Priv.-Doz. Dr. med. dent. Claus-Peter Ernst
Clinic for Restorative Dentistry
Johannes Gutenberg University Hospital, Mainz
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1. Introduction

The IADR annual convention in San Diego, California, USA, saw for the first time the presentation of a new group of restorative materials – so-called “nanofilled composites”. This type of restorative material represents a considerable improvement in the microfilled composites category whose importance has been in a continuous decline since their introduction. One reason behind this situation are the hybrid composites, which are suitable for universal application in both anterior and posterior teeth.

Let us compare the advantages and disadvantages of microfilled composites with those of hybrid composites. While microfilled composites are capable of being brought to a high polish due to their extremely small fillers, whose diameter falls well short of the half-wavelength of visible light, and are thus considered as highly aesthetic by the human eye, hybrid composites show somewhat poorer results. The use of such “large” fillers (generally 0.6-1 µm with submicrometer hybrid composites) was due to mechanical considerations: the addition of these fillers significantly increased the mechanical strength of hybrid composites in comparison to microfilled composites.

The addition of macrofillers allowed the quantity of fillers to be increased in a composite. With conventional microfilled composites on the other hand, increasing the proportion of fillers produces a thickening effect: the resulting restorative material becomes heavy-bodied relatively quickly even with low filler proportions of only 50 percent by volume and is barely ductile when used in a cavity. This imposed a limit on the maximum achievable proportion of fillers and thus also on the mechanical strength of the microfilled composites. The lower proportion of fillers in comparison to hybrid composites inevitably results in a higher matrix proportion and thus to increased polymerisation shrinkage of the microfilled composites - but not to a higher polymerisation shrinkage force due to their greater elasticity! Given their shortcomings in terms of mechanical strength, microfilled composites cannot be described as universal composites and are primarily used for Class I, III and V indications. In situations involving high mechanical stresses (Class II and IV) microfilled composites should only be used to a very limited extent.

Although the use of industrial prepolymer consisting of microfillers and resin matrix with microfilled composites (to increase the proportion of fillers) improved the mechanical properties of the microfilled composites, they nevertheless remained inferior to the mechanical properties of hybrid composites.

We thus have excellent aesthetics, due to the outstanding polishability and elasticity of the microfilled composites competing against the universal range of indications offered by the mechanically superior hybrid composites. Improvements to the two groups came to a dead end on both sides – it did not seem possible to combine the advantages of microfillers and hybrids. In recent years we have seen increasing numbers of hybrid composites with significantly reduced filler sizes appearing on the market due to the improved grinding processes. Whereas a few years ago a hybrid composite was described as a restorative material with a mean particle size < 10 µm, the fine particle hybrid composites with filler sizes < 5 µm soon become a distinct category, to then be swiftly topped by the “ultra-fine particle hybrid composites”, which achieved filler sizes < 3 µm. The group currently in the lead now contains “submicrometer hybrid composites” featuring filler sizes < 1µm. This group includes Charisma and Enamel Plus HFO, as well as Esthet-X and Point 4. However, when speaking of filler sizes we must differentiate here, between whether the “mean filler size” or the “maximum” filler size is involved: If a material has a low mean filler size but still contains some larger particles, optimum polishing properties will not result despite the low mean filler size.

The degree to which the mean filler size in hybrid composites can be reduced is limited due to the technical restrictions of the production process, and the degree to which the proportion of fillers in microfilled composites can be increased is limited for reasons of workability. A qualitative unification of both groups to form one universal material, combining all advantages of both groups did not seem possible. Filtek Supreme nanofilled composite may represent an important milestone in this development: Filtek Supreme material has even smaller fillers (nanomers) 20-75 nm in size as well as combinations of nanomers (nanoclusters) –
Filtek™ Supreme

groups of these small fillers which look rather like a bunch of grapes. These “clusters” have a total size of 0.6 – 1.4 µm (according to the manufacturer) and thus correspond to the filler size of a submicrometer hybrid composite. In addition, they contain ultra-fine radiopaque zirconium oxide fillers with a mean size of 2-5 nm (according to the manufacturer), which are responsible for the amazing radiopacity of the material. By using nanotechnology it has been possible to attain a filler proportion of approx. 72-78% by weight, which corresponds to that of a commonly used hybrid composite! This means that the material has a polymerisation shrinkage rate which is comparable to that of a hybrid composite.

As optimum polishability of the material has actually been achieved and the mechanical data published initially looks very promising, it seems that the dream of developing a composite that combines the advantages of microfilled composites with those of hybrid composites has at last become a reality.

However, the initial euphoria surrounding this material must also take account of the responsibility of translating these theoretically measurable and also reproducible benefits into clinical practice. Extensive independent material testing must prove that comparable mechanical properties, as known from the modern hybrid composites, are associated with Filtek Supreme nanofilled composite.

Given the promising technology of this new nanofilled composite it is very interesting to make a critical assessment of this innovative restorative material regarding its role as a universal composite in terms of its scope of application, in comparison to conventional hybrid composites.

2. Requirements for Restorative Materials

Given their wide range of indications, universal composites are subject to far-reaching requirements, which may, in some cases, conflict with each other for anterior and posterior teeth. The quality of a universal restorative material must be gauged by assessing to what extent it caters for such different requirements.

2.1. Requirements for Filtek Supreme composite as a restorative material for posterior teeth:

Where posterior teeth are concerned, it is the working characteristics of the universal composite material that are most important. As cusp-fissure contours have to be made in cavities of the posterior teeth, it is vital that a restorative material is sufficiently stable and permits the modelling of triangular ridges without the fissures that have already been created becoming filled. In addition, it is crucial that the shape of modelled convexities is preserved. On the other hand, the restorative material should not have a consistency that prevents it from being modelled. Such materials are sometimes colloquially known as “crumbly”.

Filtek Supreme material is unusually soft when used for the first time. It is surprising therefore that the material is nevertheless characterised by low stickiness. In principle, the flow properties of a relatively “soft” restorative material are expected to be more marked than for a firmer material. Here Filtek Supreme material has another surprise to offer: it shows an excellent level of stability; sloping cusps, triangular ridges and marginal ridges can be modelled perfectly without the structures “merging back together”. And if when compared to firmer hybrid composites, the material does not allow packing pressure to be applied due to its softer consistency, satisfactory placeability and adaptability is still seen with this material thanks to its relatively low stickiness and good stability. In comparison with hybrid composites the material can evidently be modelled for a longer period and seems to become “dry” less quickly. However, these are merely the subjective evaluations of the author.

Although the aesthetics of a restorative material are not so important in objective terms for posterior teeth when compared to anterior teeth, the constantly increasing demands of dentists interested in “Aesthetic Dentistry” and also of their patients, ensure that the expectations of modern aesthetic composites for both anterior and posterior use, are rising all the time. Here Filtek Supreme composite provides for astounding results, which can be properly described as “invisible” restorations in posterior teeth with an easily achievable surface lustre. In particular, high-lustre polishing pastes such as Prisma Gloss, Occlibrush polishing brushes or 3M ESPE Sof-Lex polishing brushes are suitable for polishing. The optimum polishability offered by this restorative material when used in posterior teeth can be justified and is derived not only from the aesthetic effect of the restorative material itself but also from the creation of smooth surfaces, the minimisation of possible locations for plaque retention and a reduction in factors that encourage abrasion.

2.2. Requirements for Filtek Supreme composite as a restorative material for anterior teeth

For anterior teeth as well as posterior teeth, good modelling properties and adaptability are key prerequisites for ensuring marginal integrity and thus long-lasting aesthetic restorations. However, for anterior teeth the emphasis falls on the aesthetic properties, such as translucency and opacity of the restorative material, as well as a maximised level of polishability to ensure a long-lasting surface lustre. A restorative material for anterior teeth should be sufficiently “transparent” to provide smooth, i.e. invisible, colour transitions but on the other hand, be opaque enough to prevent the dark oral cavity from showing through in the case of tunnelling Class III cavities or restorations on incisal edges. As translucency and opacity are two conflicting requirements which cannot be simultaneously satisfied by a restorative material to an optimum extent, the dentist inevitably resorts to layering...
with opaque core material and more transparent body-shades in the case of large-scale restorations. Here Filtek Supreme composite offers a wide selection of opaque dentine shades, extending from A2 through A4 and A6 to B3, C4 and C6! The range of main shades, the so-called “body-shades”, covers the conventional palette of Vita® shades. For extra translucency the enamel shades, which are also available in the commonly used Vita® shades, can also be applied. For additional enamel effects other “translucent effect” materials are offered in violet, grey and yellow. In comparison with the main shades – dentine, body and enamel – these three translucent materials show no radiopacity and are characterised by a slightly lower level of workability, something which takes the form of greater stickiness. In general, the principle of “less is more” can be applied to Filtek Supreme restorative: normally a combination of opaque dentine shade and body-shade will be sufficient. The body-shade offers optimum opacity and colour intensity: it also shows enough opacity to possibly also act as the only restorative material in small cavities. Body-shades, however, also have sufficient translucency to let incisal edges look sufficiently translucent. Generally caution is advised when using enamel shades: they often show excessive translucency in the incisal area, which tends to look unaesthetic in comparison with the adjacent teeth. In general the use of enamel shades on the labial areas of the incisors should be dispensed with: a long “run” of the light when striking the labial area in the labial transparent layer of enamel material causes the restoration to look slightly too dark. When in doubt slightly more opaque dentine material should be used rather than too much body or enamel material – and at the outset keep away from enamel effect materials – they are only for highly skilled users!

High-lustre polishability of the composite surfaces is crucial for the anterior teeth, as it firstly enhances the aesthetic effect of the material and secondly, prevents the appearance of discolouring films more effectively, due to the absence of micro roughness. Here Filtek Supreme nanofilled composite can offer outstanding results, which are perfectly in line with those of the microfilled composites.

3. Assessment of Filtek Supreme Restorative as a Universal Composite

3.1. Modelling properties
Filtek Supreme restorative material shows good modelling properties both for anterior and posterior teeth. The somewhat softer consistency is initially something which the dentist must get used to but has no adverse effect on the adaptability and modelling properties. Modelling of triangular ridges on posterior teeth is simple; the material is sufficiently stable to prevent any created fissures becoming filled.

3.2. Adaptability
Thanks to its agreeable consistency, the material can easily be adapted, even to complex cavity walls of posterior teeth, without detachment occurring. However, the adaptability of restorative materials greatly depends on the adhesive system used. The good modelling properties and adaptability also make the use of expensive coated instruments for composite modelling unnecessary.

3.3. Stickiness
Filtek Supreme nanofilled composite shows surprisingly low levels of stickiness, given that its handling could actually be expected to resemble that of a microfilled composite. Here the material even shows improvements in comparison with commonly used hybrid composites.

3.4. Stability
As already mentioned under item 3.1., the material offers excellent handling properties regarding holding the shape of the restoration and makes it consequently suitable for the use as a universal composite.

3.5. Polishability
In comparison with the commonly used hybrid composites, Filtek Supreme material shows outstanding polishability. This clearly represents the main benefit of this nanofilled composite! In the field of submicrometer hybrid composites, only Point 4 comes close to the polishing results achievable with Filtek Supreme restorative. Optimum polishing results can be obtained for the anterior teeth with Sof-Lex Pop-On polishing discs. The use of hybrid composite polishing pastes (e.g. Prisma Gloss, Dentsply/De Trey) also provides very good polishing results following suitable prepolishing. For the posterior teeth, optimum polishing results were achieved very quickly after surface finishing with diamond finishing burs or carbide instruments (Komet®, Intensiv, Shofur®) and subsequent treatment of the surfaces with Occlusbrush polishers or Sof-Lex polishing brushes. When discussing the polishability of restoration materials in the oral cavity, we should generally distinguish between two aspects:
1. Aesthetic effect: If we consider that all restoration surfaces are always covered by a thin film of saliva, even when speaking and laughing, an adequate polishing result can be achieved with almost all modern hybrid composites.

2. Achievement of smooth surfaces: To offer discolouring substances such as plaque the smallest possible retention area is the main objective. For this reason a composite surface should be polished to the greatest possible extent. Here Filtek Supreme restorative is definitely setting new standards for the universal composite category.

3.6. Colour stability
In the brief observation period during which Filtek Supreme restorative was used, no negative changes whatsoever were seen in terms of colour stability. No discoloration of the material was detected nor discolouring deposits. The patients were very satisfied with the aesthetic result of Filtek Supreme. However, with regard to the evaluation of long term colour stability, longer periods of observation have to be undertaken to be able to make a statement in this area.

3.7. Mechanical stability
As for mechanical stability, it is only possible to conclusively evaluate the levels of mechanical stability in clinical use after a period of two years, at the earliest. It is only after this time that signs of material fatigue appear, which for example may result in the fracture of the restorative material itself. To evaluate mechanical stability it is thus necessary to make use of comparative in vitro data. Here a critical look should above all be taken at the bond between the nanofiller particles in the clusters and its endurance under mechanical loads and hydrolytic degradation. Given the positive long-term experience with fine particle hybrid composites, this class of material is well suited to serve as a yardstick.

3.8. Aesthetics
With Filtek Supreme restorative we now seem to have a universal restorative material that should be capable of satisfying all requirements for a “high-end aesthetic composite”: The material produces an optimum appearance in terms of colour due to the careful match between opaque dentine materials and suitable body-colours, combined with outstanding polishability. With regards to the shading technique, the body-shades also allow very aesthetic results to be obtained with considerably less effort. This means that users who are not well-versed in colour layering are now also able to achieve extremely aesthetic results with simple means and in a short time.

The property prerequisites of a restorative material when used in the oral cavity appear to provided by the good handling properties of this material. If the material delivers what the manufacturer promises it will, in terms of mechanical properties on a long-term basis, Filtek Supreme restorative seems to be a true all-round restorative material for all cavity classes according to Black.

4. Use of Suitable Adhesive Systems
This restorative material should be compatible with all commonly used adhesive systems. The manufacturer, 3M ESPE, favours the use of Adper Prompt L-Pop self-etching adhesive. In addition, the multistep systems of the fourth and fifth generations are also systems which are preferred by the author for large-scale restorations. In the case report below Scotchbond 1 adhesive was used as the adhesive of choice.

5. Case Report: Canine Tooth Remodelling “making 2 from 3”:
In cases of hypodontia the prevalence of unilateral or bilateral absence of the lateral incisors is second only to that of wisdom teeth. Orthodontics very often allows the canine teeth to be adapted in place of the lateral incisors and an occlusion-concludent modelling of the dental arch of the upper jaw. In such cases the decoupling function of the canine teeth is generally taken over by the canine teeth. As completion of the orthodontic treatment is generally followed by complete functional rehabilitation of the patient, it is now up to the dentist to achieve aesthetic rehabilitation of the anterior dental arch. Veneers can certainly be used for this purpose but in very few cases is the extra “operative” effort and costs involved justified by the potentially better result achieved. The adhesive composite attachment – or “edge-up” – offers an adequate alternative solution, in terms of achieving the greatest possible effect with the least effort.

Fig. 1: Clinical findings: anterior teeth of upper jaw on right-hand side of a 28-year old patient with missing lateral incisor.
Fig. 2: The area was isolated with a rubber dam. After the enamel surface was roughened slightly, etching of the adhesive surface was carried out with ortho-phosphoric acid gel.

Fig. 3: An opaque dentine core was built up with the shade A3D.

Fig. 4: The final picture after two months shows the aesthetic rehabilitation of the anterior tooth by “remodelling” of the canine tooth into a lateral incisor. The colouring of such restorations is often made more difficult by the fact that the canine teeth are generally slightly darker than the middle and lateral incisors. This means that the shade of the build-up has to match the canine to ensure shade adaptation at the tooth itself while at the same time a harmonious shade transition to the adjacent central incisor also has to be created. By combining the dentine core shade A3D with the body-shade A2B, which was mainly used in the mesio-incisal area of the edge-up, it was possible to achieve this colour transition from the Vita® shade A3 of the canine to the Vita® shade A2 of the central incisor.
The objective of this work was to prepare highly aesthetic experimental radiopaque composites from novel nano-sized fillers and to study the mechanical properties and wear resistance (WR) of the resulting nanocomposites. Two new types of filler particles were used: (a) non-aggregated and non-agglomerated silica particles, nanomers (NM) 5 or 20 nm and (b) loosely bound agglomerates of zirconia and silica nanoclusters (NC) of primary particle size < 50 nm. The dimension of the NM and the ratio of the NM to NC were varied to study their effect on the mechanical properties and wear resistance. Diametral tensile strength (DTS) was measured according to modified ADA Spec 27, while WR (µm/10^5cycles) was measured by a modified ACTA method. The table shows the DTS and WR of various experimental formulations. Commercial composites microfill Filtek A110 (A), hybrids Z250 (Z) and Spectrum TPH (T) and micro-hybrids Esthet-X (E) and Point 4 (P) were studied for comparison.

WR of the commercial materials was A 8.9 (0.5), Z 6.2 (0.4), T 12.3 (0.4)), E 9.8 (0.9), P 8.7 (0.3). The DTS was A 59 (2), Z 92 (7), T 75 (11), E 60 (13), P 54 (20). ANOVA analysis showed that at p<0.05 all the aesthetic ENCs had wear resistance values that were significantly better than those of the commercial hybrid and microhybrids and microfill tested. The DTS values of most of the ENCs were significantly higher than the microfill and two microhybrids and were either equivalent to or higher than the hybrids tested.

**Aim of the study:** Wear resistance and physical strength are critical characteristics for new universal composites. In this investigation these properties are measured for a new nanocomposite.

**Results:** The study showed that different formulations of nanocomposites show significantly improved wear resistance and mechanical properties in comparison to conventional composite materials.
The objective of this work was to prepare experimental radiopaque nanocomposites (ENC) from novel nano-sized fillers and to study their effect on aesthetic properties of the resulting nanocomposites. Two types of filler particles were used: (a) non-aggregated, non-agglomerated silica particles, nanomers (NM) of 5 or 20nm, and (b) loosely bound agglomerates of zirconia and silica nanoclusters (NC) of primary particle size < 100nm. The dimension of the NM and ratio of NM to NC were varied to see their effect on the aesthetic properties. Highly polished cured specimens were tooth-brushed (TB) for up to 500 times and the gloss retention (GR) of the samples measured by a micro-tri-gloss instrument. The table shows GR of experimental ENCs after 200 and 500 strokes of tooth brushing. Commercial composites microfill Filtek A110 (A), hybrid Spectrum TPH (T) and microhybrids Esthet-X (E) and Point 4 (P) were tested as comparison.

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<tr>
<th>ENC</th>
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<td>GR at 200 TB</td>
<td>91.3 (0.1)</td>
<td>87.4 (0.1)</td>
<td>93.3 (0.1)</td>
<td>94.6 (0.2)</td>
<td>94.5 (0.3)</td>
<td>96.8 (0.30)</td>
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<tr>
<td>GR at 500 TB</td>
<td>69.9 (0.3)</td>
<td>79.8 (0.9)</td>
<td>88.2 (0.4)</td>
<td>88.9 (0.1)</td>
<td>90.4 (0.2)</td>
<td>95.1 (0.2)</td>
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GR of the commercial composites after 200TB and 500TB was A 92.5 (0.1) and 83.6 (0.2); T 82.6 (0.3) and 47.4 (0.1); E 85.9 (0.5) and 48.4 (0.2); P 70.6 (0.4) and 42.3 (0.3). ANOVA analysis showed that at p<0.05 all the ENCs tested have better polish retention after 500 TB compared to commercial hybrid and microhybrid materials tested. The majority of ENCs containing NM showed polish retention equivalent or superior to the microfill tested.

Aim of the study: Polish, or gloss retention is a critical aspect for aesthetic, anterior restorations. This study evaluated the polish retention of several novel nanocomposite restorative formulations in comparison to commercially available composites.

Results: All experimental nanocomposites showed excellent polish retention results. In comparison with hybrid and micro-hybrid composites significant improvements could be achieved with most of the experimental nanocomposite formulations. Nanocomposites did reach similar levels of polish retention as for microfilled composites.
Objective: Prepare highly aesthetic radiopaque experimental nanocomposites (ENC) from novel nano-sized fillers and study their mechanical properties. Two new types of filler particles were used: (a) non-aggregated and non-agglomerated silica nanomer particles (NM) ranging from 5 to 75nm and (b) loosely bound agglomerates of zirconia-silica nanoclusters (NC) of primary particle size < 50nm. The NM% was varied from 0 to 100% of the filler. Fracture toughness (FT) (K1c,MN/m3/2) was measured using a short rod fracture toughness technique; Compressive strength (CS)(MPa) was measured according to modified ADA Spec 27. The table shows the FT and CS of various experimental formulations. Commercial composites Filtek A110 (A), Z250 (Z),TPH Spectrum (T), Esthet-X (E) and Point 4 (P) were studied for comparison.

FT of the commercial materials was A 0.94 (0.05), Z 1.34 (0.02), T 1.37 (0.04), E 1.21 (0.01), P 0.94 (0.03). The CS was A 388 (24), Z 390 (14), T 396(8), E 410 (5), P 398 (77). ANOVA analysis showed that at p<0.05 the FT of the 20 and 75 nm NM ENCs was significantly better than 5nm ENCs and A. The CS values of ENCs 6 and 8 were significantly higher than A. The CS values of other ENCs were either equivalent to or higher than the commercial materials.

**Aim of the study:** The influence of different nanofiller concepts and nanofiller load on the fracture toughness and the compressive strength was to be evaluated in this study. Conventional hybrid composites and the microfilled Filtek A110 were control groups.

**Results:** The study showed that different formulations of nanocomposites display similar or even better results regarding compressive strength and fracture toughness than conventional composite materials.

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**Table:**

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<td>CS (sd)</td>
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<td>411(50)</td>
<td>486(20)</td>
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* The formulation of the experimental Nanocomposite 5 comes closest to the formulation of Filtek Supreme (standard shades)