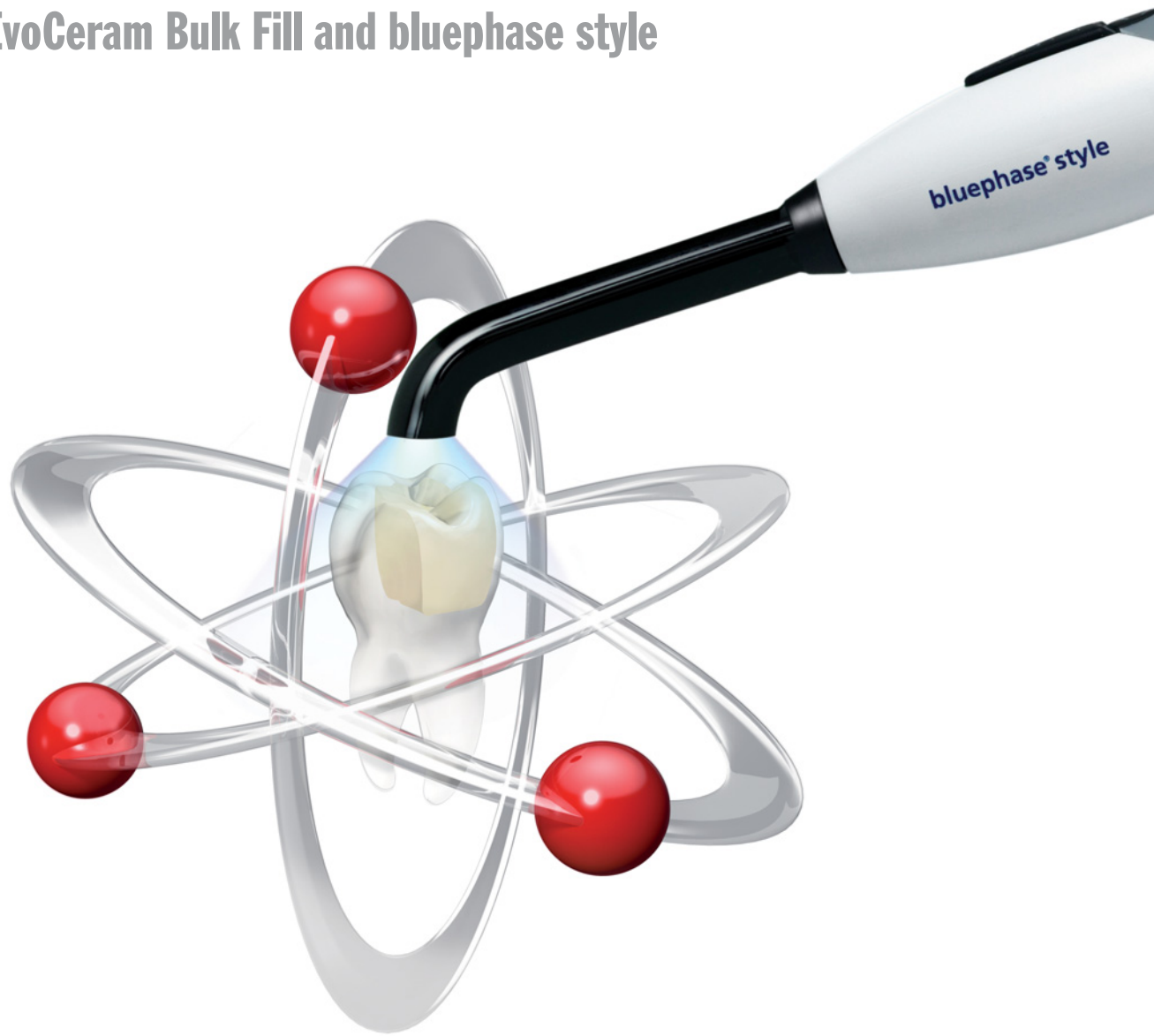
DZW
Die ZahnarztWoche

Special feature

Major breakthrough in the field of direct posterior composite resins – thanks to the combined use of Tetric EvoCeram Bulk Fill and bluephase style



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

ivoclar vivadent®
passion vision innovation

Contents

4-mm bulk fillings: placed in one increment and polymerized in one curing cycle

Dr Laurent Schenck, Ivoclar Vivadent AG – Major breakthrough in the field of direct posterior composite resins (1)

Ivoclar Vivadent, Liechtenstein, has developed a dental filling material called *Tetric EvoCeram Bulk Fill* in response to the demand for an efficient posterior composite that can be placed in one increment. Due to its unique composition featuring patented ingredients, this material can be placed in increments of up to 4 mm. The composite smoothly adapts to the cavity walls. Furthermore, it can be contoured without the pressure of time. The entire filling completely polymerizes in one curing cycle of 10 seconds with powerful curing lights, such as *bluephase style*. This particular device features a parallel-walled 10-mm light probe. It cures composite with a high light intensity of 1,100 mW/cm². The wide light probe cures fillings with large surfaces in a single exposure. In addition, the bent part of the probe is considerably shorter than that of other curing lights: As a result, patients do not have to open their mouth extremely wide for the probe to reach the back-most teeth of the jaw. With these two products, which can be used independently, quality bulk fillings can be placed quickly and easily

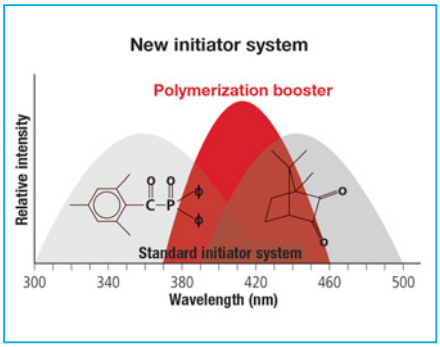


Fig. 1: Standard initiator system + polymerization booster = complete polymerization of 4-mm increments. The polymerization booster (accelerator) keeps the light curing time short, even if 4-mm thick increments are involved.

Is there really a way around the multiple increment technique? It is a well-known fact that conventional composite resins can only be placed in increments of maximum two millimetres. Furthermore, the different layers have to be individually light cured to ensure the long-term success of the filling. In order to refute this principle, the physical and chemical parameters of composites have to be rethought. Ivoclar Vivadent has done just that and developed a new approach.

The composition and its implications

Tetric EvoCeram Bulk Fill has been developed in the tradition of the proven Tetric line of products established in 1992 and in particular of Tetric EvoCeram, which was introduced in 2005. The components of this new bulk filling composite are delicately balanced in order to achieve an optimum blend of shrinkage characteristics, wear resistance, polishing properties, shade adaptation and placement and polymerization time. Like Tetric Ceram in the past, the high-performance Tetric EvoCeram has evolved into the German market leader due to continuous research and further development. To date, more than 85 million restorations have been placed with the product.

Fig. 2: Filling, contouring, polymerization: finished bulk filling. Tetric EvoCeram Bulk Fill is the first bulk filling material that can be placed without having to use a special instrument or to apply a covering layer. It can be placed in increments of up to 4 mm. Curing takes only 10 seconds with the bluephase style, for example, due to the high light intensity of 1,100 mW/cm² and the wide light tip-probe of this device.

Dr Laurent Schenck is Marketing Director clinical at Ivoclar Vivadent AG in Schaan/Liechtenstein. To contact the author, please e-mail: laurent.schenck@ivoclarvivadent.com

Tetric EvoCeram Bulk fill contains the same clinically proven ingredients of Tetric EvoCeram and therefore also demonstrates this product's excellent properties. To make the composition suitable for the new application method, several innovative components have been added. For example, the product contains a "light sensitivity inhibitor" to lengthen its working time under operating light. In order to ensure complete cure of the filling in only ten seconds, the composite resin features a "polymerization booster", a patented accelerator, as a part of the light initiation system **(Fig. 1)**. A "shrinkage stress reliever" keeps the volume shrinkage and shrinkage stress to a minimum. The material can be cured with all conventional polymerization devices.

The clinical steps

The new *Tetric EvoCeram Bulk Fill* is highly efficient. Due to its smooth consistency, it is very convenient to use in posterior teeth. The composite does not stick to instruments and is easy to pack. It readily adapts to all the surfaces of the cavity. Therefore, an initial layer of liner does not have to be placed. The material's thixotropic properties allow the tooth anatomy to be recreated in detail. Once the filling has been contoured, it retains its shape. Cavities of up to 4-mm depth can be filled in one step without any misgivings **(Figs. 2)**.

Fig. 3: As a result of its lifelike translucency, the material comes in only three universal shades that ensure good shade adaptation.

The new composite resin comes in three universal shades, which are adequate for achieving the appropriate match to the surrounding tooth substance (Fig. 3) as they are characterized by lifelike translucency and shade adaptation. Furthermore, the light refraction indices of the fillers, nano-pigments and the monomer matrix are carefully coordinated. Therefore, shades IVA (between A2 and A3), IVB (between B1 and B2) and IVW (whitish; e.g. deciduous teeth) cover almost the entire spectrum of tooth colours.

After the fillings have been contoured, they are polymerized in one light-curing cycle. As a result of the coordinated filler technology, cured *Tetric EvoCeram Bulk Fill* restorations are easy to polish to a high-gloss finish – e.g. with the one-step polishers OptraPol "Next Generation". The fillings are highly wear resistant due to the well-balanced composition of primarily small fillers. Therefore, the restorations do not have to be covered with another composite resin, in contrast to commercially available bulk flow material.

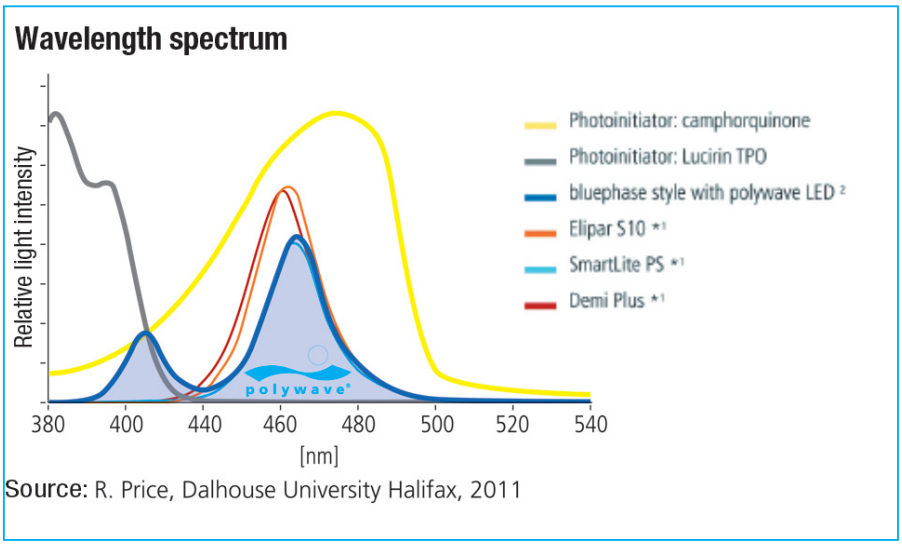
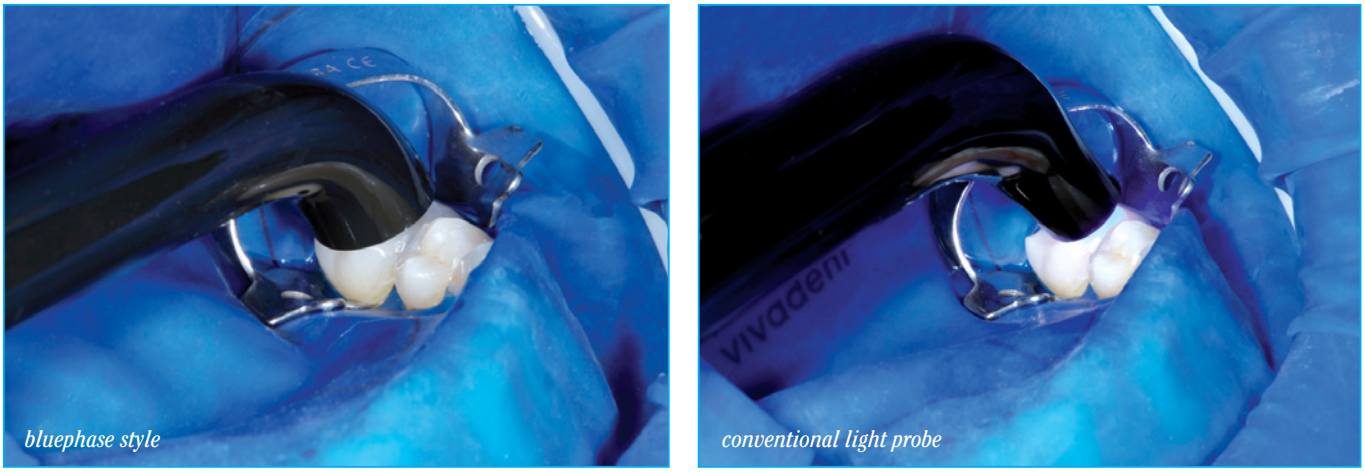


Fig. 4: Due to the polywave LED, bluephase style reliably cures all materials used in dentistry. This advanced technology is responsible for the halogen-like wavelength range of 380 to 515 nm.
** These brands are not registered trademarks of Ivoclar Vivadent AG. ¹ LED unit of the 2nd generation. ² LED unit of the 3rd generation.*

Light curing and the curing light

The light-curing unit itself plays an important role in the polymerization of 4-mm thick composite resin layers within 10 seconds. The polymerization unit *bluephase style* from Ivoclar Vivadent is finely "tuned" to this task. However, this third-generation LED unit also completely cures all the available filling composites and adhesives (Fig. 4). Its light intensity measures 1,100 mW/cm² (milliwatt per square centimetre).

The polywave LED, which has been developed by Ivoclar Vivadent, is responsible for the high performance of this curing light. It has a wide halogen-like light spectrum with a wavelength range between 380 and 515 nm. The energy released in this spectrum is capable of activating all the different types of photoinitiators, unlike the spectra of the first and second generation of LED devices, which were only effective on camphorquinone. The new polywave technology places the new *bluephase style* on a par with the tried-and-tested bluephase G2, which was introduced in 2008. As a result of its outstanding polymerization properties and exceptionally reliable light output, bluephase is considered to be the best-selling brand of LED polymerization units in Europe. It is regarded as the standard in clinical studies (IADR Barcelona 2010) and has received numerous prestigious awards. For example, it was given the highest rating of five pluses by the highly recognized and independent American test institute "The Dental Advisor". In addition, "CR Clinicians Report" ranked the product as No. 1. The new *bluephase style* incorporates the proven blue-



Figs. 5 and 6: The 10-mm light probe covers the entire surface of large Tetric EvoCeram Bulk fillings. Therefore, only one exposure to the curing light is necessary, which saves time. The light probe is located directly after the bend in the probe. The short probe is easy to introduce into difficult-to-reach treatment areas.

Fig. 7: The light and slender bluephase style is comfortable to grip for both men and women. The ergonomic design helps keep the hand and arm relaxed.

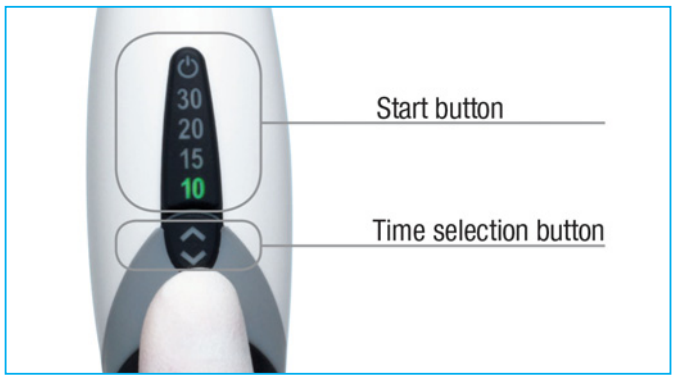


Fig. 8: The device only has two buttons. Therefore, it is very easy to operate

(All picture credits: Ivoclar Vivadent AG)

phase concept together with further improvements that make work easier in the dental practice.

An entire filling composed of a 4-mm increment of Tetric Bulk Fill can be completely cured with *bluephase style*. The light probe featuring special fibre optics plays a significant role in this process. The probe's parallel-walled design keeps the beam focused.

Large fillings need to be exposed to the curing light only once due to the wide diameter of the probe of 10 mm. This satisfies a real clinical need, as large cavities often occur in posterior teeth. Since the wide probe covers the entire bulk filling surface, only one curing cycle is necessary to fully polymerize the restoration, which saves considerable time. The short light probe additionally enhances the efficiency of the device. As the light probe of *bluephase style* is located immediately after the bend, the operator can hold the light very closely to areas that are usually difficult to reach with bulky conventional light probes (Figs 5 and 6). Fillings can be comfortably cured even in very small mouths. This presents a considerable advantage in the treatment of children's teeth and posterior molars.

Slender and ergonomic design and ease of handling

The *bluephase style* is very comfortable to hold (Fig. 6). The device is considerably smaller and lighter than the traditional curing lights. As a result of its slender shape and balanced weight distribution, the device is easy to grip for men and women alike. The straight design, in contrast to the shape of the predecessor model, allows the light to be held either like a gun (conventional) or a pen (popular), whichever way is preferred. The new ergonomic shape does not tire the hand and arm.

This sleek curing light is equipped with only two self-explanatory keys for efficient handling (Fig. 7). Consequently, there is no barrier to learning how to operate the device.

Outlook

The demand of practitioners for an economical and easy-to-use solution for restoring posterior teeth has been fulfilled with the development of the new nano-hybrid composite *Tetric EvoCeram Bulk Fill* and the efficient *bluephase style* curing light. Evaluations have shown that the bulk technique is up to 50 per cent faster compared with the increment technique involving conventional composites and multiple polymerization cycles. This topic will be discussed in more depth in three further articles.

Dr Laurent Schenck,
Schaan/Liechtenstein

LITERATURE REFERENCES:

[1] ADA, American Dental Association: *Professional Product Review,* Vol. 1, Issue 2, Fall 2006 (2006;1(2), Herbst 2006). Siehe auch Lit. 7

[2] *The Dental Advisor.* Top Light-Curing Unit: 2011, 2010 und 2009. http://www. dentaladvisor.com

[3] *Clinicians' Report: CRA* 2010;3(Okt.). www.clinicians report.org. (Ivoclar Vivadent stellt Interessierten auf Anfrage den gesamten Bericht zur Verfügung.)

[4] Ernst C-P et al.: Feldtest zur Licht-emissionsleistung von Polymerisationsgeräten in zahnärztlichen Praxen. In: *DZZ* 2006;60(9):466-471. Siehe auch Lit. 7

[5] Enggist L: Nur auf den Preis schauen kann teuer werden. Dr. Lukas Enggist zu den Kriterien für die Auswahl von LED-Polymerisationsgeräten – Was ist beim Kauf zu beachten? In: *DZW* 2009; 46:18.

[6] Ernst C-P: Die richtige Auswahl eines Polymerisationsgerätes. In: *Dental Kompakt* 2009:220-221.

[7] *Gut, wenn man die Fakten kennt. Leitfaden über klinisch entscheidende Kriterien bei der Auswahl eines Polymerisationsgerätes.* Hg.: Ivoclar Vivadent, Schaan, Liechtenstein. 32 Seiten.

[8] IADR – International Association for Dental Research/General Session, Barcelona, July 14-17, 2010. www.iadr.org. (Die meisten Produktnennungen in Abstracts)

[9] Price R BT, Fahey J, Felix C: Knoop hardness of five different composites cured with singlepeak and polywave LED curing lights. *Quintessence Int* 2010;41;e181-e191.

[10] Price R BT: Evaluation of a dual peak third generation LED curing light. Department of Dental Clinical Sciences, Dalhousie University, Halifax, Nova Scotia, Canada. *Compend Contin Educ Dent* 2005(26):331-2, 334, 336-8 passim; quiz 348.

[11] Price R BT: Third generation vs a second-generation LED curing light: effect on Knoop microhardness. Department of Dental Clinical Sciences, Dalhousie University, Halifax, Canada. *Compend Contin Educ Dent* 2006(27): 490-6; quiz 497, 518.

[12] Repetto-Bauckhage T: Beunruhigende Ergebnisse für Polymerisationsgeräte. Wenn die Leistung nicht mehr stimmt. *DZW* 2011(21):20-21.

[13] *Ivoclar Vivadent Report* Nr. 18 2007; August:29-39.

[14] Kleverlaan CJ, Feilzer AJ. Polymerization shrinkage and contraction stress of dental resin composites. *Dent Mater* 2005;21:1150-1157.

[15] Ferracane JL, Mitchem JC. Relationship between composite contraction stress and leakage in Class V cavities. *Am J Dent* 2003;16(4): 239-243.

[16] Watts DC, Marouf AS, Al-Hindi AM. Photo-polymerization shrinkage-stress kinetics in resin-composites: methods development. *Dent Mater.* 2003 Jan; 19(1):1-11.0

Moving on from conventional layering techniques: 4-mm bulk fill with 10-second single-cure polymerization

Dr Peter Burtscher, Ivoclar Vivadent AG – Major breakthrough in the field of direct posterior composite resins (2)

Features such as wear resistance, esthetics (i.e. shade and translucency), mouldability, polishability, strength, volumetric shrinkage and shrinkage stress are carefully balanced in line with the principle of cause and effect and ultimately result in a restriction of the layer thickness to two millimetres. In the anterior region, this restriction does not necessarily mean more work, because the esthetic requirements of these restorations command a great deal of attention to detail and hence the application of thin layers anyway. In the posterior region, however, an efficient working method takes the priority, particularly when basic restorations are fabricated. In addition, dental professionals – and patients – would like the chairtime to be short. Now a material that meets exactly these requirements has become available. With *Tetric EvoCeram Bulk Fill*, restorations can now be accomplished using a single increment and single-cure polymerization with a high light intensity curing unit, e.g. the new *bluephase style* LED light which offers an intensity of 1,100 mW/cm^2. The need for several increments and curing cycles has been eliminated.

A newly developed initiator system containing patented proprietary ingredients has been incorporated into this new nano-hybrid bulk fill composite to achieve the desired profile of properties **(Figs. 1 and 2)**.

Technological achievements of Tetric EvoCeram Bulk Fill

The first single-increment material that offers uncompromising quality: Patented layered silicates and the well-balanced organic matrix composition impart a pleasant mouldable consistency to this bulk fill material. The composite easily adapts to the cavity walls, eliminating the need for an initial coating of flowable composite.

A material that is applied in 4-mm increments and subsequently contoured needs to offer a longer working time than conventional composites. It must not polymerize prematurely when exposed to operatory light. A patented light sensitivity inhibitor ensures that premature polymerization does not occur in the new bulk fill material, granting a working time of more than three minutes under defined light conditions of 8000 lux **(Fig. 3 and 4)**. An important additional feature of this molecule is that it does not impair polymerization when exposed to the intensive light of a LED source.

Fig. 1: Initial situation: inadequate amalgam fillings

Figs 1 and 2: Dr Eduardo Mahn, Las Condes, Santiago/Chile

Fig. 2: Tetric EvoCeram Bulk Fill restorations, two weeks after placement

Dr Peter Burtscher is the Head of Development for restoratives and cementation materials at Ivoclar Vivadent AG in Schaan/Liechtenstein. To contact the author, please e-mail: peter.burtscher@ivoclarvivadent.com

To accelerate the polymerization process, a patented polymerization booster **(Fig. 5)** has been added to the standard initiator system. As a result, the material features an absorption maximum in the blue-light range from around 370 to 460 nanometres. When exposed to the light of a high-energy polymerization unit – e.g. *bluephase style* – at an accurately set emission spectrum, the bulk filling cures rapidly to a consistent depth of cure (see Box 1). By contrast, other commercially available materials contain conventional stabilizers, which start to polymerize after a shorter time and offer less time to shape the restoration.

The polymerization booster allows *Tetric EvoCeram Bulk Fill* to be set to an enamel-like 15 per cent translucency. This is not possible with conventional composites that do not contain a polymerization booster. Whilst the number of photons that reach the cavity floor is significantly smaller than the number of photons on the restoration surface, it is still sufficient for the light sensitive booster molecules to trigger the polymerization reaction even in layers that are 4 mm deep or even deeper **(Fig. 6)**.

A welcome co-effect: The finely balanced translucent properties and the specifically coordinated refractive indices of the filllers, nano-pigments and monomer matrix enable the material to blend seamlessly into the natural dentition without producing the greyish discolouration so often encountered in highly translucent composites. Masking the underlying tooth structure with a cavity liner (e.g. Tetric EvoFlow A3.5 Dentin) is required only in exceptional cases, for instance if an amalgam filling is replaced.

Style and ergonomics: The new LED curing light bluephase style (below) combines these two features. A juxtaposition of the conventional bluephase (on top) and the new curing light clearly illustrates the differences between the two versions.

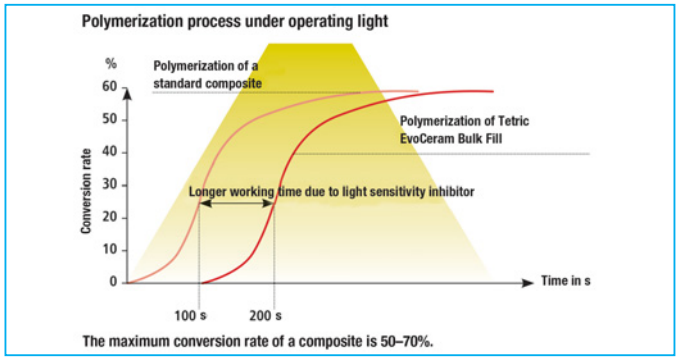


Fig. 3: The patented light sensitivity inhibitor delays the polymerization reaction to ambient light, e.g. the light in the treatment room.

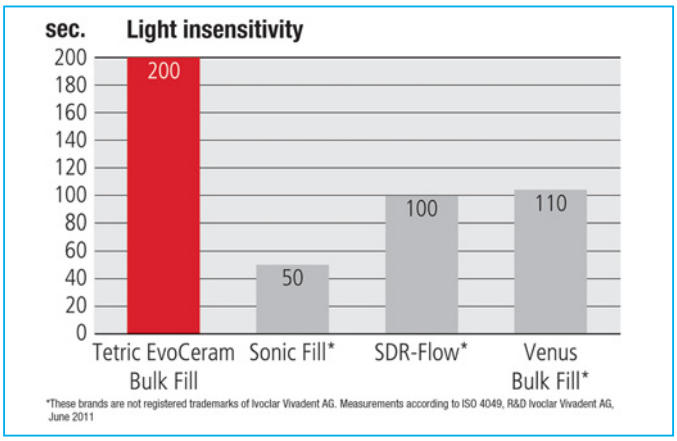


Fig. 4: Tetric EvoCeram Bulk Fill showed a working time of 200s when tested under the defined ambient light conditions of 8000 lux according to ISO 4049 and therefore offers the longest working time of all materials that can be applied in the bulk fill technique.

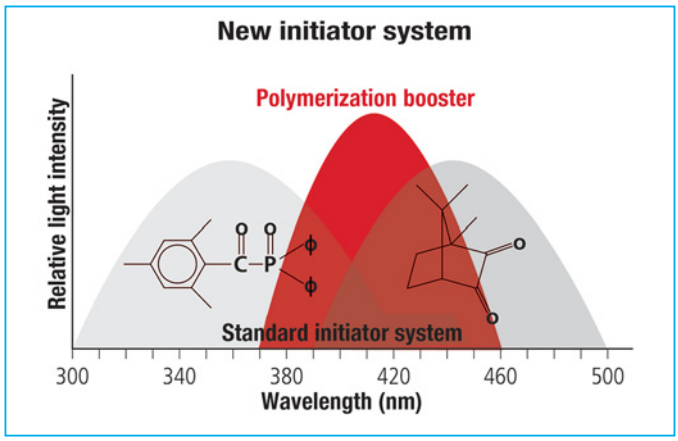


Fig. 5: Standard initiator system + polymerization booster = complete polymerization of 4-mm increments. A patented polymerization booster is used in Tetric EvoCeram Bulk Fill as an additional photoinitiator.

The development of the filler technology is marked by additional technological achievements, which enable the material to be used in the bulk fill technique in conjunction with a single-cure polymerization step: The fillers are restricted to a small size to produce a compact, wear-resistant surface that does not require coating with an additional composite. In addition, a shrinkage stress reliever ensures that the shrinkage stress and volumetric shrinkage are kept low during polymerization. (*Part 3 of this series of articles will discuss this topic in greater detail.*)

Initiator system and single-cure polymerization

To initiate the polymerization, the absorption spectrum of the photoinitiators and the light emission spectrum of the curing light have to be compatible with each other.

Curing depth: a decisive factor for bulk materials

If we assume that the light intensity and curing time are set correctly and the emission spectrum of the light unit is compatible with the absorption spectrum of the photoinitiators, the shade and translucency of a composite resin are the two factors that have the most significant effect on the curing depth.

Measurements have shown that the degree of cure continuously decreases in areas deeper than approx. 0.5 mm. The degree of cure is highest at a depth of 0.5 mm, because the covering layer is slightly softer due to the effects of inhibition. In practice, however, this layer tends to be removed in the course of polishing and grinding, so that the hardest layer forms the top surface of the restoration. From this layer downwards, the light intensity entering the material decreases steadily: the filler particles scatter the light and the colour pigments absorb it. Remaining radicals undergo a post-curing reaction, mostly within 24 hours after the initial polymerization. This is accompanied by a decrease in the yellowish tinge if camphorquinone is used as photoinitiators.

To determine the degree of cure in deep layers, test samples are first stored for 24 hours before the measurements are carried out. If the manufacturer's directions regarding the curing times and light intensities are followed, a good degree of cure is usually obtained particularly on the surface of a composite irrespective of the degree of translucency or shade. However, users have no way of assessing the degree of cure across the entire thickness of the restoration.

Profile measurements, which measure the degree of cure step by step in ever deeper layers, provide information on the curing depth down to the bottom surface of the test samples. With regard to evaluating the results, Professor David Watts (*) from the University of Manchester in Great Britain has come to the following conclusion: The curing depth meets the clinical requirements if the degree of cure measured on the bottom surface is at least 80 per cent of the value measured on the top surface (Fig. 8).

Bulk fillings that consist of Tetric EvoCeram Bulk Fill and are cured for 10 seconds in a single-cure procedure meet this requirement. In addition, they also offer favourable esthetic qualities and a well-balanced translucency of 15 per cent due to the polymerization booster. In compliance with ISO standards, conventional composites should not exceed a layer thickness of two millimetres to ensure an adequate degree of cure for all translucencies and shades.

Source:
Burtscher P. Visible light curing of composite resin. In: Ivoclar Vivadent Report No. 18, 2007; August: 29-39.

**) Watts DC, Amer O, Combe EC. Characteristics of visible-light-activated composite systems. Br Dent J 1984; 156:209-215.*

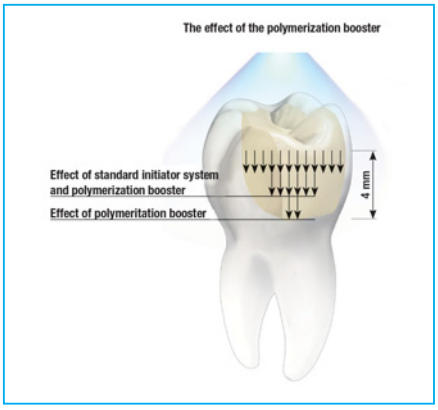


Fig. 6: This innovative polymerization booster initiates polymerization even if only a few photons reach the deep layers of the cavity. Consequently, there is no need to increase the translucency to allow more photons to pass through the depth of the material and start polymerization.

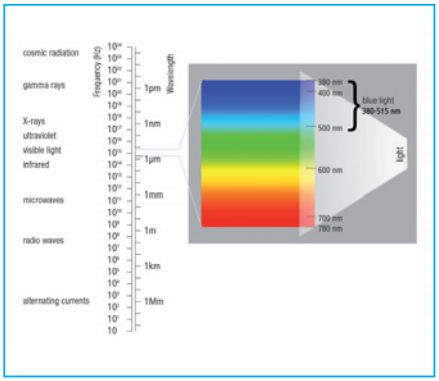


Fig. 7: The visible light spectrum ranges from 380 to 780 nanometres. The polymerization of modern composites requires blue light in the wavelength range from 380 to 515 nanometres to ensure that all photoinitiators are capable of absorbing energy. The bluephase style curing light achieves this spectrum by means of polywave LED technology specifically developed by Ivoclar Vivadent.

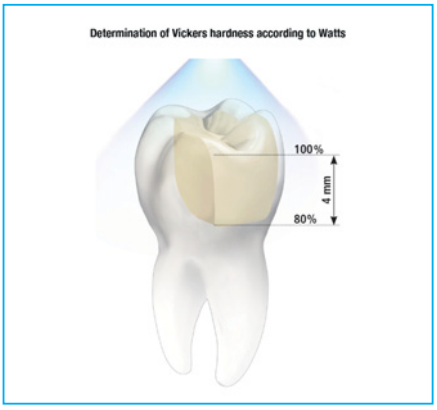


Fig. 8: Watts states that a material exhibits a clinically sufficient depth of cure if the value measured on the bottom surface amounts to at least 80 % of the value measured on the top surface of the restoration (see Box 1).

Fifs.. 3 to 8: Ivoclar Vivadent AG

The polywave technology, which Ivoclar Vivadent has developed specifically for its range of bluephase curing lights, ensures that polymerization is triggered reliably **(Fig. 7)**. As the polywave LEDs achieve a broadband spectrum in the wavelength range of 385 to 515 nanometres, similar to halogen lights, they are suitable for dental resins that typically contain champorquinone or Lucerin as initiators (see Box 2) as well as for materials that incorporate the new "polymerization booster". The first and second generation of LED lights are not capable of emitting light in such a comprehensive range; they can only polymerize composites containing camphorquinone and the "polymerization booster". Only the third generation of LED lights is suitable for all initiators. This generation includes the newly introduced *bluephase style* and bluephase G2, which was launched in 2008.

These cutting-edge polymerization units are capable of reliably polymerizing all restorative composites currently available on the market. These lights offer a consistent high light intensity and easy operation. By virtue of these features, bluephase has been regarded as the brand that sells the most LED polymerization lights in Europe. The lights have earned several renowned awards from recognised bodies and they are often mentioned as the standard in clinical studies (see literature references previously published in Part 1 of this series).

The light produced in the polywave light diodes is guided through a parallel-walled light probe. In this way, the light beam does not scatter and the light intensity remains high until the beam reaches the restoration surface. For instance, *bluephase style* produces a light intensity of around 1,100 mW/cm^2 (milliwatts per square centimetre), allowing 4-mm increments of *Tetric EvoCeram Bulk Fill* to be polymerized in ten seconds. In addition, the large 10-mm diameter of the light probe ensures that even extensive restoration surfaces are completely covered with light, allowing polymerization to be carried out in a single step. Light units with a narrower probe often require several exposures to cure the restoration in its entirety.

Final note: Making the best even better

The bluephase technology is now housed in a smaller, handier casing. The shape of the light unit has been revamped to develop *bluephase style* (Fig. 7). The latest edition of bluephase features an elongated, pen-like shape. It sits more comfortably in the hands of women and men than other polymerization units and can be held like a gun, as before, or conveniently like a pen. With its handy proportions, the light does not cause fatigue, even if the treatment field is situated in the posterior region or if a patient's mouth opening is restricted. The light probe is shortened with the light head being located immediately after the angled bend. This facilitates the handling, particularly if space is tight. In addition, the unit is as easy to operate as could be. It features two buttons, one to start polymerization and the other to select the exposure time.

More information on the properties and economic efficiency of these products can be found out in two additional instalments of this series.

Dr Peter Burtscher,
Schaan/Liechtenstein

Photoinitiators – Curing lights – Composite esthetics

Camphorquinone is the most important photoinitiator. From their beginnings, polymerization lights were tailored and restricted to the wavelength range of camphorquinone. This initiator features an absorption peak in the visible blue light spectrum between 465 and 475 nanometres and therefore produces a pronounced inherent yellowish tinge. Since camphorquinone does not completely break down during polymerization, the composite keeps its slightly yellowish hue even when it is cured. This does not represent a problem for teeth that fall into the standard range of shades; to the contrary, a slightly yellowish tone is often even desirable.

Tetric EvoCeram Bulk Fill contains a newly developed photoinitiator, for which Ivoclar Vivadent owns a patent. This initiator ensures that the material polymerizes even in the deep parts of a cavity. This "polymerization booster" allows the composite to be endowed with a favourable enamel-like translucency (see main text). It has an absorption peak at around 415 nanometres, which is significantly lower than that of camphorquinone. However, its reactivity is so high that it is capable of absorbing light in a broad wavelength range (from 370 to 460 nanometres). This allows the composite to be cured with conventional light-curing lights.

With an absorption peak at around 400 nanometres, Lucerin (acyl phosphine oxide) is used as photoinitiator in conjunction with shorter wavelength ranges. This photoinitiator is contained in bleach shades as it offers a convenient advantage: the material does not discolour during polymerization.

The cutting-edge bluephase style curing light is equipped with polywave technology and consequently emits light in a broadband spectrum that is suitable for all initiators currently available on the market. This LED light is therefore compatible with all light-curing composite materials.

Low shrinkage and shrinkage stress: an essential prerequisite for composite restoratives that can be bulk filled and cured in a single step

Dipl.-Ing. Karin Vogel, Ivoclar Vivadent AG – Major breakthrough in the field of direct posterior composite resins (3)

High demands are placed upon the shrinkage behaviour of composite resins which even allow bulk filling of large cavities and achieve a complete cure within a short exposure time. With *Tetric EvoCeram Bulk Fill*, Ivoclar Vivadent has launched a new nanohybrid composite which can be bulk filled in 4-mm increments and cured in a single step with high-performance LED curing lights such as the *bluephase style*. The outstanding properties of the new dental composite are based on an innovative initiator system and the clever use of state-of-the-science filler technology.

Composite resins shrink during polymerization. Problems associated with polymerization shrinkage include marginal discolouration, marginal gap formation, secondary caries, debonding along the cavity floor and walls, restoration loss – even enamel cracking and hypersensitivity: any of these factors may impair a restoration's longevity. Composite manufacturers are putting a lot of effort into further optimizing the dental composites they market. Ivoclar Vivadent for instance has a large, well-staffed in-house research and development facility equipped with the latest technology and equipment. Their researchers are working on various aspects of composite technology simultaneously in order to provide what today's dental professionals demand: a composite that avoids the problems mentioned above. Controlling the processes involved in polymerization is one of the keys to success, as will be shown in the following article.

Dipl.-Ing. Karin Vogel works at the Research and Development facilities of Ivoclar Vivadent in Schaan/Liechtenstein. To contact the author, please e-mail: karin.vogel@ivoclarvivadent.com

Figs. 1 and 2: Before (Fig. 1) and directly after the placement of the filling (Fig. 2)
Picture courtesy of Dr Eduardo Mahn, Las Condes, Santiago/Chile

Shrinkage stress – marginal leakage – resistance against chewing forces: How deformable should dental composites be?

The modulus of elasticity of composite resins is known to be a relevant factor for achieving marginal integrity. The forces acting

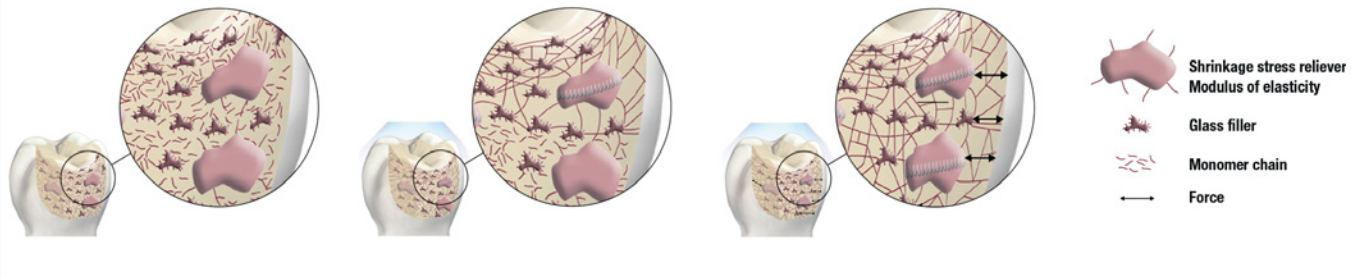


Fig. 3: The shrinkage stress reliever attenuates shrinkage-induced stress. This special filler, which is partially functionalized with silanes, adheres to the cavity walls together with the monomer matrix and the adhesive and resists the shrinkage force.

on the cavity walls during the polymerization process are not only influenced by the amount of shrinkage, but also by the elastic modulus of a dental composite, which itself is composed of the elastic moduli of the filler and the monomer matrix.

If a material is hardly deformable, i.e. shows high resistance to deformation, it is described as being inelastic and having a high modulus of elasticity. During the shrinkage process, high stress is generated as rigid materials fixed to the tooth structure by means of adhesives tend to "tear" at the cavity walls (Lit. 1). As a result marginal gaps may form (Lit. 2).

By keeping the modulus of elasticity at a low level, the build-up of high shrinkage stress is avoided. However, resilient material is not strong enough to withstand the masticatory forces in the long term. Composites with an elastic modulus between 8 and 11 GPa have been shown to perform best in stress-bearing areas. Therefore, the elastic modulus of *Tetric EvoCeram Bulk Fill* has been tuned to a favourable level of 10 GPa.

Flowable composites are examples of restorative materials with a low modulus of elasticity. As a consequence, these materials demonstrate low shrinkage stress. Due to the high monomer content, however, their loss of volume during polymerization amounts to at least 3.5 per cent. Therefore, they have to be applied in thin layers. Flowable composites are thus only recommended for use as cavity liners and preventive resin restoratives or for restoring Class V cavities. They should not be used in cavities requiring thicker layers of material.

A composite restorative such as *Tetric EvoCeram Bulk Fill* (Figs. 1a and b), which can be applied in increments of 4 mm and cured in a single step, should exhibit low shrinkage stress and low volumetric schrinkage. In order to achieve this, fillers with a special composition aimed at reducing shrinkage and shrinkage stress have been used in *Tetric EvoCeram Bulk Fill* (Fig. 2).

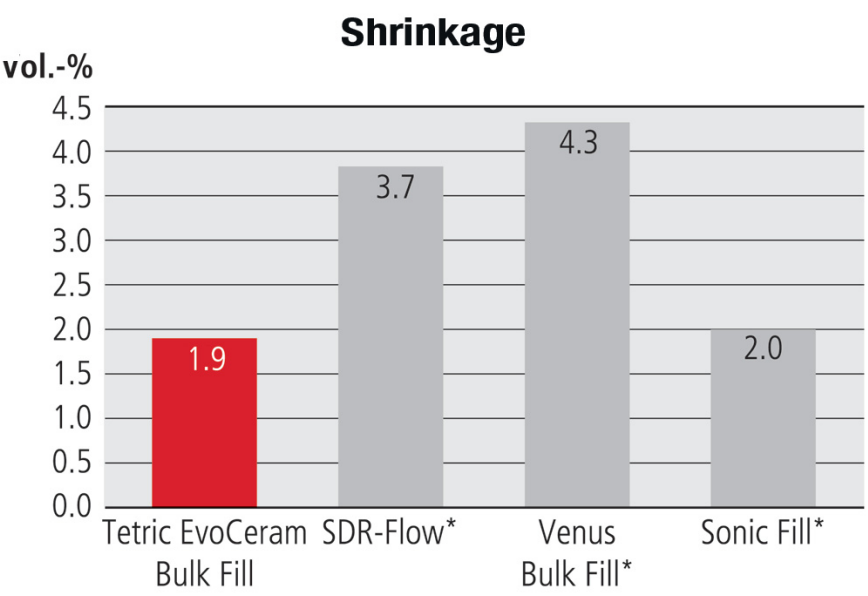


Fig. 4: Tetric EvoCeram Bulk Fill's low volumetric shrinkage of 1.9 per cent is attributable to the elastic properties and the special particle size of the shrinkage stress reliever.

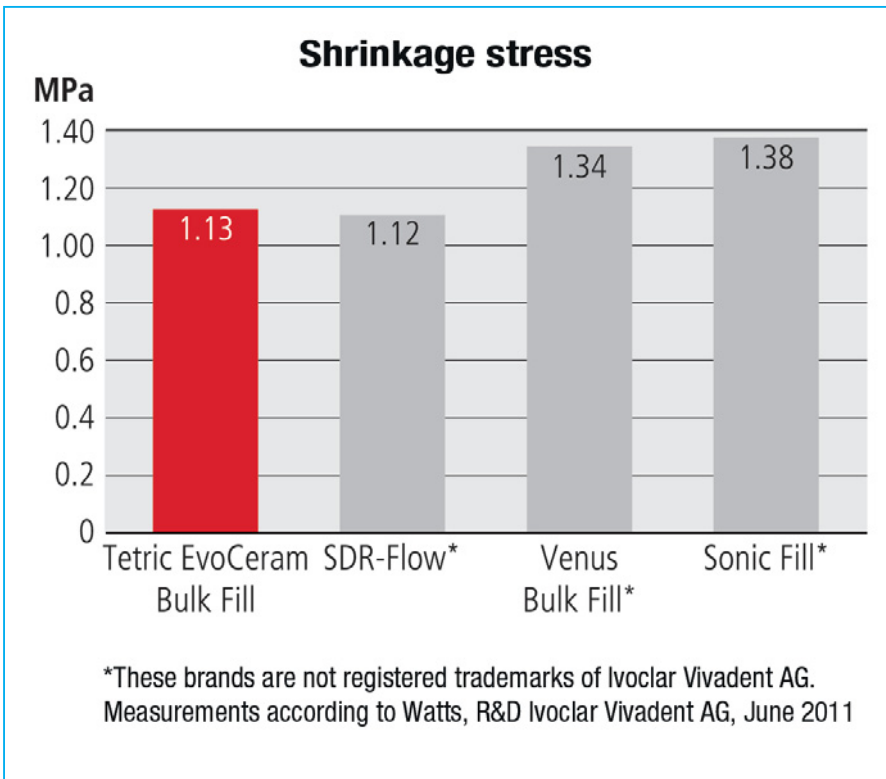


Fig. 5: Another positive effect of the stress reliever's spring-like behaviour: the shrinkage stress level does not exceed 1.13 MPa.

The solution: a shrinkage stress reliever

Apart from standard fillers with a modulus of elasticity of 71 GPa and a high degree of silanization, the new filler mixture also comprises a composite filler designed to relieve shrinkage stress. This filler features a highly desirable and very useful modulus of elasticity of 10 GPa as well as specially conditioned surfaces (silanization, see box).

Tetric EvoCeram Bulk Fill's mode of action: During polymerization, the individual monomers move closer together and combine to form a polymer network. As a result, the material starts to shrink: shrinkage forces develop and the cavity walls are exposed to shrinkage stress (shrinkage force per unit area). This is when the shrinkage stress reliever unfolds its action. Due to its size and low modulus of elasticity of 10 GPa, this filler shows elastic, spring-like behaviour. As a con-

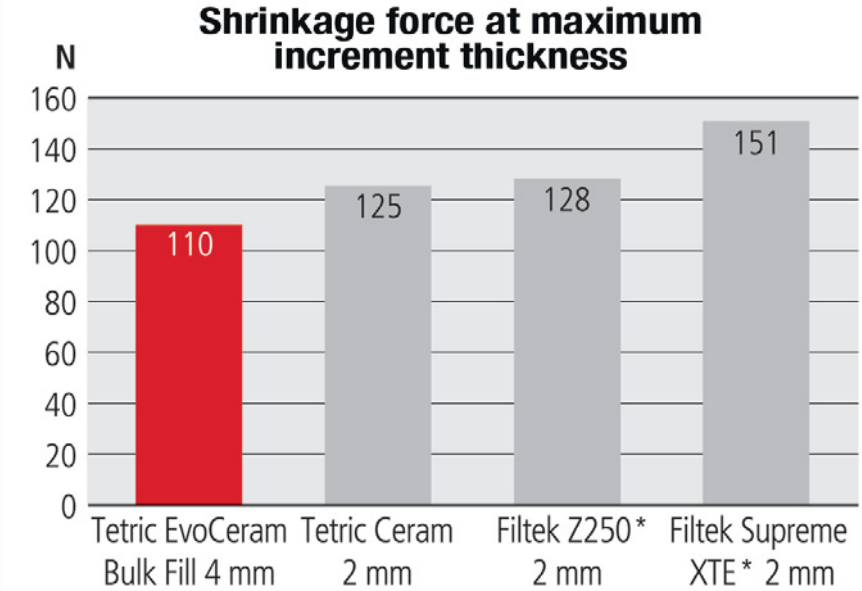


Fig. 6: Comparison of shrinkage forces occurring in different composites. With a force of 110 Newton (N) acting on the cavity walls, Tetric EvoCeram Bulk Fill demonstrates a more favourable value than conventional composites.

sequence, it relieves shrinkage stress; moreover, due to its low surface area, volumetric shrinkage is reduced. As the filler is partially functionalized by silanes, it "holds on" to the cavity walls together with the matrix and the adhesive by bonding to the walls. Moreover, its special silanization gives the stress reliever a certain amount of freedom during polymerization so that it can partially react with the polymer network and prevent shrinkage tension.

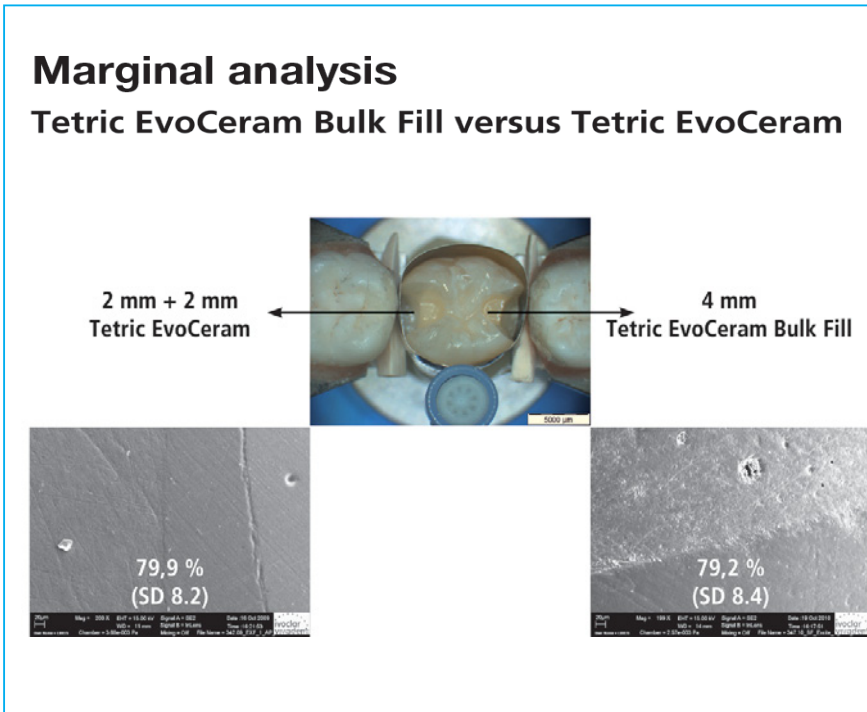


Fig. 7: Assessment of the marginal quality under the scanning electron microscope at 200-foldmagnification. If restorations show 75 per cent or more intact margin, the marginal quality is considered to be "excellent".

Figs. 3 to 7: Ivoclar Vivadent

Low volumetric shrinkage, low shrinkage forces along cavity walls

The effectiveness of the shrinkage stress reliever has been proven in several tests. A 4-mm increment of *Tetric EvoCeram Bulk Fill* demonstrates volumetric shrinkage of only 1.9 per cent (Fig. 3). Consequently, operators have the option of placing thicker layers without putting the restoration at risk. The measured stress level (Fig. 4) does not exceed 1.13 MPa (Newton per square millimetre = MegaPascal) – a sound basis for achieving a good marginal seal. The investigations were conducted based on the test method developed by Professor David Watts of the University of Manchester, UK (Lit. 3).

Virtually the same low shrinkage forces were observed in 4-mm increments as in conventional 2-mm increments (Fig. 5). It is definitely reassuring to know that the shrinkage forces of 110 Newton produced in a bulk-cured *Tetric EvoCeram Bulk Fill* increment of 4 mm thickness are lower than those occurring in 2-mm increments of clinically proven products (e.g. Tetric Ceram). The measured data confirm that the bulk filling material is clinically acceptable and the marginal quality of the filling is not compromised. It can thus be concluded that intermediate polymerization after the placement of 2-mm increments is unnecessary. The entire cavity can be filled in one go and bulk-cured with any curing light currently available.

Tight marginal seal

An analysis of composite restorations using scanning electron microscopy clearly shows that low shrinkage and low shrinkage force or stress (a measure for shrinkage force per unit area) are clinically relevant factors (Fig. 6). When using the 4-mm increment technique with *Tetric EvoCeram Bulk Fill*, restorations show 79.2 per cent intact margin – compared to 79.9 per cent achieved by Tetric EvoCeram.

For this comparison, two 4-mm deep MO cavities were prepared in one molar. The cavities were pretreated with ExciTE F adhesive. One cavity was conventionally filled with two 2-mm increments of composite and involved an intermediate and a final polymerization step (*bluephase style* curing light). The other cavity was filled with a single 4-mm increment and cured only once with *bluephase style*. The tooth was then subjected to thermocycling (10,000 cycles). Following this, the margins of both fillings were examined. If restorations show 75 per cent or more intact margin at 200fold magnification, the marginal quality is considered to be "excellent". This applied to both materials in this case.

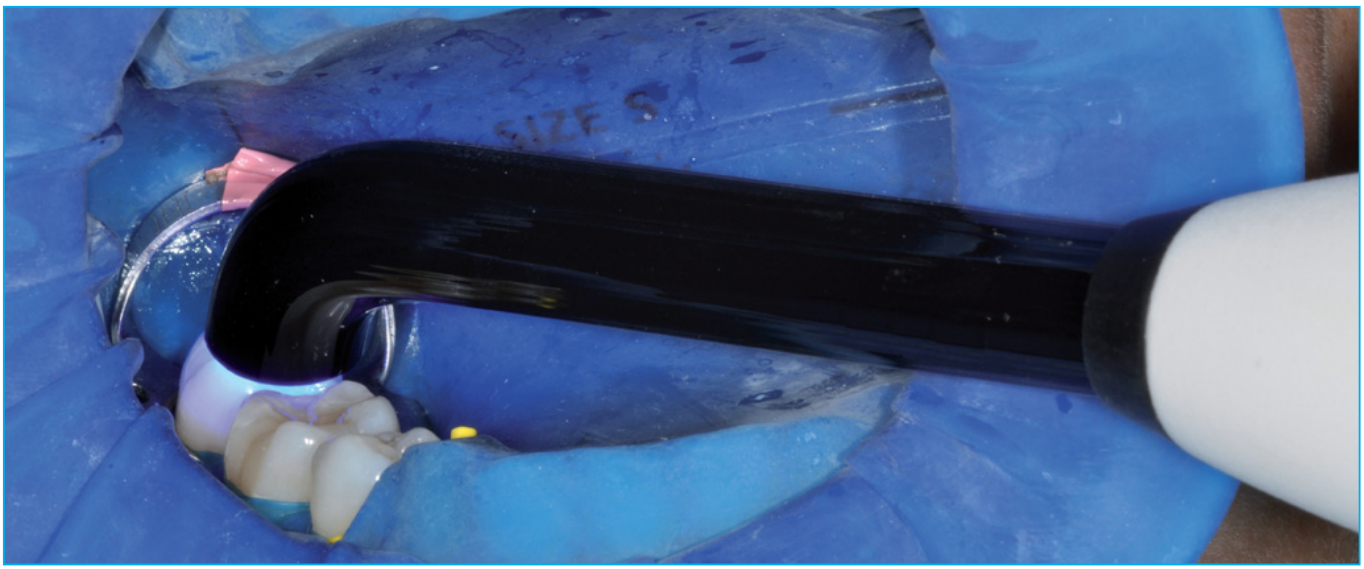


Fig. 8: Useful and convenient: the short light probe of the new bluephase style. Even difficult-to-reach areas can be accessed without extreme opening of the mouth. The 10-mm wide light probe enables even extensive fillings to be cured in one curing cycle.

Picture courtesy of Dr Eduardo Mahn, Las Condes,Santiago/Chile

The role played by the curing light

Dental manufacturers not only have to provide materials suitable for the bulk filling technique, e.g. by means of the incorporation of a shrinkage stress reliever such as in the case presented here. Successful restorative results are also dependent on effective curing lights. When bulk-curing 4-mm increments of *Tetric EvoCeram Bulk Fill* in 10 seconds, the use of a high performance LED curing light is certainly advantageous and saves considerable time. The new *bluephase style* from Ivoclar Vivadent is ideal for this purpose. In addition, it allows all types of currently available composites to be cured efficiently and reliably. The broadband wavelength spectrum covered by the polywave technology of *bluephase style* is suitable for the excitation of all photoinitiator systems currently employed in composite restoratives (for more details see Part 1 and 2 of this article series).

With 1,100 mW/cm² (milliwatt per square centimetre), bluephase features a high light intensity. This means that its light intensity corresponds to that of bluephase G1, a curing light whose reliability in terms of light intensity has been confirmed by a study conducted at the University of Mainz (Germany). The German scientists measured the actual light intensity of LED polymerization lights of different manufacturers used on a regular basis in 301 dental surgeries (Lit. 4). The low fluctuation range of ±10 per cent indicated in the bluephase Operating Instructions was confirmed by the study. Other curing lights were shown to produce much weaker light intensities than those indicated by the manufacturers. A US study conducted with brand new LED curing lights provided by the manufacturers revealed similar results (Lit. 5).

Because of its excellent curing power, *bluephase style* allows 4-mm thick layers of *Tetric EvoCeram Bulk Fill* to be reliably cured down to the cavity floor in only ten seconds. Only one curing cycle is required. This is made possible by the parallel-walled design of the light probe, among other things. It ensures that the light intensity is kept constant until the light hits the restoration surface.

In contrast to conventional lights, *bluephase style* comes with light probes that feature a wide diameter of 10 mm. As a result, even extensive restorations can be reliably cured in one curing cycle. Reaching the posterior molars, which can be difficult with conventional lights, is no problem at all with *bluephase style*. Its light probes feature a shortened design with the light emission window located directly after the bend (Fig. 7). So if the area to be treated can be accessed directly, the exposure time does not have to be extended. Moreover, the narrow, slender design of the new light enhances ease of handling and curing efficiency.

What is the function of silanes?

In order to improve the bond between the inorganic filler (glass and quartz particles) and the monomer matrix, silanes are bonded to the filler particles. They are capable of establishing a chemical bond between the glass surface and the matrix.

Find out more about the efficiency and cost-effectiveness of the bulk filling technique in combination with one-step bulk curing in the last part of this series.

Dipl.-Ing. Karin Vogel,
Schaan/Liechtenstein

LITERATUR

[1] Kleverlaan CJ, Feilzer AJ. Polymerization shrinkage and contraction stress of dental resin composites. *Dent Mater* 2005;21:1150-1157.

[2] Ferracane JL, Mitchem JC. Relationship between composite contraction stress and leakage in Class V cavities. *Am J Dent* 2003;16(4): 239-243.

[3] Watts DC, Marouf AS, Al-Hindi AM. Photo-polymerization shrinkage-stress kinetics in resin-composites: methods development. *Dent Mater.* 2003 Jan;19(1):1-11.

[4] Ernst C-P et al. Feldtest zur Lichtemissionsleistung von Polymerisationsgeräten in zahnärztlichen Praxen. *DZZ* 2006;60(9):466-471.

[5] ADA, American Dental Association. *Professional Product Review,* Vol. 1, Issue 2, Fall 2006 (2006;1[2], Herbst 2006).

For further literature references see Part 1 and 2.

Saving valuable time – thanks to a single 4-millimetre increment and single-cure photopolymerization

Hans-Christian Weinhold, dentist, ICDE Ivoclar Vivadent AG – Major breakthrough in the field of direct posterior composite resins (4)

Dental practices can now benefit from a new level of efficiency. The need for applying several increments of composite material to fabricate posterior restorations has been eliminated in most cases. The reason: Ivoclar Vivadent's innovative nano-hybrid composite *Tetric EvoCeram Bulk Fill* allows you to save valuable time. Without having to use a flowable material or applying an additional covering layer, you can fill cavities with a depth of up to four millimetres in one step. The material does not require intermediate polymerization and is cured within ten seconds. Compared with the conventional layering technique, Bulk Fill restorations are completed in half the time. If you use the material in conjunction with a high-performance LED curing light, for instance the new *bluephase style*, one curing cycle is sufficient to cure all deep restorations made with this material. This applies even to large restorations, because this state-of-the-art curing light is equipped with a large light probe with a diameter of ten millimetres and a correspondingly wide light emission window. *Tetric EvoCeram Bulk Fill* and the new *bluephase style* are reliable partners in your daily work. It goes without saying that these products can also be used separately.

Figs. 1 and 2: A great deal of time can be saved thanks to the bulk fill technique: by placing four-millimetre increments, by using only one material for the entire cavity from the bottom to the occlusal surface and by curing the entire restoration for ten seconds in a single curing step.

The introduction of the incremental technique was considered a step forward. By dividing a restoration into several increments, dentists were able to control the polymerization shrinkage and thus improve the marginal quality of the restorations. For a long time, halogen curing lights and a curing time of 40 seconds were considered the gold standard. In addition, the application of several increments allowed dental professionals to combine different shades to improve the esthetic outcome. This has been the textbook procedure for generations of dentists.

A true bulk composite

The incremental technique, however, has a major drawback: It is very time-consuming. Creating highly esthetic, high-quality restorations in a time-saving procedure still was an unmet requirement; amalgam and its short processing time were and still are present in the minds of dental professionals. With the new posterior composite from Ivoclar Vivadent, dentists can benefit from a time-saving procedure that does not require the application of the incremental technique (Figs 1a and 1b). From the point of view of the dentist, there are three aspects which make this possible: efficient 4-mm bulk filling, one material for the entire restoration from the bottom to the top and short one-step curing cycles.

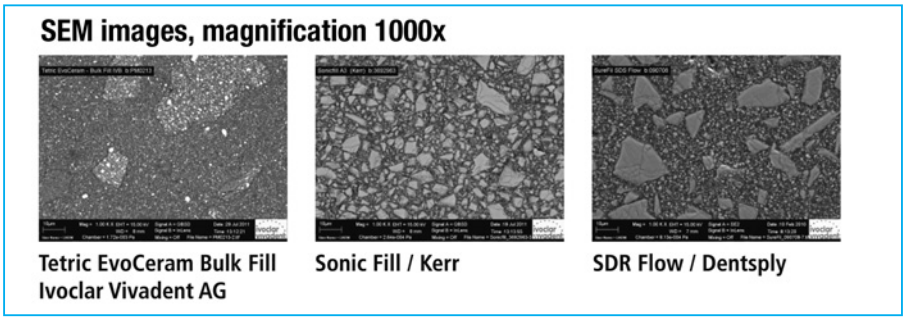


Fig. 3: Compared with all other bulk composite materials, Tetric EvoCeram Bulk Fill features very small fillers.

Hans-Christian Weinhold is a dentist working at the International Center for Dental Education (ICDE) of Ivoclar Vivadent in Schaan/Liechtenstein. To contact the author, please e-mail: hans-christian.weinhold@ivoclarvivadent.com.

Efficient procedure

To allow the placement of large increments, the fillers used in *Tetric EvoCeram Bulk Fill* had to be modified in such a way that the volumetric shrinkage and the shrinkage stress remain low and a sound marginal quality is achieved. In addition, a "light sensitivity inhibitor", which slows down the reaction to light, provides for an ample working time of more than three minutes; the operatory light does not initiate the polymerization process. This effect allows you to fully benefit from the efficiency potential of this new material.

The composite features a smooth consistency. It can be easily applied in the cavity, does not stick to instruments and readily adapts to the cavity floor and walls. In addition, it is packable. Contrary to a flowable composite, this material has a viscosity that is ideally suited to contouring the occlusal area and contact points in a short time. The convenient consistency is achieved by means of patented layer silicates.

As opposed to other bulk materials, *Tetric EvoCeram Bulk Fill* does not require an addi-

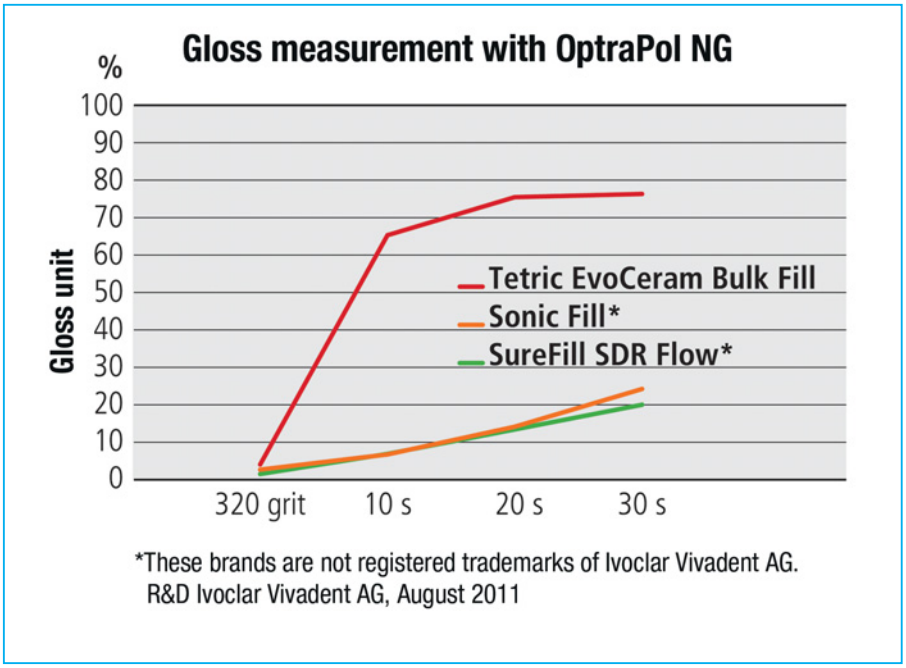


Fig. 4: The OptraPol "Next Generation" silicone polisher contains micro-fine diamond crystals for a high polishing performance.

tional covering layer. This is another aspect that helps save time. The filler particles used in *Tetric EvoCeram Bulk Fill* have a comparatively small diameter (Fig. 2). This results in a high wear resistance and a dense surface, which can be quickly polished to a high gloss. And this, in turn, allows for further time savings (Fig. 3). The level of efficiency is further

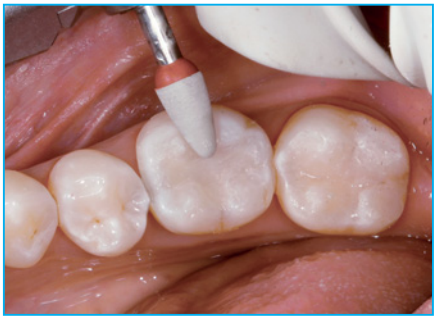


Fig. 5: The OptraPol "Next Generation" silicone polisher contains micro-fine diamond crystals for a high polishing performance.

boosted by using the newly developed one-step polishing system OptraPol "Next Generation" (Fig. 4). Using the small or the large flame, the cup or the lens, you can create a high gloss on the different restoration surfaces within just a few seconds.

However, some users might ask themselves how they can possibly achieve an adequate esthetic outcome for the different patient cases and tooth shades if only one material is applied in only one increment? The most important reason why *Tetric EvoCeram Bulk Fill* results in such beautiful restorations is the material's lifelike translucency of 15 per cent. In order to ensure that restorations are fully polymerized, other bulk materials exhibit a higher translucency, at the risk of causing restorations to appear grey in some cases. This is not so in the case of the new bulk fill material from Ivoclar Vivadent, where the small mean filler size and the coordinated light refraction indices of fillers, nano-pigments and monomer matrix, combined with the material's translucency level, enable a balanced and lifelike shade adaptation to the surrounding tooth substance.

Three shades (Fig. 5) are therefore sufficient to cover almost the entire shade spectrum from deciduous teeth to permanent teeth showing age-related characteristics. With the universal shades IVA (between A2 and A3), IVB (between B1 and B2) and IVW (whitish), time-consuming shade determination and shade selection are a thing of the past. In addition, with only three shades, stock-keeping of syringes or Cavifils is reduced.

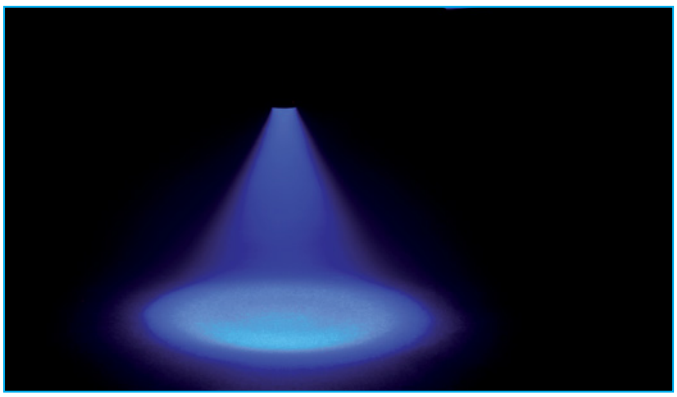
To improve the esthetic outcome, an opaque flowable material, for instance Tetric EvoFlow Dentin A3.5, can be used for masking purposes. An instance where this procedure may prove helpful is when discoloured tooth substance is left on the preparation after the removal of an amalgam filling.

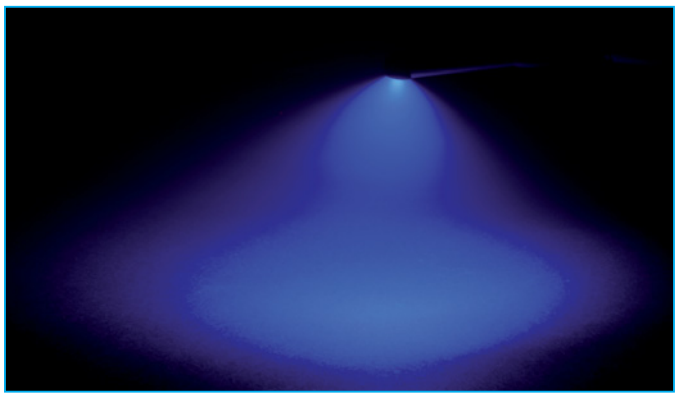
Efficient light-curing

The efficiency that is achieved with *Tetric EvoCeram Bulk Fill* also extends to the polymerization process. With the new *bluephase style* LED curing light, the curing process takes a single step and only ten seconds. First and foremost, this is possible due to the high light intensity of 1,100 mW/cm² (milliwatts per square centimetre) and the light probe's large diameter of ten millimetres. The light cone thus completely covers large restorations, which are placed quite frequently, and therefore renders repeated curing cycles unnecessary. Practical experience has shown: An estimated 20 per cent of all fillings placed in adult patients are too large to be polymerized with the light of an eight-millimetre light probe in a single curing step. A large-size light emission window is therefore an advantage that helps to keep the curing step short in all cases.

The parallel-walled light probe also helps to achieve time savings. Due to this design, the light is not diffused but focussed onto the restoration surface (Figs 6a and b). As a result a ten-second curing cycle at a high light intensity is possible. Other commercially available curing lights which are equipped with an LED mounted at the light emission window cause a wide light cone of scattered light and a lower light intensity. The light of these LEDs is diffuse and, due to the irradiation behaviour, dispersed to the entire oral cavity, rather than focused onto the restoration. As soon as only 50 per cent of the original light intensity of e.g. 1,100 mW/cm² reach the composite, the curing time has to be doubled. This may be the case already at a distance of two to four millimetres. In the case of bluephase, the time has not to be doubled up to a distance of nine millimetres. The curing time of ten seconds is therefore applicable in virtually all patient cases.

Fig. 6: A natural-looking shade adaptation is achieved with only three universal shades. The material is supplied in Cavifils or syringes to suit the user's preference.





Figs. 7 and 8: The light is focussed through the parallel-walled light probe of bluephase style (left) and maintains its high intensity. The curing time must only be doubled at a distance of approx. nine mm. If the LEDs are located in the tip of the light probe (right), the curing time has to be doubled already at a distance of approx. two to four millimetres.

Fig. 9: Access to the treatment site is improved due to the shortened light probe of bluephase style.

Fig. 10: Also a factor that improves the ergonomic properties for direct restorative procedures: the slimmer design of bluephase style.

Shorter light probe for comfortable and time-saving application

The new *bluephase style* has been further optimized for clinical use. This is only a small modification, which might seem insignificant at first glance, but it is this change that improves the access to the restoration and reduces the time required for the procedure: The light probe has been shortened (Fig. 7) and the light emission window is located directly after the bend of the probe. This design allows for an easy and quick access also to second molars and more generally if a patient's ability to open his or her mouth is impaired. Due to the shortened light probe, a considerably higher percentage of restorations can be cured from the buccal and the lingual aspects. As a result, *bluephase style* is highly suitable also for the treatment of children.

One further aspect that improves the access to the treatment area is the new, handy design (Fig. 8). Compared with the predecessor model, the new light features a straighter and slimmer shape and is therefore comfortable to hold for both men and women. Fatigue-free working is an issue that must not be neglected, and this is achieved in *bluephase style* by the low and well-distributed weight. Moreover, this stylish device may be held like a gun or a pen.

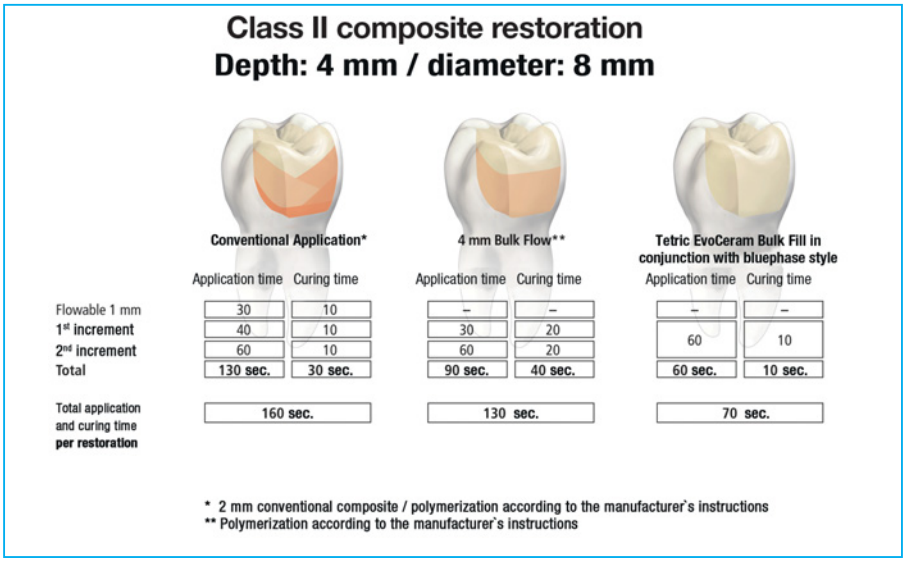


Fig. 11: Impressive calculations: Placed in four-millimetre increments and cured only once for ten seconds with the bluephase style LED light, the Tetric EvoCeram Bulk Fill material affords the dental team valuable time savings.

picture credits Figs. 1-11: Ivoclar Vivadent AG

The bottom line for the dental practice: time savings

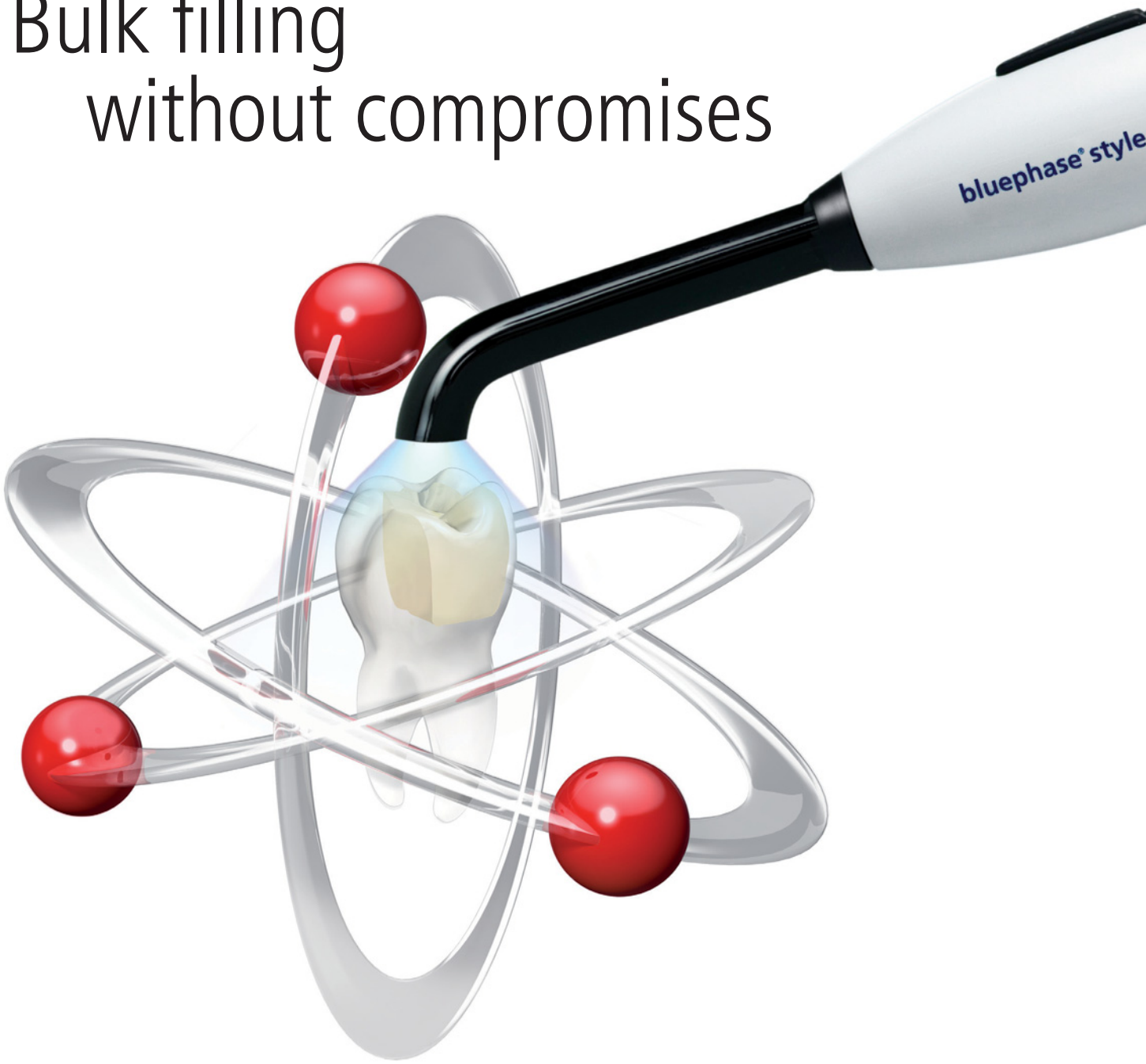
The time savings that can be achieved by using the bulk fill technique in conjunction with a single short curing cycle can be quantified on the basis of practical experience (Fig. 9). When two increments are placed and intermediately cured once, the time that is saved already amounts to one and a half minutes – or 50 per cent – per restoration. Consequently, for dentists who are used to working with the conventional technique involving the application of three or four increments, the time savings are even higher. Changing from other bulk materials which are more time-consuming to apply to *Tetric EvoCeram Bulk Fill* is also an equally expedient decision.

Time savings in conjunction with the bulk fill technique and direct restorative procedures in general are reliably achieved in the daily work if the new *bluephase style* LED light and its ten-millimetre light probe are used. The valuable time that is saved can be purposefully used otherwise: for a well-deserved break, for one or two additional patient appointments per day, for a more comprehensive patient consultation – there are many things we could think of.

More information about the underlying technologies, for instance the innovative filler technology, the shrinkage behaviour and the polymerization mechanism, can be found in the first three instalments of this sequence of articles published in the previous issues of DZW.

Dentist Hans-Christian Weinhold, Schaan/Liechtenstein

Bulk filling without compromises



Tetric EvoCeram® Bulk Fill

&

bluephase® style

One filling: Teeth are filled and contoured without requiring a final composite layer.

One material: The composite's smooth consistency enhances adaptation.

One increment: The 4-mm bulk increment technique streamlines filling procedures.

One curing cycle: The 10-mm light probe enables quick curing.

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

ivoclar vivadent®
passion vision innovation