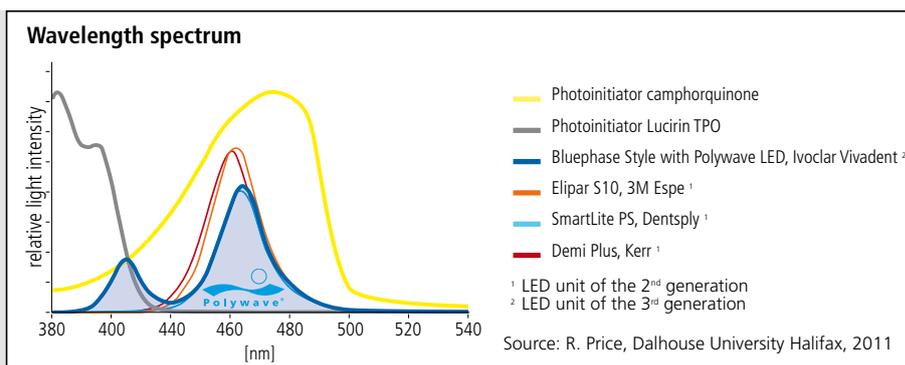


Offers low shrinkage stress
during polymerization

Special patented components of Tetric EvoCeram Bulk Fill

A material that is applied in 4-mm increments and subsequently contoured needs to offer a longer working time than conventional composites. A patented light sensitivity filter prevents premature polymerization of the new Tetric EvoCeram Bulk Fill and guarantees a working time of more than three minutes under defined light conditions of 8000 lux. An important additional feature of this molecule is that it does not impair polymerization when exposed to the intensive light of an LED light source.

Handling of curing lights



Most of the curing lights used do not have a broad spectrum and are not suitable for all the different initiators. Bluephase Style is one of the exceptions.

As previously mentioned, new initiators have to be added in order for composites to attain a high depth of cure. These initiators are sensitive to another wavelength range than camphorquinone.

A number of manufacturers are already using photoinitiators that work independently from or synergistically with camphorquinone. Acylphosphine oxides are frequently used for this purpose, due to their weak yellowish-white colour. The absorption peak of this compound is in the UV range with a small portion extending into the visible region (violet light). Monoacylphosphine oxide (Lucirin TPO®), phenylpropanedione (PPD) and bisacylphosphine oxide (Irgacure 819) are preferably used in translucent or Bleach composites. In these cases, the concentration of the yellow initiator (camphorquinone) is reduced or completely replaced.

With their emission peak at 460 nm, LED curing units of the second generation perfectly match the peak absorption of camphorquinone. Nevertheless, they are not compatible with the above mentioned initiators. In order to produce a light output in other wavelength ranges, the curing lights have to be equipped with additional LEDs, e.g. violet ones.

Over the past few years, new curing units with a broad emission spectrum have been launched on the market. These units are theoretically suitable for polymerizing all dental materials, in other words, also for composites containing whitish initia-

tors such as Lucirin TPO. They are considered to represent the third generation of LED curing lights. In order to attain the necessary peaks in the different wavelength ranges and therefore the absorption peaks of different initiators, state-of-the-art curing lights are equipped with various types of LEDs (with different wavelengths). Bluephase Style featuring the Ivoclar Vivadent Polywave LED is one of these curing lights.

Demands on light probes

Unfortunately, due to the many technical challenges encountered in the development of new polymerization lights, some handling and efficiency aspects have been neglected in the past. Access to posterior cavities, for example, in Class I or Class V cavities in a second molar can be problematic in patients with restricted mouth opening if certain polymerization lights with straight light probes are used. In pediatric patients, in particular, a straight light probe can cause very challenging situations. Some manufacturers have tried to overcome this problem by launching LEDs without a light probe. However, this created another problem: an extreme loss of intensity with distance due to the wide irradiation of the LEDs. Another shortcoming of this type of lamp is the fact that the tip cannot be autoclaved.

Nonetheless, the solution was easier than many had anticipated. By shortening the tip of the light probe of the new Bluephase Style, the handling and the scope of the curing light were dramatically improved with no loss of light intensity.



There are considerable differences between the light probes of different curing lights.

Ideally, the light probe of a curing light should be long enough to reach posterior areas comfortably. At the same time it should have a short bent tip to focus the light on the area desired and reduce the space needed for placing it. The following pictures show several well-known curing units and their handling problems. A short bent light probe tip considerably improves handling, which is clearly shown in the case of the new Bluephase Style.



For applications in the posterior region, the tip of the light probe should be short. Unfortunately most of the light probes are not properly designed to reach second molars or treat children or patients who cannot open their mouth wide.

The design of the curing light is a very important aspect for the operator during longer treatments. A number of manufacturers produce curing lights that are shaped like a gun, while others consider the pen shape to be more advantageous. Ideally, a curing unit should be available in both shapes in order to allow the operator to choose between the two options. Depending on the indication the one or other design may be more suitable.



Differences between Bluephase® G2 and Bluephase Style

Bulk fill composites in a nut shell

In sum, bulk fill composites are a very heterogeneous group of materials. They can be divided into basically two groups:

1. Materials with a flowable consistency
2. Materials with a sculptable consistency

The first group is mainly indicated for minimally invasive restorations or cavity bases that are maximum 4 mm thick (Frankenberger et al., 2012). Due to the size of their fillers and their wear properties and polishability, these materials should not be used alone and need to be covered with another material.

Tetric EvoCeram Bulk Fill combines the best of both worlds. The shrinkage stress reliever in the matrix considerably reduces shrinkage stress. The recently patented initiator Ivocerin increases the depth of cure to 4 mm. The material exhibits the excellent mechanical properties, wear resistance and polishability of well-known nano-hybrid composites. Therefore, its range of indications also covers deep Class I, Class II and Class V cavities. Increments of up to 4 mm can be placed and contoured with this material.



Dr Eduardo Mahn
Director Clinical Research
email: emahn@miuandes.cl
Universidad de los Andes
San Carlos de Apoquindo 2200
Santiago, Chile

” I will never forget the first time I had a discussion with some friends about bulk filling composite. It was before we could even think about shrinkage relievers or modulators and about initiators other than camphorquinone. Well, these aspects are exactly the ones that are making today's bulk fillings a reality. After I tried Tetric EvoCeram Bulk Fill for the first time more than a year ago, I immediately switched to using this product in the posterior region. As far as Class V restorations are concerned, it took me a bit longer. But now it is my filling material of choice for posterior restorations, and IPS Empress Direct® (Ivoclar Vivadent) is my first choice for anterior restorations when the patient's esthetic demands are higher.

Even if you are not completely convinced of bulk filling materials at this stage, you can still use them in the conventional way, and you can expect less shrinkage stress and theoretically deeper curing results. In my case, I am still searching for a reason to go back to using conventional nano-hybrid composites! ”

Class V fillings – scientific data

In many countries, the prevalence of caries and periodontal disease has diminished due to comprehensive public health strategies. Nonetheless, the prevalence of other pathologies is rising: for example, non-carious cervical lesions (NCCLs) such as abrasion, erosion and abfraction. The glossary of periodontal terms (American Academy of Periodontology) defines these terms as follows:

- Abrasion is considered to be “the wearing away of a substance or structure through an abnormal mechanical process.” An example of this is dental abrasion owing to incorrect brushing.
- Erosion has been defined as “an apparent chemical dissolution of enamel and dentin, unrelated to caries, causing a cavity that has a hard, smooth base.”
- Abfraction is understood to be “a hypothetical tooth surface abrasion in conjunction with occlusal forces.”

Despite the ongoing publication of studies on this topic, there still does not seem to be sufficient evidence to support the association of NCCLs and occlusal loading (Senna et al., 2012). In a systematic review done by Senna et al. (2012), the causal relationship between NCCLs and occlusion could not be demonstrated clinically by prospective studies. Nevertheless, these pathologies have been treated in the same way for many years, in other words, with direct restorations done made of glass ionomer cements including all their modifications: compomers and composite resins.

It is a well-known fact that non-carious cervical lesions are used as a clinical model to evaluate the efficacy of dentin bonding agents in non-retentive tooth preparations. This model is recommended by the ADA in its Acceptance Program for Adhesive Restorative Materials (ADA). In non-retentive cervical lesions, the clinical performance of a restoration relies on the bond strength values of the adhesive resin used. As a result, it is desirable for the materials used in these cases to cause minimum shrinkage stress at the tooth-restoration interface. The loss of marginal adaptation is one of the most important factors that indicate the failure of a restoration and provide a reason for replacing it (Browning and Dennison, 1996).

Many studies have been undertaken to evaluate the performance of different adhesive and composite application protocols. Peumans et al. (2005) concluded that the self-etch technique is less favourable than an etch-and-rinse protocol. Superior performance of etch-and-rinse systems was also reported by Heintze et al. (2011) in a systematic review of clinical trials from 1994 to 2008.

Van Dijken and Pallesen (2008) evaluated the clinical long-term retention of five different adhesives and a resin-modified glass ionomer cement. They concluded that all the systems showed continuous degradation, but with a wide variation. The adhesive systems Syntac® and Vitremer performed clearly better than the other materials examined over the long term. As shown by Heintze et al. (2010), cervical restorations fabricated with glass ionomer cements produced good retention rates, but poor esthetics (Gladys et al., 1999). Since the primary aim of restoring non-carious cervical lesions is the preservation of esthetics, this aspect is of major importance.

Apart from the material used, there are many other factors clinicians should know and control. In some studies the incisal or occlusal enamel margin was bevelled. The bevel was created to increase the enamel surface for adhesion purposes and to improve the esthetic outcome. For example, the presence of a bevel has been reported to heighten retention and reduce microleakage (Van Meerbeek et al., 1993, Hall et al., 1993, Grieve et al., 1993). Van Meerbeek et al. (1994) showed that when enamel was etched with phosphoric acid reliable adhesion of the restorations was obtained (even with bonding systems which showed inferior clinical dentin retention). In a meta-analysis by Heintze et al. (2010), the review revealed that clinicians should roughen the dentin (and enamel) surfaces, as this measure increases the durability of cervical restorations. Additional bevelling of the enamel can be omitted as this step does not influence the clinical performance of the restoration. In conclusion, the bevel as a part of the surface roughening measures has a positive effect. However, the bevel per se only on enamel together with the selected isolation method (rubber dam or cotton rolls) does not have a significant influence.

That said, it seems logical that a composite with reduced shrinkage stress (Tetric EvoCeram Bulk Fill) as a result of the stress relievers contained in it, together with the use of a three-step etch-and-rinse system such as Syntac or a two-step self-etch adhesive like AdheSE will produce the best possible clinical outcome. In addition, the natural translucency of 15% renders the transition between the composite and the enamel invisible in most instances, as shown in the subsequent clinical cases.

Clinical case I:

Class V restorations with Tetric EvoCeram® Bulk Fill



Pre-operative situation



Placement of a retraction cord and removal of caries and stains:
The preparation margins are clearly visible.



A retraction cord was placed prior to etching, bonding (Syntac) and the placement of the composite in order to protect the gingival tissue.



Result after one week: The lower anterior teeth have been optimally restored with Tetric EvoCeram Bulk Fill.

Clinical case II:

Class V restorations with Tetric EvoCeram® Bulk Fill



Pre-operative situation



Magnification of Class V defects. Considerable gingival recession and loss of tooth structure is evident.



Etching with phosphoric acid



Bonding with Syntac



Application of Tetric EvoCeram Bulk Fill



Result after seven days. The transition between the composite filling and the tooth structures is almost perfect.

Straightforward Class I cavities



Pre-operative situation. Unsightly discoloration underneath the composite resin fillings



Zinc-eugenol based material exposed after composite removal



Excavation (coarse burs) and finishing of the cavities (fine burs)



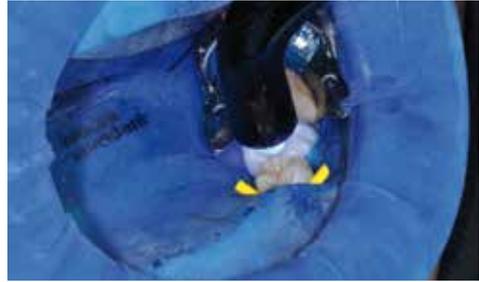
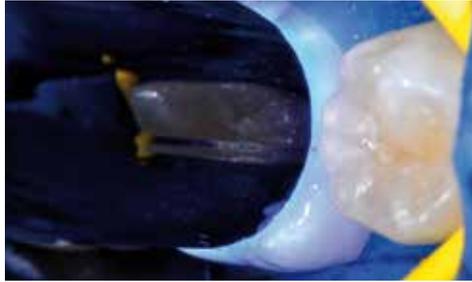
Bonding with a self-etching system



Placement of a flowable composite



Bulk filling (Tetric EvoCeram Bulk Fill): one composite layer and one-stage curing



Light-curing. Awkward positioning of the light due to the long light probe



Easy handling with the shorter light probe of Bluephase Style



Result at the three-month recall

Class II restorations, multiple cavities



Pre-operative situation: caries in tooth 26 (mesial and distal), caries underneath amalgam in tooth 27 (mesial)



Situation after matrix and ring placement. System used: Composit-Tight 3D™ (Garrison, USA)



ExcITE F was applied and light cured with Bluephase Style for 10 seconds.



After curing, a flowable material was placed as a liner. This step is optional.



Subsequently, Tetric EvoCeram Bulk Fill was applied.



The cavity was filled with only one increment, which was light cured.



At the three-month recall

References

- Alomari QD, Reinhardt JW, Boyer DB. Effect of liners on cuspal deflection and gap formation in composite restorations. *Oper Dent* 2001; 26:406–411.
- American Academy of Periodontology. Glossary of periodontal terms, 4th edn. Chicago: American Academy of Periodontology; 2001.
- Braem M, Lambrechts P, Van Doren V & Vanherle G. The impact of composite structure on its elastic response. *Journal of Dental Research* 1986; 65(5):648–653.
- Browning WD and Dennison JB. A survey of failure modes in composite resin restorations. *Operative Dentistry* 1996; 21(4):160–166.
- Burgess J, Cakir D. Comparative properties of low-shrinkage composite resins. *Compend Contin Educ Dent* 2010; 31(2):10–15.
- Burtscher P, Rheinberger V. New Germanium-based Photoinitiator as an Alternative to Camphorquinone/Amine. *IADR Abstract* 2008, 1611.
- Carvalho RM, Pereira JC, Yoshiyama M, Pashley DH. A review of polymerization contraction: the influence of stress development versus stress relief. *Oper Dent* 1996; 21:17–24.
- Chen HY, Manhart J, Hickel R, Kunzelmann KH. Polymerization contraction stress in light-cured packable composite resins. *Dent Mater* 2001; 17:253–259.
- Choi KK, Ferracane JL, Hilton TJ, Charlton D. Properties of packable dental composites. *J Esthet Dent* 2000; 12:216–226.
- Cobb DS, MacGregor KM, Vargas MA, Denehy GE. The physical properties of packable and conventional posterior resin-based composites: a comparison. *J Am Dent Assoc* 2000; 131:1610–1615.
- Czasch P, Ilie N. In-vitro comparison of mechanical properties and degree of cure of bulk fill composites. *Clin Oral Investig*. 2012 Mar 14.
- Davidson CL, de Gee AJ, Feilzer A. The competition between the composite–dentin bond strength and the polymerization contraction stress. *J Dent Res* 1984; 63:1396–1399.
- Durmaz Y, Moszner N, Yagci Y. Visible light initiated free radical promoted cationic polymerization using acylgermane based photoinitiator in the presence of onium salts. *Macromolecules* 2008, 41, 6714.
- Feilzer AJ, De Gee AJ, Davidson CL. Setting stress in composite resin in relation to configuration of the restoration. *J Dent Res*. 1987 Nov; 66(11):1636–9.
- Flury S, Hayoz S, Peutzfeldt A, Hüslér J, Lussi A. Depth of cure of resin composites: is the ISO 4049 method suitable for bulk fill materials? *Dent Mater*. 2012 May; 28(5):521–8.
- Frankenberger R, Vosen V, Kraemer N, Roggendorf M. Bulk-fill-Komposite: Mit dicken Schichten einfacher zum Erfolg? *Quintessenz* 2012; 63(5):579–584.
- Gladys S, Van Meerbeek B, Lambrechts P, Vanherle G. Evaluation of esthetic parameters of resin-modified glass-ionomer materials and a polyacid-modified resin composite in Class V cervical lesions. *Quintessenz Int* 1999; 30:607–14.
- Grieve AR, Saunders WP, Alani AH. The effects of dentin bonding agents on marginal leakage of composite restorations – long-term studies. *J Oral Rehab* 1993; 20:11–8.
- Hall LH, Cochran MA, Swartz ML. Class 5 composite resin restorations: margin configurations and distance from the CEJ. *Operative Dent* 1993; 18:246–50.
- Heintze SD, Ruffieux C, Rousson V. Clinical performance of cervical restorations a meta-analysis. *Dent Mater*. 2010 Oct; 26(10):993–1000.
- Heintze SD, Thunpithayakul C, Armstrong SR, Rousson V. Correlation between microtensile bond strength data and clinical outcome of Class V restorations. *Dental Materials* 2011; 27:114–25.
- Heintze SD, Rousson V. Effectiveness of Direct Class II Restorations – A Meta-Analysis. *J Adhes Dent*. 2012 Oct; 14(5):407–31.
- Hickel R. Moderne Füllungswerkstoffe. *Dtsch Zahnärztl Z* 1997; 52:572–585.
- Ilie N, Kunzelmann KH, Hickel R. Evaluation of micro-tensile bond strengths of composite materials in comparison to their polymerization shrinkage. *Dent Mater*. 2006 Jul; 22(7):593–601
- Ilie N, Jelen E, Clementino-Luedemann T, Hickel R. Low-shrinkage composite for dental application. *Dent Mater J*. 2007 Mar; 26(2):149–55.
- Ilie N, Hickel R. Can CQ be completely replaced by alternative initiators in dental adhesives? *Dent Mater J*. 2008 Mar; 27(2):221–8.
- Ilie N, Hickel R. Investigations on a methacrylate-based flowable composite based on the SDR technology. *Dent Mater* 2011; 27:348–355.
- Ivoclar Vivadent AG. Translucency test. Research and development department
- Lambrechts P, Ameye C & Vanherle G. Conventional and micro-filled composite resins, Part II: Chip fracture. *Journal of Prosthetic Dentistry* 1982; 48(5) 527–538.
- Leinfelder KF. Posterior composite resins: the materials and their clinical performance. *J Am Dent Assoc* 1995; 126(5):663–672.
- Leinfelder KF, Bayne SC, Swift EJ. Packable composites: overview and technical considerations. *J Esthet Dent* 1999; 11:234–249.
- Li Y, Swartz ML, Phillips RW, Moore BK, Roberts TA. Effect of filler content and size on properties of composites. *J Dent Res* 1985; 64:1396–1401.
- Manhart J, Chen HY, Hickel R. The suitability of packable resin-based composites for posterior restorations. *J Am Dent Assoc* 2001; 132:639–645.
- Manhart J, Chen H, Hamm G, Hickel R. Buonocore Memorial Lecture. Re-view of the clinical survival of direct and indirect restorations in posterior teeth of the permanent dentition. *Oper Dent* 2004; 29:481–508.
- Manhart J, Chen HY, Hickel R. Clinical Evaluation of the posterior composite Quixfil in class I and class II cavities: 4 year follow-up of a randomized controlled trial. *J Adhes Dent* 2010; 12: 237–243.
- McCulloch AJ, Smith BG. In vitro studies of cuspal reinforcement with adhesive restorative material. *Br Dent J* 1986; 161:450–452.
- Moorthy A, Hogg CH, Dowling AH, Grufferty BF, Benetti AR, Fleming GJ. Cuspal deflection and microleakage in premolar teeth restored with bulk-fill flowable resin-based composite base materials. *J Dent*. 2012 Jun; 40(6):500–5.
- Moszner N, Fischer UK, Ganster B, Liska R, Rheinberger V. Benzoyl germanium derivatives as novel visible light photoinitiators for dental materials. *Dent Mater*. 2008 Jul; 24(7):901–7.
- Moszner N, Zeuner F, Lamparth I, Fischer U. Benzoylgermanium derivatives as novel visible-light photoinitiators for dental composites. *Macromolecular materials and Engineering*. 2009 December 10; Vol 294, Issue 12, pag 877–886.
- Palaniappan S, Elsen L, Lijnen I, Peumans M, Van Meerbeek B, Lambrechts P. Three-year randomised clinical trial to evaluate the clinical performance, quantitative and qualitative wear patterns of hybrid composite restorations. *Clin Oral Investig*. 2010 Aug; 14(4):441–58.
- Pilo R, Oelgesser D, Cardash HS. A survey of output intensity and potential for depth of cure among light-curing units in clinical use. *J Dent* 1999; 27:235–41.
- Peumans M, Kanumilli P, De Munck J, Van Landuyt K, Lambrechts P, Van Meerbeek B. Clinical effectiveness of contemporary adhesives: a systematic review of current clinical trials. *Dental Materials* 2005; 21:864–81.
- Polydorou O, Manolakis A, Hellwig E, Hahn P. Evaluation of the curing depth of two translucent composite materials using a halogen and two LED curing units. *Clin Oral Invest* 2008; 12:45–51.
- Sakaguchi RL, Douglas WH, Peters MC. Curing light performance and polymerization of composite restorative materials. *J Dent* 1992; 20:183–8.
- Senna P, Del Bel Cury A., Rosing C. Non-cariou cervical lesions and occlusion: a systematic review of clinical studies. *Journal of Oral Rehabilitation* 2012; 39; 450–462.
- Sideridou ID, Karabela MM, Vouvoudi ECh. Physical properties of current dental nanohybrid and nanofill light-cured resin composites. *Dent Mater*. 2011 Jun; 27(6):598–607.
- Surefil® SDR™ flow Product Brochure (2010) Dentsply international. http://www.surefilstrflow.com/sites/default/files/SureFil_Brochure.pdf
- Van Meerbeek B, Braem M, Lambrechts P & Vanherle G. Evaluation of two dentin adhesives in cervical lesions. *Journal of Prosthetic Dentistry* 1993; 70(4) 308–314.
- Van Dijken JW, Pallesen U. Long-term dentin retention of etch-and-rinse and self-etch adhesives and a resin-modified glass ionomer cement in non-cariou cervical lesions. *Dent Mater*. 2008 Jul;24(7):915–22.
- Van Meerbeek B, Peumans M, Verschuere M, Gladys S, Braem M, Lambrechts P, et al. Clinical status of ten adhesive systems. *J Dent Res* 1994; 73:1690–702.
- Van Meerbeek B, Braem M, Lambrechts P, VanHerle G. Evaluation of two dentin adhesives in cervical lesions. *J Prost Dent* 1993; 70:308–14.
- Verluis A, Tantbirojn D, Pintado MR, DeLong R, Douglas WH. Residual shrinkage stress distributions in molars after composite restoration. *Dent Mater*. 2004 Jul; 20(6):554–64.
- Willems G, Lambrechts P, Braem M, Celis JP & Vanherle G. A classification of dental composites according to their morphological and mechanical characteristics *Dental Materials* 1992; 8(5) 310–319.

Descriptions and data constitute no warranty of attributes.

© Ivoclar Vivadent AG, Schaan/Liechtenstein
649953/en/2013-01-30

Ivoclar Vivadent AG
Bendererstr. 2
9494 Schaan
Liechtenstein
Tel. +423 / 235 35 35
Fax +423 / 235 33 60
www.ivoclarvivadent.com



ivoclar
vivadent[®]
passion vision innovation