FGM

Vittra APS

Premium composite resin

TECHNICAL PROFILE

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Vittra APS

1. INTRODUCTION

Composites are one of the most versatile materials in restorative odontology, and their use has continued to grow since their introduction into the market more than 50 years ago.

Together with adhesion techniques, these materials revolutionized restorative concepts and techniques, in which esthetics and preservation of healthy tooth structure gained progressive prominence. Expanding the use of these materials in a wide range of applications places high demands on their performance and properties.

Among the notable evolutions, significant improvements in mechanical properties, wear resistance, gloss and polishing, reduced polymerization contraction and putties with different degrees of opacity stand out.

With extensive experience in odontology innovation, in 2016 FGM launched the Vittra APS line, a premium composite that, following the evolution of materials, offers high esthetics and excellent physical-chemical properties. Added to the singularity of the APS (Advanced Polymerization System) technology, present in the composite, the product offers excellent handling with superior tolerance to ambient light and high efficacy in polymerization.

2. PRODUCT DESCRIPTION

Vittra APS is a submicrometric composite of high esthetic capacity indicated for restorations of all classes in anterior and posterior teeth. The composite is radiopaque, its filler is based on a spheroidal shaped silica-zirconia complex, with average particle size of 200 nm, total inorganic filler content by weight of 72 to 82% (52 to 60% by volume). This format, content and type of filler contribute to obtaining elevated mechanical properties and high esthetics, which can be evidenced by the ease of obtaining polishing and gloss longevity. Vittra APS formulation is free of Bis-GMA and Bis-EMA, following the trend of bisphenol A (BPA) free products.

The Advanced Photopolymerization System (APS), developed by FGM and incorporated into the composite, allows obtaining advantages that increase its functional and esthetic performance. In addition to physical-chemical properties, such as greater depth of cure and degree of conversion, APS allows even longer working time under reflector light and minimal visual shade change before and after photopolymerization.

The range of shades and opacities allows success in the stratification technique, meeting the esthetic needs of simple to complex restorations. It is available in 18 shades* with three levels of opacity, as shown in the table.

INDICATION	SHADE NAME	TRANSLUCENCY*	DETAILS
Dentin layer	DA1 DA2 DA3 DA3.5 DB1	**33-37%**	Hue A composites in different saturations (chroma).
	DBL1 DBL2 DBL3		Composites lighter than B1, indicated as a body layer in whitened teeth.
Enamel layer	EA1 EA2 EA3 EB1	**43-47%**	Hue A and B composites in different saturations (chroma).
	EBL1 EBL2 EBL3		Composites lighter than B1, indicated as the most superficial layer in whitened teeth
Enamel EFFECT layer	TRANS N	**63-67%**	High translucency composite with little shade interference, indicated as an effect in areas of enamel predominance (incisal and proximal).
	TRANS OPL	**57-61%**	Composite of high translucency and opalescent effect with little shade interference, indicated as an effect in areas of enamel predominance (incisal and proximal).

Note: Values measured by X-Rite SP62 spectrophotometer with specimen thickness/increment of 1 mm.

Shade options include the most used hues. By combining them with effect shades, it is possible to easily create more complex layered restorations.

* Check availability in your country.

3. BASIC COMPOSITION

Active ingredients: mixture of methacrylic monomers, photoinitiator composition (APS), co-initiators, stabilizers, pigments and silane. Inactive ingredients: zirconia, silica and pigment filler particles.

4. KEY CHARACTERISTICS

SUBMICROMETER: Vittra APS is composed of submicrometric fillers of zirconia silicate, with an average particle size of 200 nm that give the composite better mechanical performance, greater wear resistance and esthetics, providing better gloss and polishing. Fillers also influence viscosity, providing greater fluidity in handling.

POLISHING, HIGH GLOSS AND WEAR RESISTANCE CAPACITY: The high gloss, polishing and maintenance of these are directly influenced by the submicrometric particles of zirconia silicate, which have a spheroidal shape with great symmetry. The submicrometer size and shape of the filler particles give the surface a great ability to resist impacts and abrasive processes, as such particles do not have "sharp corners" and therefore are not easily removed from the composite. This feature, combined with a highly resistant polymeric matrix, gives the product high resistance to wear and consequently maintenance of smoothness and gloss.

APS SYSTEM: The innovative polymerization system allows optimizing the degree of conversion and depth of cure of the material, resulting in a high resistant polymeric matrix. In the case of Vittra APS, another clinical advantage is notable: the composite has a minimal visual shade change from before to after photopolymerization, which allows for better result predictability during shade selection

STABILITY UNDER AMBIENT LIGHT: Another benefit of the APS system is the composites' lower sensitivity to ambient or reflector light. This allows the increments to be sculpted calmly, without material viscosity changes throughout the process.

BPA FREE

BISPHENOL A FREE COMPOSITE: Concerned about possible harmful effects that some monomers can bring to the body, FGM launched the first Brazilian composite free of bisphenol A (BPA), a toxic substance banned in several applications. Vittra APS is free of Bis-GMA, Bis-EMA, monomers which may contain traces of BPA or which may release it upon degradation. It's technology for health.

SHADE AND OPACITY SYSTEM: With a reduced, but consistent, number of shades, Vittra APS offers the most used shades in restorations divided into three levels of opacity that allow simple as well as complex restorations to be carried out.

FLUORESCENCE: It is the tooth's ability to absorb ultraviolet radiation (like black light) and emit this radiation in the visible light range with a bluish appearance. Therefore, it is important that the restorative material has this property compatible with tooth enamel so that the esthetic result is as natural as possible. Non-fluorescent composites are detected as a dark area when exposed to ultraviolet light.

OPALESCENCE: It is an optical property of enamel, observed mainly at the incisal edges, and is related to its ability to selectively transmit the long waves of the spectrum, giving the enamel an orange-tinted appearance. At the same time, the enamel reflects the short waves, which gives it a bluish color. Opalescence is an important property because, when incident light is transmitted or reflected, the restorative material presents different tonalities under such lighting, simulating what happens in a natural tooth. **In this way, the shade TRANS OPL (corresponding to "translucent opalescent") is the ideal shade to be used when there is a need to restore the incisal area of an anterior tooth.**

5. PHYSICAL-CHEMICAL PROPERTIES

5.1 THREE-POINT FLEXURAL STRENGTHS

Flexural strength is a mechanical property that allows evaluating the composites strength to fracture. It is one of the properties that demonstrates the quality of the composite formed after polymerization, a result of the important relationship between the polymeric matrix and the fillers used and the ability of photoinitiators to convert monomers into polymer.

For this evaluation, composite specimens were made in bar format (25 x 2 x 2 mm), in a bipartite metallic matrix on two strips of polyester. After photopolymerization (1000 mW/cm², 20 s on each side) and storage in water (24 hours at 37º C), each specimen was taken to a universal testing machine and subjected to a compression load in its center in a three-point test until fracture. This test followed ISO 4049 recommendations.

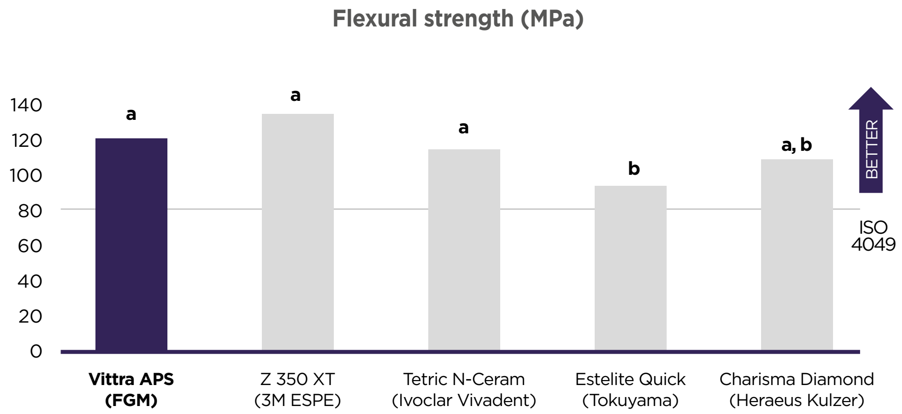

Figure 1: Three-point flexural strength (mean and standard deviation in MPa) of different composites (n=10) (1-way ANOVA and Tukey test; $p<0.05$).

Source: Carvalho E, Bauer M, Pailover P, Malaquias P, Gutierrez F, Reis A, Bauer J, Loguercio A. Universidade Estadual de Ponta Grossa (UEPG) and Universidade Federal do Maranhão, 2016.

The result demonstrates that Vittra APS presented excellent flexural strength, comparable or superior to products already known in the market.

5.2 MODULUS OF ELASTICITY

In the same way as flexural strength, the modulus of elasticity reflects a material's intrinsic property to withstand pressure imposed by masticatory forces. The modulus of elasticity for human dentin can be estimated in the range of 10 to 15 GPa (it varies greatly according to the literature) and having a composite with an identical or slightly lower modulus of elasticity can be beneficial in the sense that the restoration fractures before the tooth, if the restored tooth is subjected to an effort greater than its strength limit.

The same specimens used for the flexural strength were also used for the modulus of elasticity evaluation. For this, on loading each specimen in the flexural test, the universal testing machine's software captures the stress and strain at each loading point. The data obtained from the straight part of the stress curve versus strain were used to calculate the modulus of elasticity.

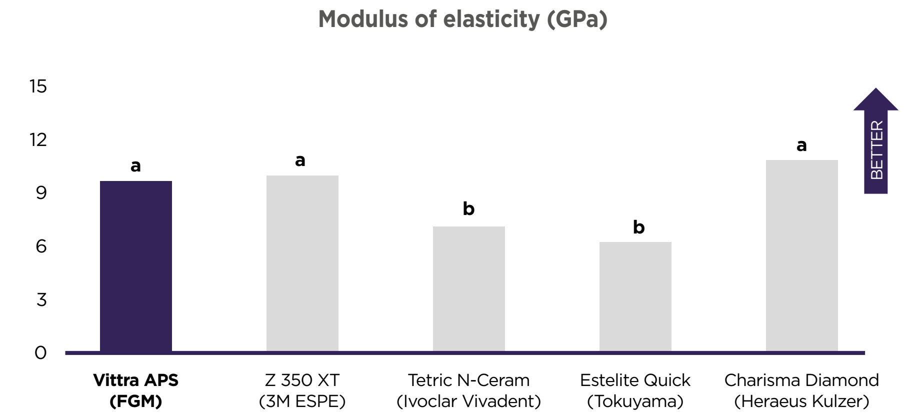

Figure 2: Modulus of elasticity (mean and standard deviation in GPa) of different composites (n=10) (1-way ANOVA and Tukey test; $p<0.05$).

Source: Carvalho E, Pailover P, Malaquias P, Gutierrez F, Bauer M, Reis A, Bauer J, Loguercio A. Universidade Estadual de Ponta Grossa (UEPG) and Universidade Federal do Maranhão, 2016

Vittra APS presented a superior modulus of elasticity to Estelite Quick (Tokuyama Dental) and Tetric N-Ceram (Ivoclar Vivadent) composites, being compatible with the lower limit value assigned to human dentin.

5.3 **COMPRESSIVE STRENGTH**

Composite specimens were made in a circular metal matrix (6 mm thick and 4 mm in diameter). After photopolymerization (1000 mW/cm2, 30 s on each side) and storage in water (24 hours at 37º C), each specimen was taken to a universal testing machine and subjected to compressive load until fracture.

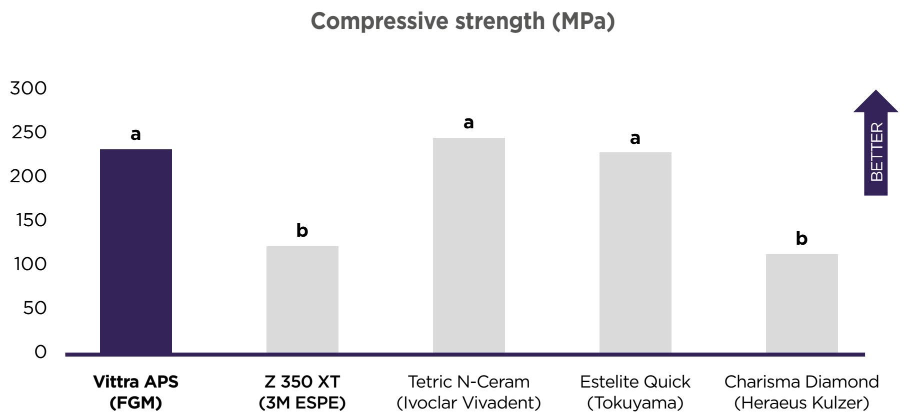

Figure 3: Compressive strength (mean and standard deviation in MPa) of different composites (n=10) (1-way ANOVA and Tukey test; $p<0.05$).

Source: Bauer M, Pailover P, Malaquias P, Carvalho E, Gutierrez F, Reis A, Bauer J, Loguercio A. Universidade Estadual de Ponta Grossa (UEPG) and Universidade Federal do Maranhão, 2016.

It can be seen that Vittra APS showed superior compressive strength to Charisma Diamond (Heraeus Kulzer) and Filtek Z350 XT (3M ESPE) composites, and equivalent to the other evaluated composites.

5.4 **FRACTURE TOUGHNESS**

In general, toughness means how much the material withstands until fracture. Fracture toughness, on the other hand, means how much the material, already with embrittlement, withstands until it fractures. According to Callister, by definition, fracture toughness is a property that is a measure of a material's strength to brittle fracture when a fissure is present. For the evaluation of dental composites, fracture toughness is understood as one more measure that reflects the material's strength to force and fatigue to which it will be subjected in the oral environment. The higher the fracture toughness value, the greater the longevity that can be expected for the composite.

For this test, bar-shaped composite specimens (25 x 2 x 2 mm) with a central fissure of 2.5 mm were made in a bipartite metallic matrix on two polyester strips. After photopolymerization (1000 mW/cm^2, 20 s on each side) and storage in water (24 hours at 37º C), each specimen was taken to the universal testing machine and subjected to a compressive load in its center in a three-point test until fracture. This test followed the recommendation of the ASTM guidelines (American Society for Testing Materials, Standard E-399).

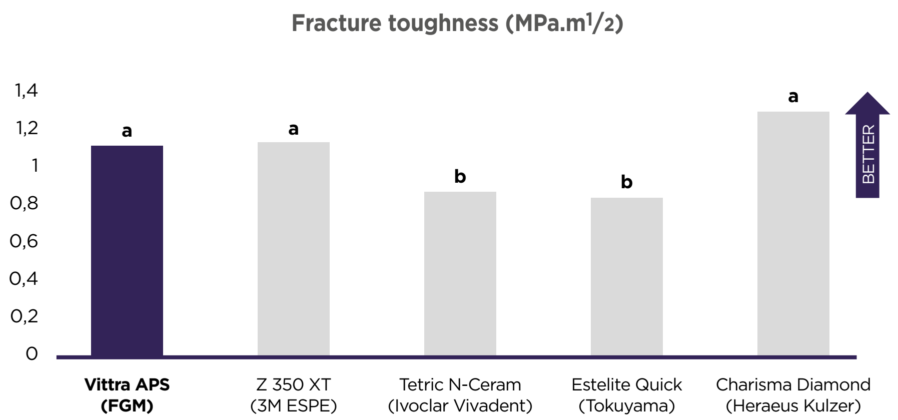

Figure 4: Fracture toughness (mean and standard deviation in MPa. m1/2) of different composites (n=10) (1-way ANOVA and Tukey test; p<0.05).

Source: Carvalho E, Malaquias P, Gutierrez F, Bauer M, Pailover P, Reis A, Bauer J, Loguercio A. Universidade Estadual de Ponta Grossa (UEPG) and Universidade Federal do

Vittra APS showed similar fracture toughness to Charisma Diamond (Heraeus Kulzer) and Filtek Z350 XT (3M ESPE) composites.

5.5 **KNOOP HARDNESS**

Wear resistance and gloss maintenance are properties that depend intrinsically on the composite's mechanical properties, the type of force it is subjected to, and the properties offered by the filler elements that the composite contains. One way to obtain indirect information on the strength that can be expected from the composite's surface is to measure its hardness. The higher the hardness, like porcelain, the greater the abrasion resistance that can be expected from the material.

Composite specimens were made in a circular metal matrix (6 mm thick and 4 mm in diameter). After photopolymerization (1000 mW/cm^2, 30 s on each side) and storage in water (24 hours at 37º C), each specimen was embedded and polished. The surface of each specimen was subjected to the Knoop indenter with a 10 g load for 15 s at several points

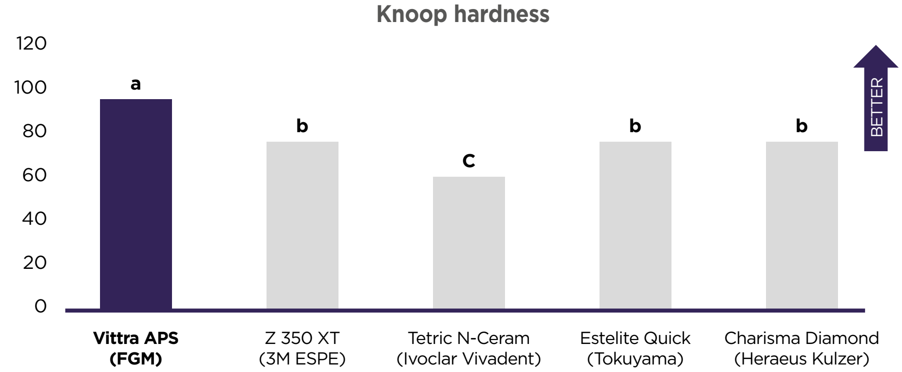

Figure 5: Knoop hardness (mean and standard deviation in KHN) of different composites (n=5) (1-way ANOVA and Tukey test; p<0.05).

Source: Carvalho E, Gutierrez F, Bauer M, Pailover P, Malaquias P, Reis A, Bauer J, Loguercio A. Universidade Estadual de Ponta Grossa (UEPG) and Universidade Federal do Maranhão, 2016.

Vittra APS had the highest surface hardness among the composites participating in the test, demonstrating amazing values. Such hardness originates from the quality, morphology and content of the fillers used, as well as the quality of the formed polymer and its interaction with such fillers.

5.6 **DEGREE OF CONVERSION**

The degree of conversion gives us information on how much the monomers actually react and transform into polymers. The measured result depends on the monomers used, the effectiveness of the photoinitiator system and the optical properties of the monomeric mixture and fillers (when the photoinitiator's efficacy is low and the product has a certain opacity, there may be degree of conversion loss). From a theoretical point of view, a degree of conversion of 100% would indicate that all monomers reacted and formed a single polymer molecule. From a practical point of view, the possibility of 100% conversion is practically impossible, as there are several chemical and physical issues involved that prevent it. A low degree of conversion indicates that few molecules reacted and/or that the polymer molecules formed are of low molecular weight, therefore being more soluble and less resistant. Considering these concepts, what is sought in dental composites is a degree of conversion around 50 to 60%, a value derived from the existing experience with dental composites, and which reflects a certain optimal population of monomers converted into polymers of good molecular weight and good resistance. A critical point in this case is to have a good photoinitiator system, which guarantees the desired degree of conversion and performs it efficiently even at greater depths, in which the opacity of the composite begins to impede the arrival of the photopolymerizer's light. The APS system demonstrates that efficiency is its strong point.

Composite specimens were made in a circular metal matrix (2 mm thick and 4 mm in diameter). Before and after photopolymerization (1000 mW/cm^2, 20 s on each side) and storage in water (24 hours at 37º C), each specimen was subjected to micro-Raman spectroscopy to measure the degree of conversion. The relationship between methacrylate and aromatic peaks before and after photopolymerization was used to calculate the degree of conversion.

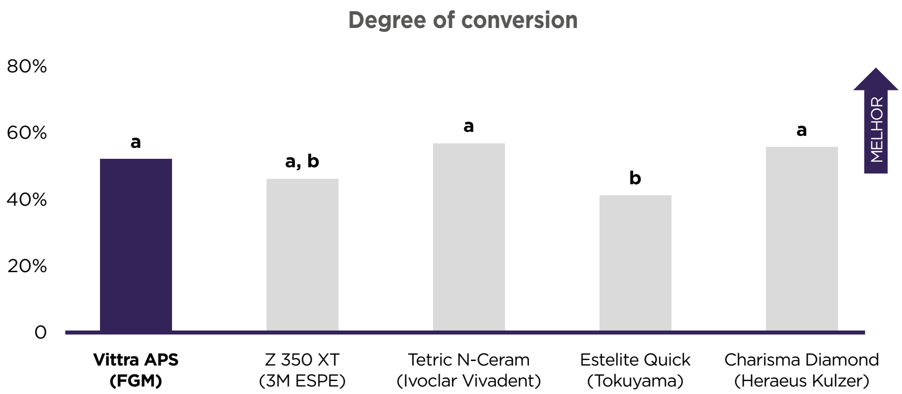

Figure 6: Degree of conversion (mean and standard deviation in %) of different composites (n=5) (1-way ANOVA and Tukey test; p<0.05).

Source: Bauer M, Pailover P, Malaquias P, Carvalho E, Gutierrez F, Reis A, Bauer J, Loguercio A. Universidade Estadual de Ponta Grossa (UEPG) and Universidade Federal do Maranhão, 2016.

Vittra APS showed a degree of conversion similar to the other materials in the test and within a range considered optimal. The excellent mechanical results previously demonstrated are evidence for this observation.

5.7 **ROUGHNESS BEFORE AND AFTER SIMULATED BRUSHING**

In addition to the optical and esthetic properties that are expected in a good restorative composite, the material's resistance to abrasion is also very important, as the longevity of the work carried out will depend on it, both from an esthetic as well as a functional perspective. A complete dental composite must have adequate optical properties, translated into a good range of shades, different options of translucency, opalescence, fluorescence, "chameleon" effect, etc., and still have the proper resistance to maintain and give longevity to restorations. In the Vittra APS composite, the best was sought in terms of synergy between optical properties and wear resistance.

Composite specimens were made in a circular metal matrix (6 mm thick and 4 mm in diameter). After photopolymerization (1000 mW/cm^2, 30 s on each side) and storage in water (24 hours at 37º C), each specimen was taken to a rugosimeter, which evaluated the roughness (Ra) at several points of each specimen. Next, the same specimens were coupled to a special brushing machine, undergoing simulated brushing (medium hardness brush and standard toothpaste for 50,000 cycles). At the end, again, the surface roughness was measured.

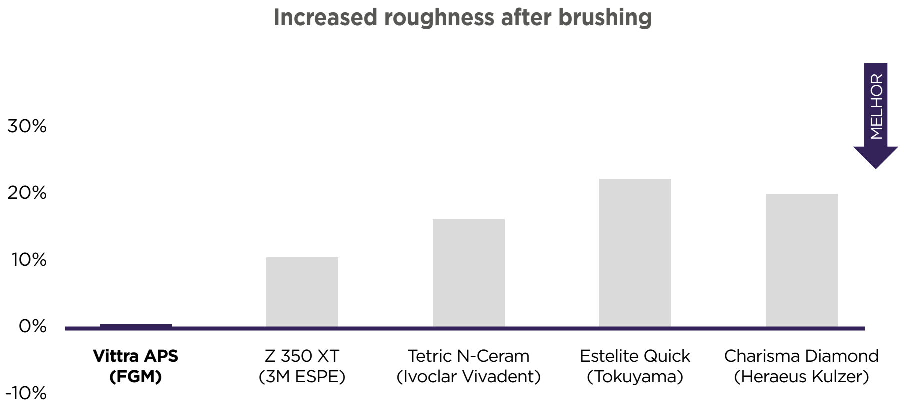

Figure 7: Roughness increase (mean in %) after simulated brushing (n=10).

Source: Pailover P, Malaquias P, Carvalho E, Gutierrez F, Bauer M, Reis A, Bauer J, Loguercio A. Universidade Estadual de Ponta Grossa (UEPG) and Universidade Federal do Maranhão, 2016.

Vittra APS was the only composite that did not show an increase in surface roughness after simulated brushing. This result demonstrates the high abrasion resistance and reflects the expected properties due to the high Knoop hardness value that the product has. From a practical point of view, we see that Vittra APS has increased surface smoothness, which explains its ability to maintain long-term gloss.

5.8 **APS AND SHADE BENEFIT**

The vast majority of dental composites on the market have camphorquinone as a photoinitiator, which invariably has the adverse effect of imposing a certain orange tone on the composite while it is unpolymerized and the disappearance of this shade when the composite is photopolymerized. In practice, the composite before polymerization has a different shade from the tooth and the professional must develop the ability to predict shade migration to a lesser yellow after polymerization. The APS system made it possible to completely change this characteristic of shade change after photopolymerization. With APS, the Vittra composite presents a very small shade variation, within a range that is imperceptible to the human eye.

The APS composition is a combination of several substances that allow efficient polymerization to be obtained even at very low levels, in such a way that the shade impacts of traditional camphorquinone do not exist.

Circular specimens, with a diameter similar to the tip of the Easy Shade digital spectrophotometer, and 2 mm thick, were made in a white Teflon matrix. This matrix was placed on a white background, and the shade was measured before and after polymerization with the aid of the aforementioned Easy Shade digital spectrophotometer. Shade differences (^{2}E) before and after polymerization were calculated for different composites.

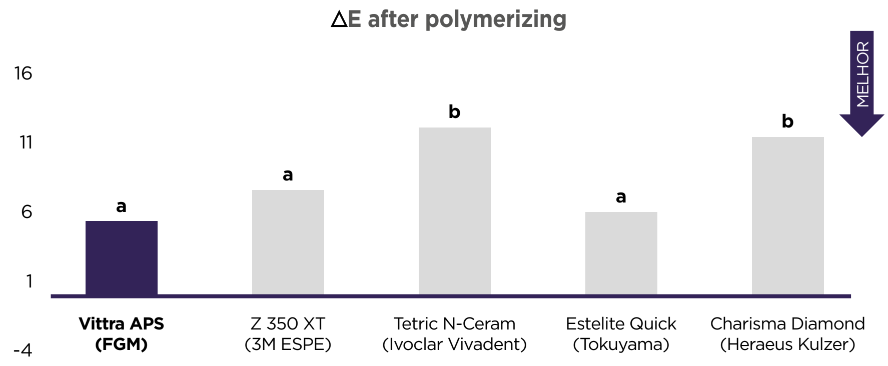

Figure 8: Shade variation (mean, ΔE) before and immediately after polymerization (n=3) (1-way ANOVA and Tukey's test; $p<0.05$).

Gutierrez F, Bauer M, Pailover P, Reis A, Bauer J, Loguercio A. Universidade Estadual de Ponta Grossa (UEPG) and Universidade Federal do Maranhão, 2016.

Vittra APS showed the least shade change, being similar to Estelite Quick (Tokuyama) and Filtek Z350 XT (3M ESPE) composites.

5.9 **WORKING TIME UNDER REFLECTOR LIGHT**

Adequate working time is also an important property of dental composites, as it directly influences the time the professional has available to manipulate the composite and make the necessary sculptures during a direct restoration. Obviously, the composite needs to be tolerant to a certain amount of light (direct or indirect) to allow the operative field to be illuminated and provide adequate visualization by the professional. It is in this regard that some composites have a deficiency, as they need a high concentration of a photoinitiator system to ensure good polymerization of the product. The APS system has very particular characteristics regarding the influence of light, with good tolerance to ambient light and high polymerization efficacy when under blue light irradiation from photopolymerizers.

The test conducted by differential scanning calorimetry (DSC) allows estimating a composite's working time. Samples of different composites were exposed to a light source with an intensity of 10,000 lux, **similar to the light emitted by dental equipment reflectors.** Therefore, this test simulates the working time that different composites present when making a restoration in which the light of the dental reflector is used as direct illumination.

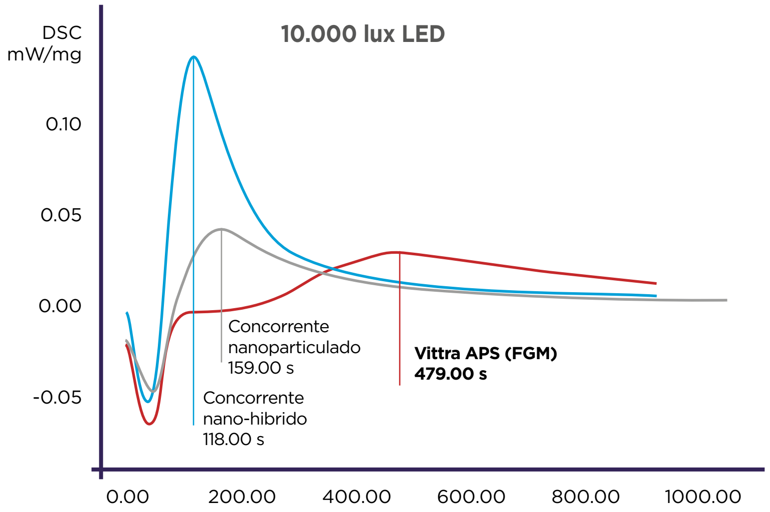

Figure 9: Working time (average in seconds) of the Vittra APS composite and two other composites: one nano-hybrid and one nanoparticulated.

Source: Internal data, FGM (2016).

It can be seen in the DSC graph that the APS system provides the Vittra APS composite with a longer working time (approximately 8 minutes) when compared to competitors with conventional initiator systems. The less inclined curve of the Vittra APS composite also indicates that its polymerization reaction is much less intense than that of the other products, confirming its lower sensitivity to exposure of the ambient and reflector light. However, when exposed to the blue light of the photopolymerizer, its polymerization is intense and fast.

6. CLINICAL CASE

Author: Dr. Ahmed Alrashedi

MALE PATIENT, 30 YEARS OLD.

Main Complaint: The patient was dissatisfied with the esthetics of his smile and wanted to restore his two central incisors.

1 | Initial intraoral photograph..
2 | Tests on composites to select shade.
3 | Isolation and smoothing of edges

4 | 4 First and second layer of Vittra APS in the shades DA3 and DA2 being added.
5 | **Vittra APS** Trans OPL added.
6 | White spot was added to obtain halo effect

7 | **Vittra APS** EBL added with layers of 0.5mm. **8** | Delimitation of the shadow and mirror areas.

9 | 9 Lateral view of the final result after polishing with **Diamond Master kit. 10** | Final intraoral.

7. REFERENCES

1. Ferracane, J. L. (2011). Resin composite—State of the art. Dental Materials, 27(1), 29–38.

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