TECHNICAL REPORT

Tokuyama

OMNICHROMA®

Every Shade, One Choice

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1. Introduction

In direct restorations of teeth using resin-based composites, correct shade taking is an important esthetic factor. Due to positional and individual differences in natural teeth, it is necessary to consider what shade of composite is appropriate to restore a cavity in the context of the target tooth and adjacent teeth. To meet this need to restore different shades of teeth, dental manufacturers have developed various composites with different color and/or translucency. However, shade taking increases chair time and is subjective to the individual performing the shade-taking procedure, which is burdensome for both dentists and patients.

To address this issue, TOKUYAMA DENTAL has developed resin-based composites formulated on a “Wide Color Matching” concept, creating shades that can cover a wide range of natural teeth colors to reduce the time investment of shade taking and reduce the amount of composite shades needed in inventory. For example, TOKUYAMA launched ESTELITE® SIGMA QUICK in 2007, and the wide color-matching ability and esthetics of this composite has been recognized by the market.

TOKUYAMA has continued to develop composite technologies designed for the simplest shade systems and has succeeded in completing a new brand, “OMNICHROMA®,” which is the culmination of over 35 years of research and development efforts. This technical report describes the technical background, features, and material properties of OMNICHROMA.

2. OMNICHROMA Overview

2.1 Material Components

- UDMA, TEGDMA
- Uniform sized supra-nano spherical filler (260nm spherical SiO_2-ZrO_2)
- Composite filler (include 260nm spherical SiO_2-ZrO_2)
- Filler loading 79 wt% (68 vol%)

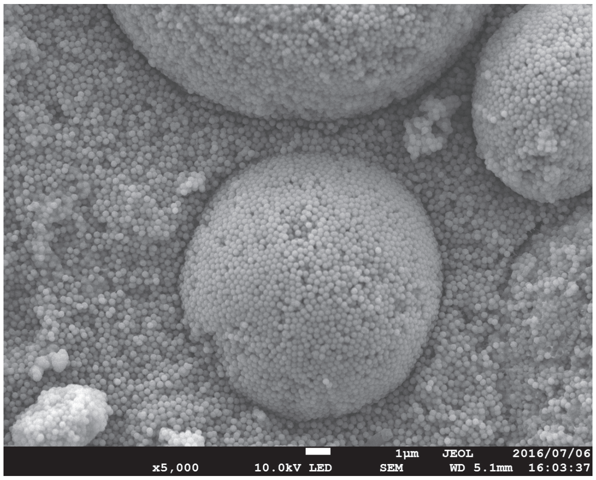


Fig. 1a SEM image of OMNICHROMA at 5,000x magnification

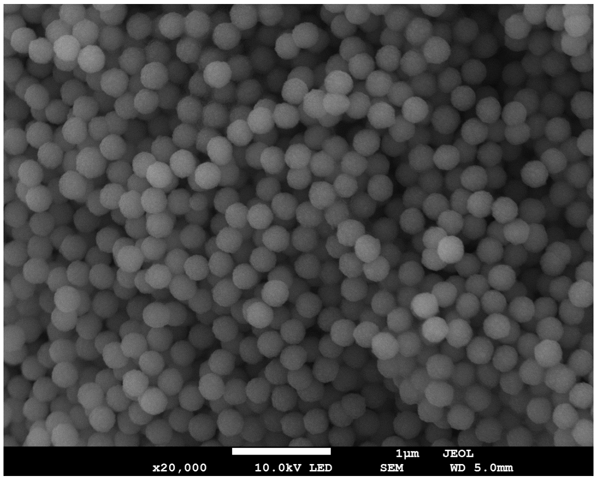


Fig. 1b SEM image of OMNICHROMA at 20,000x magnification

2.2 System

OMNICHROMA

OMNICHROMA is a single shade structurally colored universal composite designed for use with most direct restorative clinical cases. Its wide color-matching ability eliminates the need for a shade-taking procedure and reduces composite inventory.

OMNICHROMA BLOCKER

OMNICHROMA BLOCKER is a supplementary material designed for use as a thin layer at the lingual cavity wall of extensive class III and IV restorations when there is limited surrounding dentition. The function of OMNICHROMA BLOCKER is to reduce shade-matching interference caused by other parts of the mouth. OMNICHROMA BLOCKER can also mask slight staining or be used to reconstruct a highly opaque tooth.

2.3 Concept and Features

OMNICHROMA has such a wide color-matching property that it is possible to esthetically match the 16 VITA classical shades with just one shade of composite. Therefore, no shade taking is necessary, allowing clinicians to minimize chair time, reduce composite inventory, minimize the wastage of unused composite shades, and reduce reliance on shade-matching procedures. OMNICHROMA also inherits the features of TOKUYAMA’s spherical fillers from the ESTELITE series.

Excellent esthetic properties

- Unprecedented color matching
- High polishability

Excellent physical-mechanical properties

- Highest wear resistance
- High compressive strength
- Exceptional handling

2.4 Indications

- Direct anterior and posterior restorations
- Direct bonded composite veneers
- Diastema closures
- Repair of porcelain/composite restorations

3. Technical Background

3.1 Smart Chromatic Technology

OMNICHROMA exhibits the ultimate wide-range color-matching ability, covering all VITA classical shades with just one shade of composite, thanks to TOKUYAMA's Smart Chromatic Technology. The Smart Chromatic Technology is achieved through the uniformly sized 260nm spherical fillers included in OMNICHROMA. The scientific background and mechanisms of the Smart Chromatic Technology are detailed in the following sections.

3.1.1 Color

There are two types of coloring mixing used to create color in practical purposes: additive and subtractive. Additive color mixing applies to colors produced by light. The three primary colors in additive mixing are red, green, and blue. If all three primary colors are combined, the result is white. Additive mixing is used in television and computer monitors to produce a wide range of colors using only three primary colors. On the other hand, the three primary colors in subtractive mixing are yellow, magenta, and cyan, leading to the CMYK color model widely used in color printing. In subtractive color mixing, the combination of all three primary colors creates black. Subtractive mixing is used to create a variety of colors when printing on paper and when painting by combining multiple ink colors. Subtractive color mixing is typically used for color adjustment of dental composites using pigments or dyes. Figure 2 illustrates additive (left) and subtractive (right) color mixing.

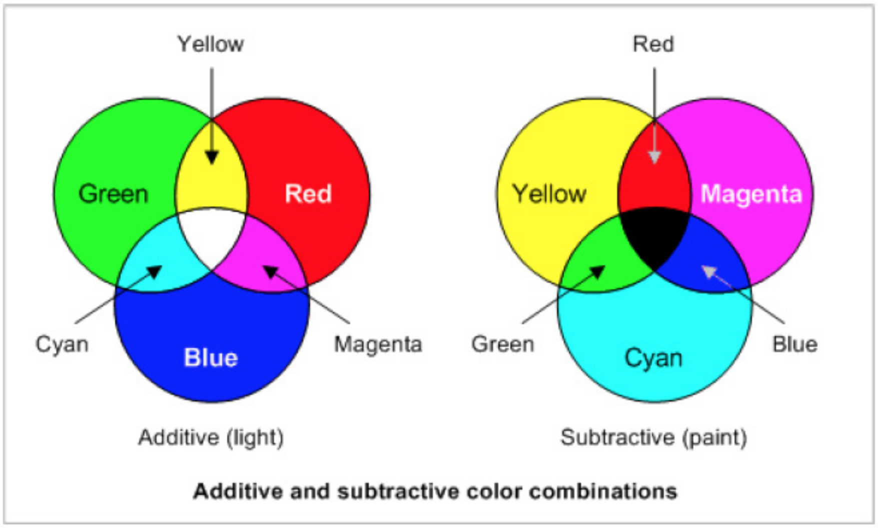


Fig. 2 Additive and subtractive color mixing[1]

3.1.2 Tooth color

Figure 3 is a Munsell sphere that indicates the complete visible color space. As shown in Figure 4, the range of colors for natural teeth is quite limited and distributed in the narrow range of red to yellow from A1 to D4, with varying degrees of lightness, darkness, and saturation.

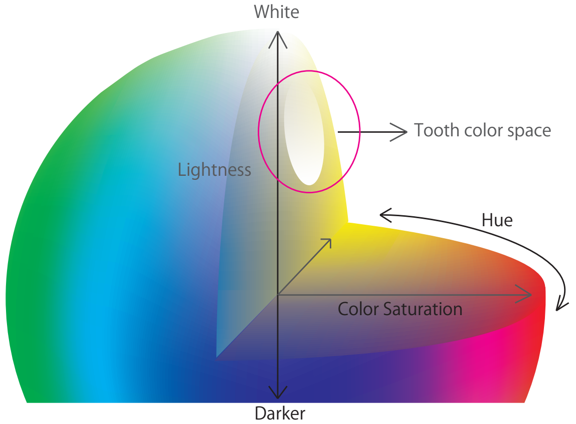


Fig. 3 Munsell sphere

Fig. 4 A1-D4 range of tooth shades

3.1.3 Light Mechanics

OMNICHROMA is a composite that achieves wide color matching by generating red-to-yellow structural color equivalent to natural teeth in an additive color mixing system.

Figures 5a and 5b illustrate a color matching image for conventional composites that utilize the chemical color of added dyes or pigments. In these cases, excellent color match can be achieved if the correct shade is selected. However, the color matching will be poor if shade taking is performed incorrectly because the shade-matching ability of typical composites is weak.

Figures 6a and 6b illustrate a color matching image for OMNICHROMA. OMNICHROMA generates red-to-yellow structural color equivalent to the color elements of a natural tooth. Structural color is expressed only by the physical properties of light (diffraction, refraction, interference, scattering, etc.) without an exchange of light energy. As this red-to-yellow structural color is generated, it combines with the reflected light and color of the surrounding tooth in an additive color mixing process, maximizing OMNICHROMA's ability to match natural teeth. This use of structural color in combination with an additive color mixing system makes the use of pigments and dyes unnecessary.

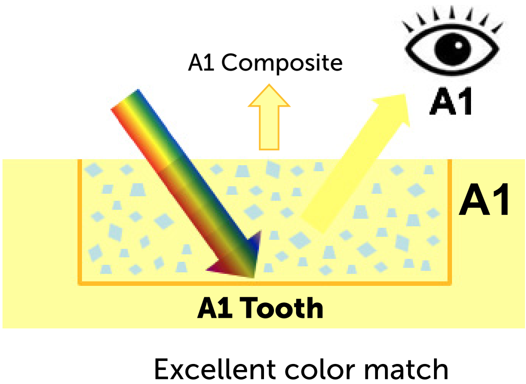


Fig. 5a A1 tooth restored using A1 shade composite

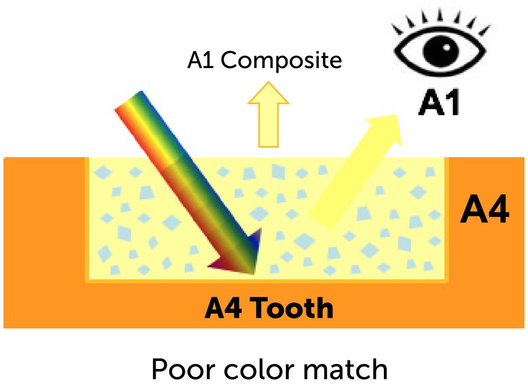


Fig. 5b A4 tooth restored using A1 shade composite

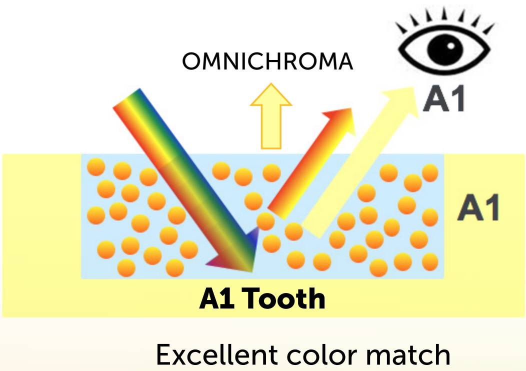


Fig. 6a A1 tooth restored using OMNICHROMA

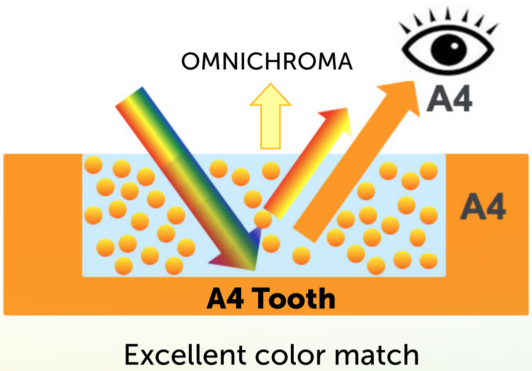


Fig. 6b A4 tooth restored using OMNICHROMA

To express structural color, it is very important that the filler of the composite consists of specific, single-sized spherical particles only. To examine the relationship between particle size and shape and the structural color phenomenon, filler powders of various sizes and shapes were spread out on black and white paper backgrounds. The visible color phenomenon for each filler powder is demonstrated in Figure 7 below. Filler powder itself has no color, as demonstrated by its appearance on a white paper background. White light reflected by the white background is very strong, which is why a structural color phenomenon is not visible on the white background. As is demonstrated, TOKUYAMA's research found that 260nm spherical filler generates the red-to-yellow color necessary to match natural teeth. Variations in the size and shape of the filler material can alter or impede the structural color phenomenon, and ultimately the composite's shade-matching ability. Therefore, OMNICHROMA uses 260nm spherical filler (OMNICHROMA Filler) material exclusively.

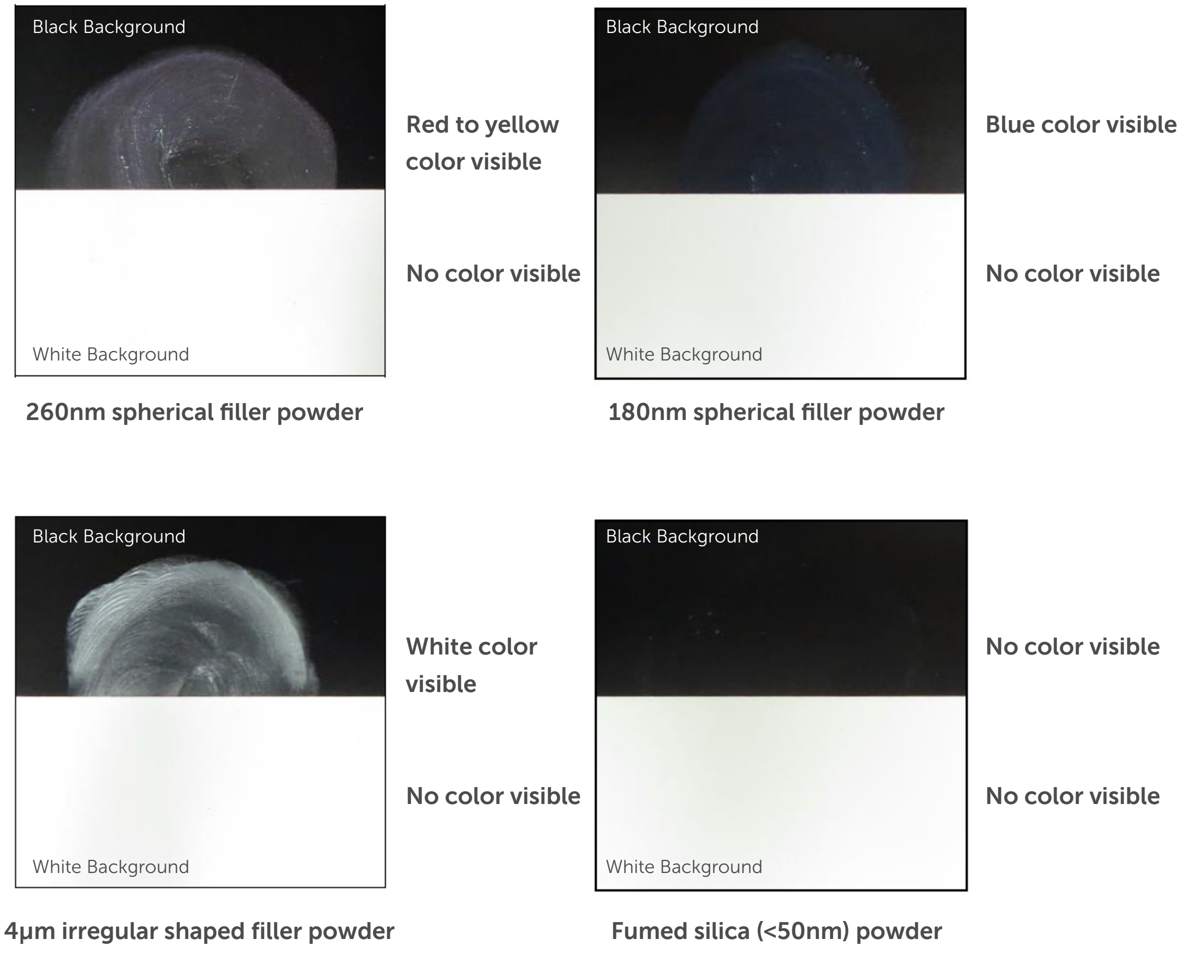


Fig. 7 Relationship between particle size and structural color phenomenon

3.2 Manufacturing Process

TOKUYAMA DENTAL synthesizes the uniformly sized OMNICHROMA Fillers (260nm spherical filler) using a special technique called the Sol-Gel Method. Unlike conventional filler manufacturing methods, which involve crushing glass materials until they reach a roughly desirable size, the Sol-Gel Method produces fillers from filler cores in organic solvent and allows the filler to grow gradually from the cores. This method makes it possible to produce uniform spherical fillers (Figure 8).

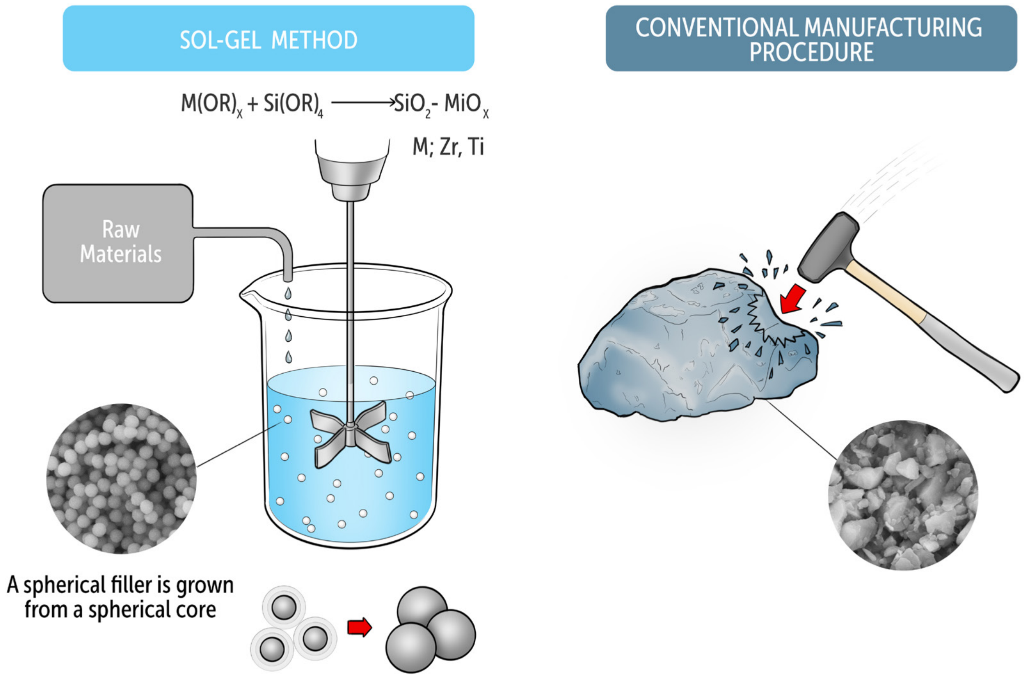


Fig. 8 Sol-Gel Method vs conventional filler method

A key benefit of the Sol-Gel Method is that the filler size can be controlled by adjusting the reaction times. In composite resins, filler size significantly affects the physical characteristics of the cured body and its esthetic aspects. Smaller filler sizes produce a superior surface glossiness but make it difficult to increase filler content. These smaller sized filler particles can lead to drawbacks such as increased polymerization shrinkage and poor physical characteristics such as reduced flexural strength.

Figure 9 shows the correlation between filler particle size, filler content, and compressive strength. The figure illustrates how filler content begins to fall significantly below 100nm but is nearly constant at sizes above that. In addition, it shows maximum compressive strength for particle sizes ranging from 100 to 500nm. Figure 10 shows the correlation between filler particle size, surface roughness, and hardness. This figure illustrates that surface roughness decreases with particle sizes down to approximately 500nm, but remains constant at sizes below 500nm. Surface hardness reaches the highest value at particle sizes ranging from 100 to 500nm. TOKUYAMA utilized these properties to develop the ideal balance between esthetics and physical characteristics with supra-nano sized particles.

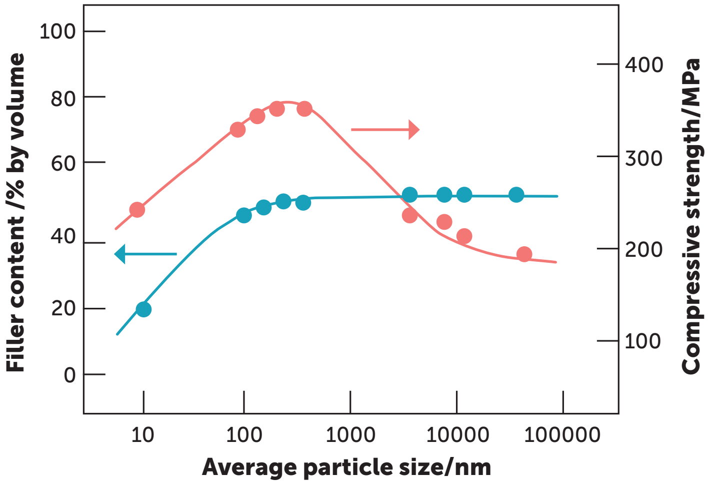


Fig. 9 Correlation between particle size, filler content, and compressive strength

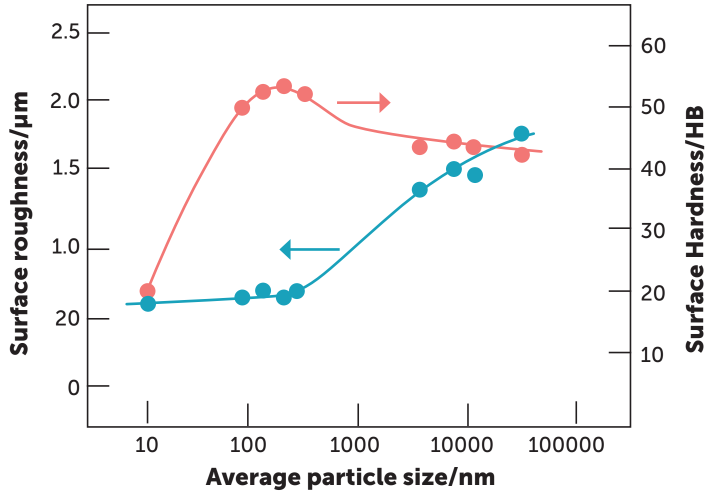


Fig. 10 Correlation between particle size, surface roughness, and surface hardness

Another key benefit of the Sol-Gel Method is that the refractive index of the filler can be controlled by changing the type and fraction of the additive. To reproduce the semi-translucent quality of natural teeth using composite resins, we must control the difference between the refractive indices of the filler and the organic resin. Composite resins consist of fillers and organic resins containing catalysts. When the refractive indices of both materials are equal, the composite resin appears highly translucent; when the refractive indices differ significantly, the resin appears opaque.

The refractive index of resins tends to change after polymerization, and the refractive index of the cured resin (polymer) tends to be higher than that of the resin (monomer) before curing. This property of refractive indices is demonstrated graphically in Figure 11.

To express excellent color matching, OMNICHROMA has been designed to optimize the translucency of the composite body after curing. While appearing opaque white before curing, OMNICHROMA achieves a natural look by transitioning from opaque to semi-translucent after curing.

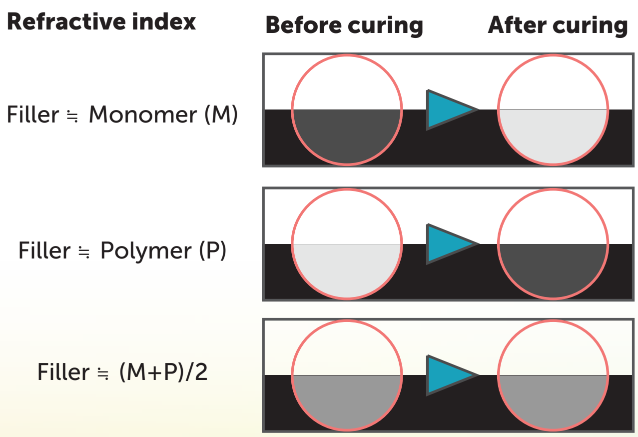
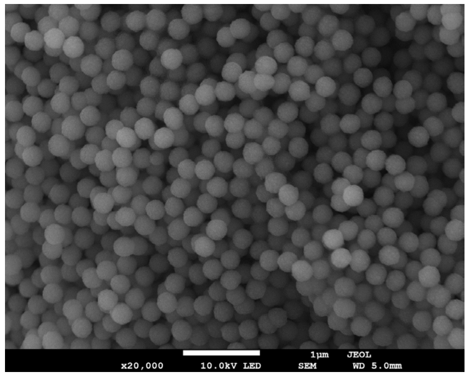


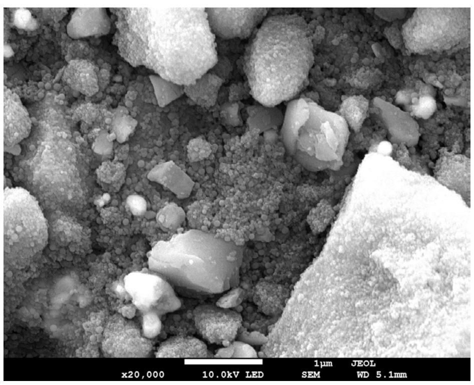
Fig. 11 Relationship with refractive index and translucency

3.3 SEM Comparisons of Filler Materials

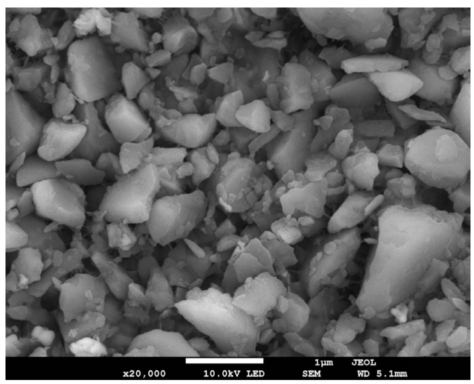
The SEM images on the following pages show the fillers used in OMNICHROMA and in composite resins from other manufacturers.



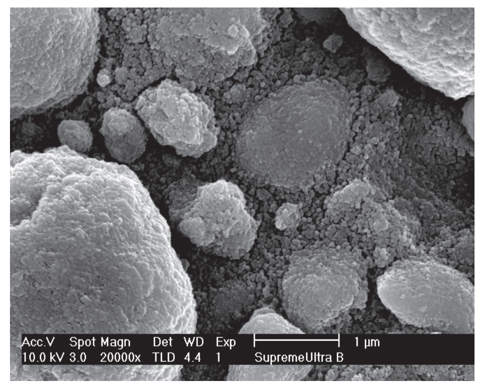
OMNICHROMA



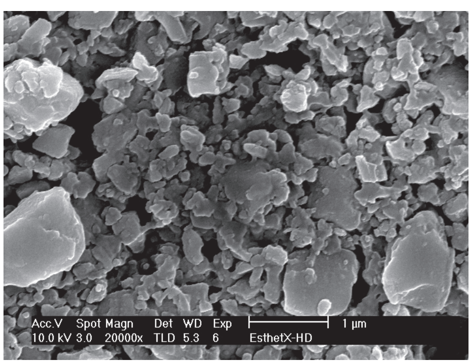
Harmonize



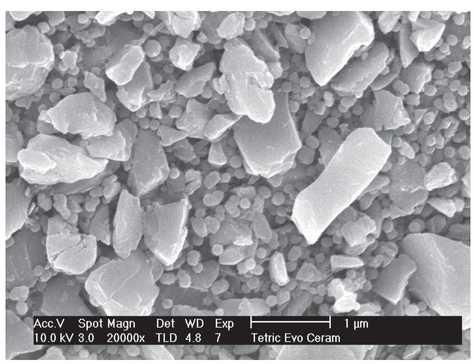
TPH Spectra ST



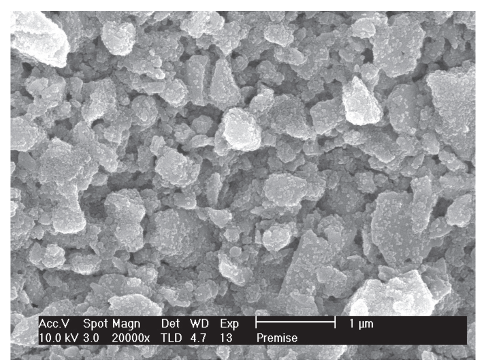
Filtek Supreme Ultra



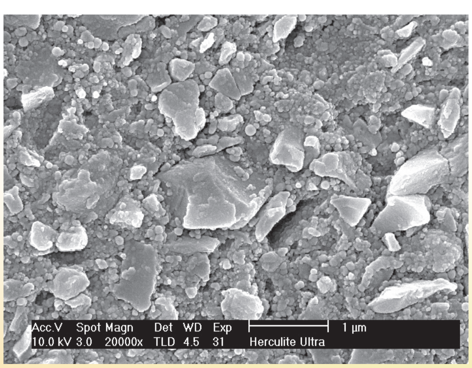
Esthet-X HD



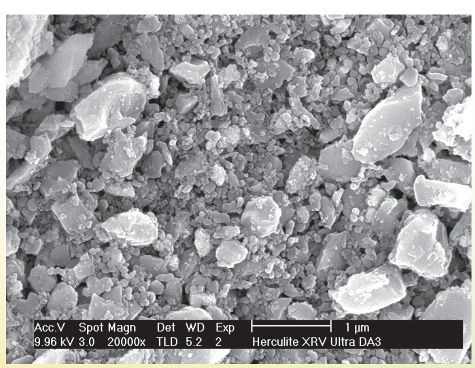
Tetric EvoCeram



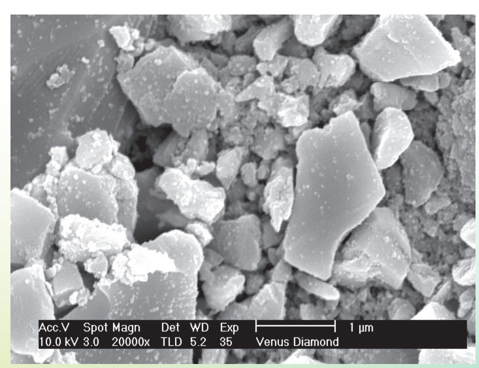
Premise



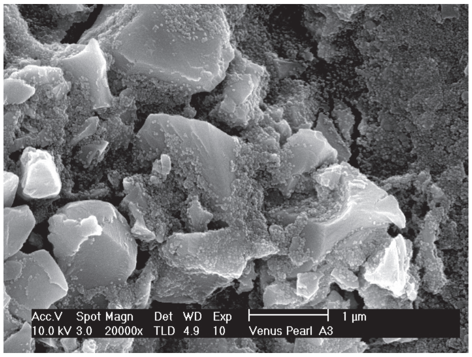
Herculite Ultra



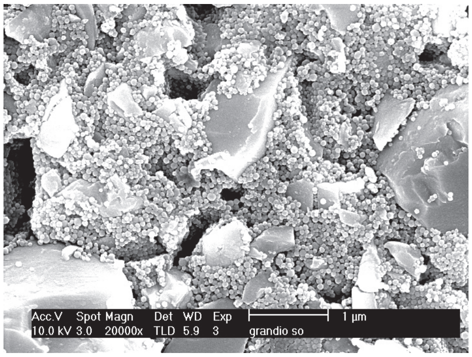
Herculite XRV Ultra



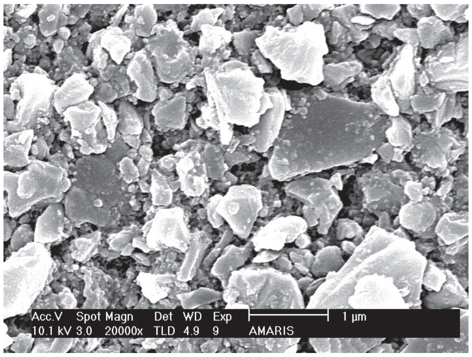
Venus Diamond



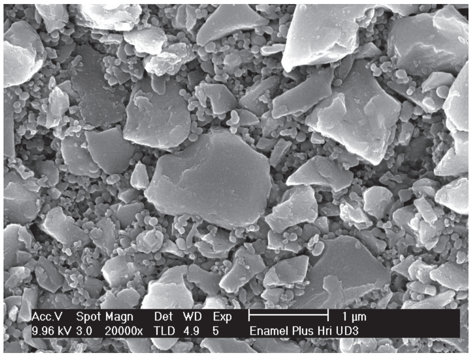
Venus Pearl



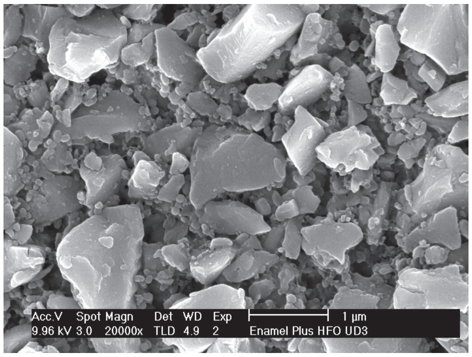
Grandio SO



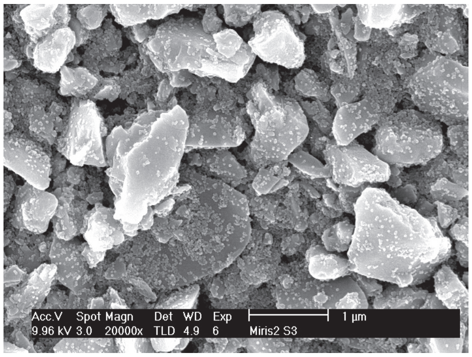
Amaris



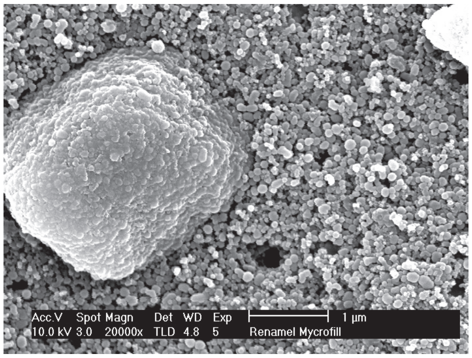
Enamel Plus HRi



Enamel Plus HFO



Miris^2



Renamel Microfill

4. Material Properties

4.1 Color Matching

The color-matching property of OMNICHROMA versus ESTELITE SIGMA QUICK (ESQ) was evaluated visually and by instrument. Artificial composite resin teeth were prepared with a cavity size of 4mm diameter and 2mm depth, and the teeth were then filled and evaluated.

Fig. 12a Before preparation

Fig. 12b After preparation

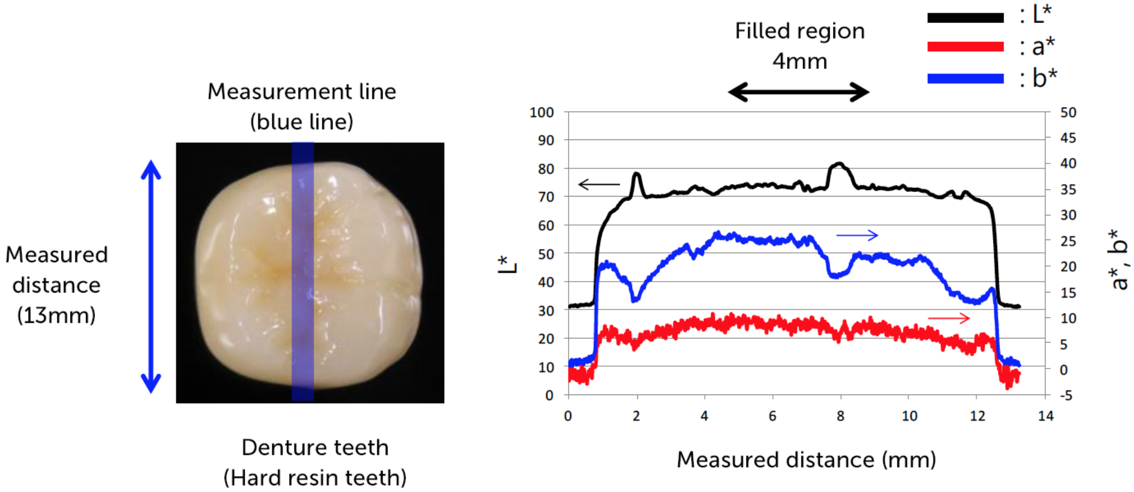


Fig. 13 Instrumental evaluation method using two-dimension color analyzer (RC500)

OMNICHROMA showed excellent color matching for all shades, as the value and chroma changed according to the surrounding tooth. In instrumental evaluation, L*, a*, and b* of OMNICHROMA was very close to those of original artificial teeth for all VITA shades.

ESTELITE SIGMA QUICK showed good color matching; however, lower color matching was measured, particularly in lighter shades (A1, A2, B1, C1).

A Group

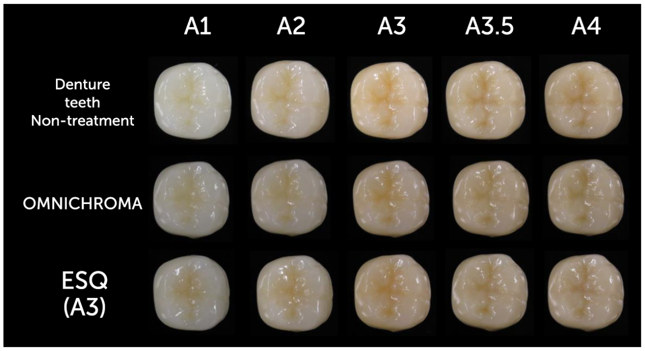


Fig. 14a Photos after restoration (A group)

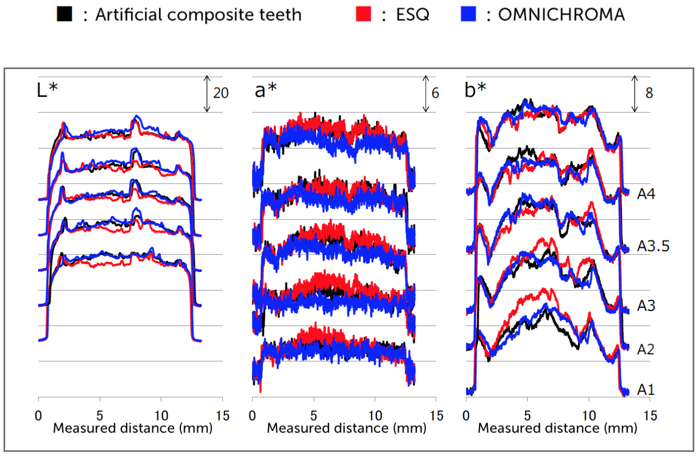


Fig. 14b Results of two-dimension color analyzer (A group)

B Group

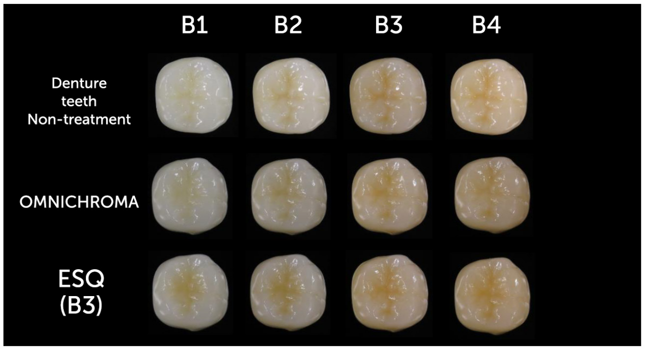


Fig. 15a Photos after restoration (B group)

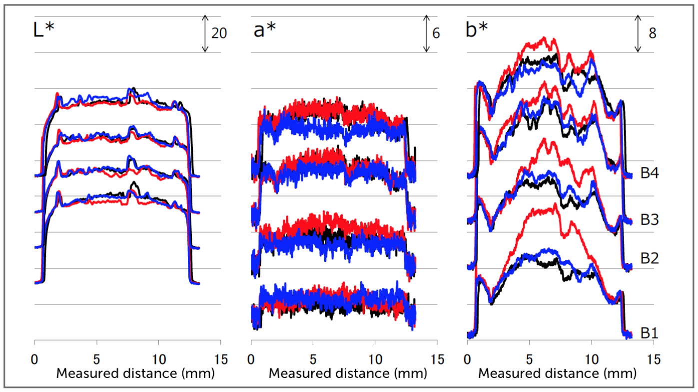


Fig. 15b Results of two-dimension color analyzer (B group)

C Group

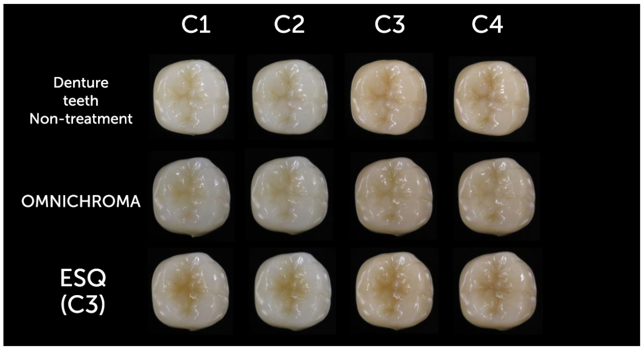


Fig. 16a Photos after restoration (C group)

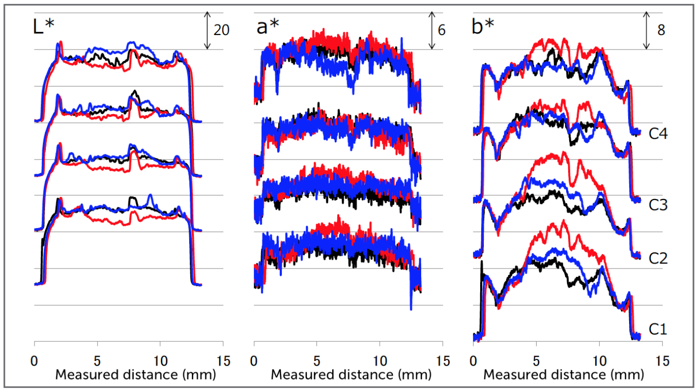


Fig. 16b Results of two-dimension color analyzer (C group)

D Group

Fig. 17a Photos after restoration (D group)

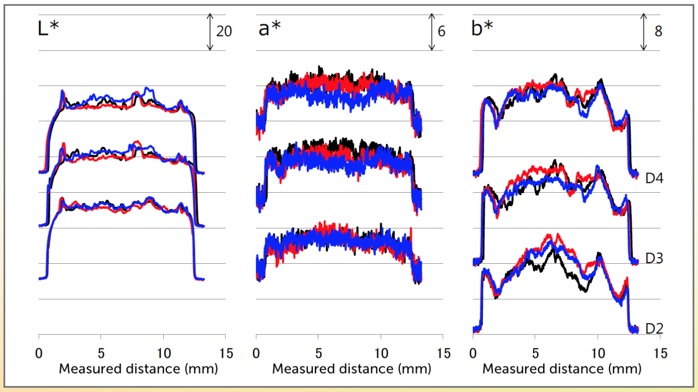


Fig. 17b Results of two-dimension color analyzer (D group)

Evaluation of OMNICHROMA Using Extracted Human Teeth

OMNICHROMA showed excellent color matching for all shades, as the value and chroma changed according to the surrounding tooth.

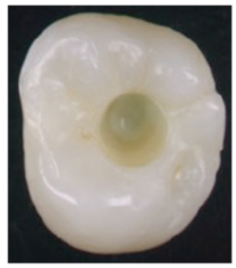
Class I
Shade A1 and A4

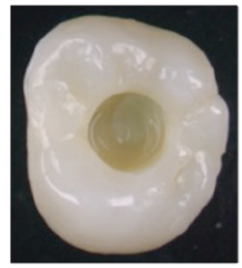
A1

Before preparation

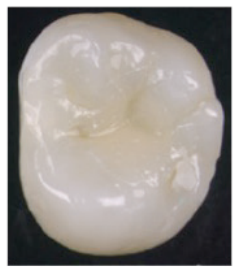
2mm depth | **3mm depth**

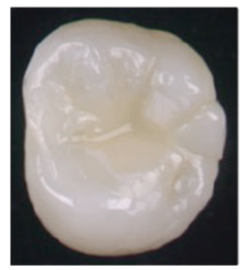
After preparation





Results



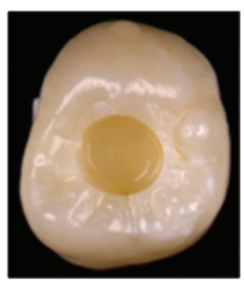


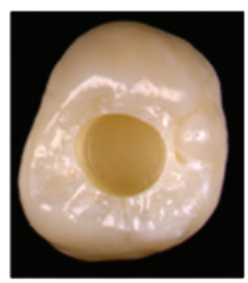
A4

Before preparation

2mm depth | **3mm depth**

After preparation

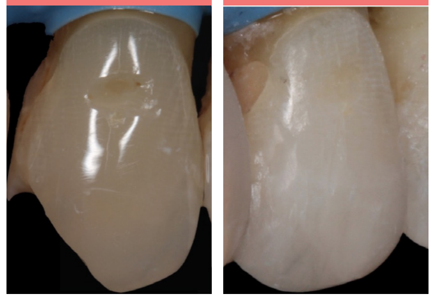




Results

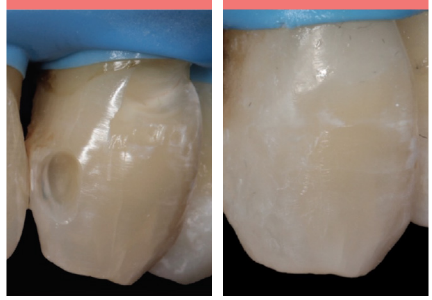
Class IV
Shade A4

Preparation | Results*



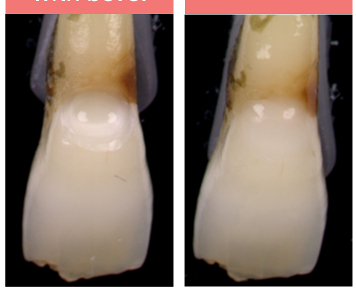
Class III
Shade A3.5

Preparation | Results*

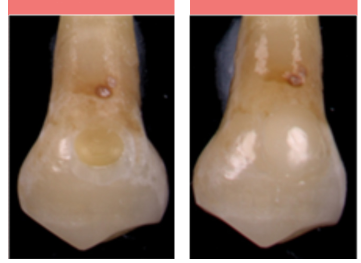


Class V
Shade A1 and A4

Preparation with bevel | Results

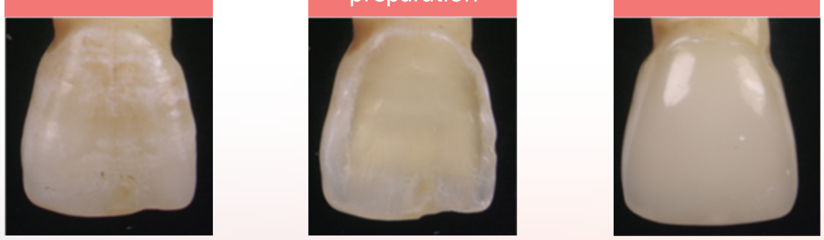


Preparation with bevel | Results



Composite Veneer
Shade A2

Before | After preparation | Results



*Bevel preparation used with OMNICHROMA in conjunction with OMNICHROMA BLOCKER

4.2 Polishability

Figure 18 shows surface glossiness after each surface of cured composite is polished with #1500 sandpaper, followed by Sof-Lex™ superfine discs (3M-ESPE) for 60 seconds under running water. The results show that both TOKUYAMA's ESTELITE SIGMA QUICK and OMNICHROMA produce extremely high glossiness.

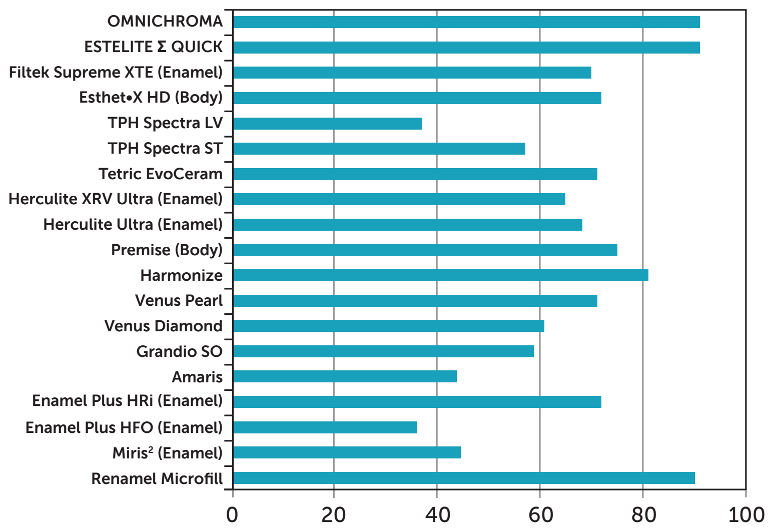


Fig. 18 Surface glossiness (%)

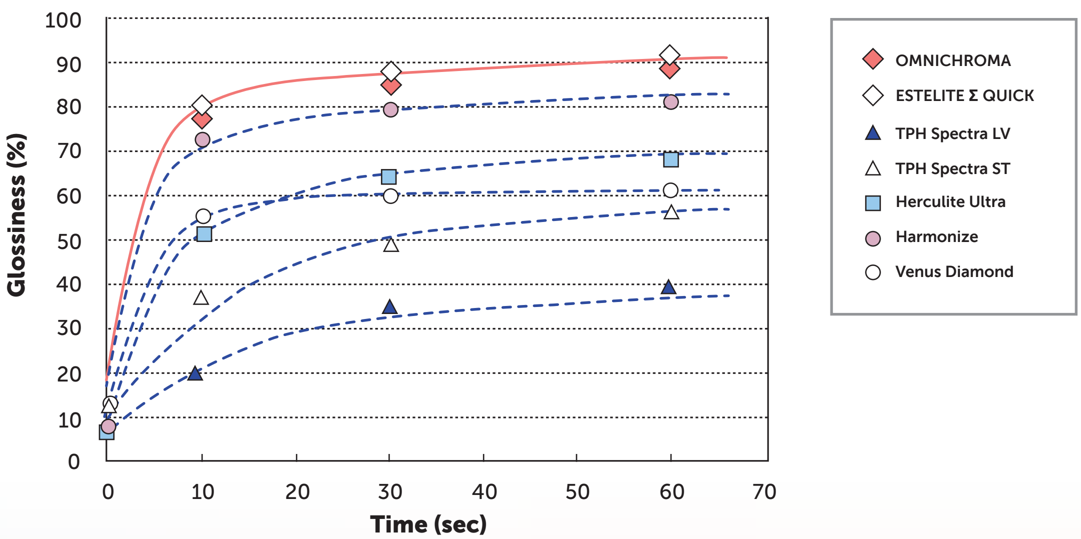


Fig. 19 Relationship of surface glossiness and polishing time

4.3 Strength

Figure 20 presents the flexural strength and Figure 21 presents the compressive strength of OMNICHROMA and other commercially available resin composites.

The flexural strength and the compressive strength of OMNICHROMA are of average or higher levels among commercially available resin composites, ensuring clinically acceptable results.

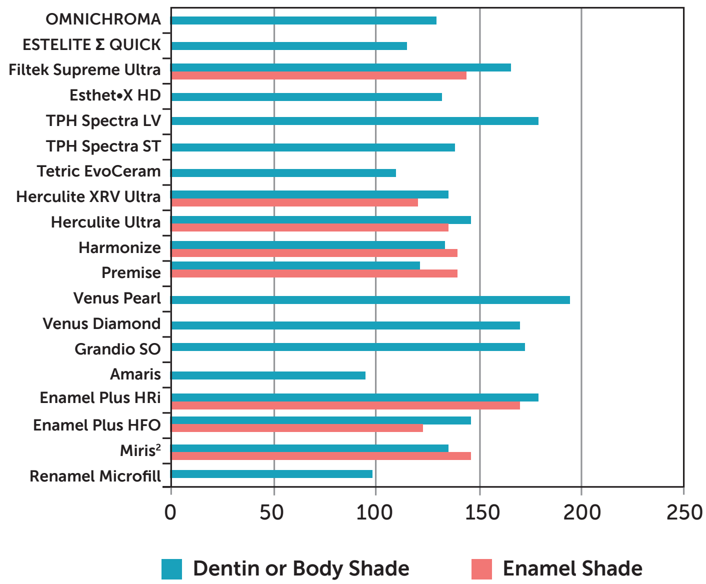


Fig. 20 Flexural strength (MPa)

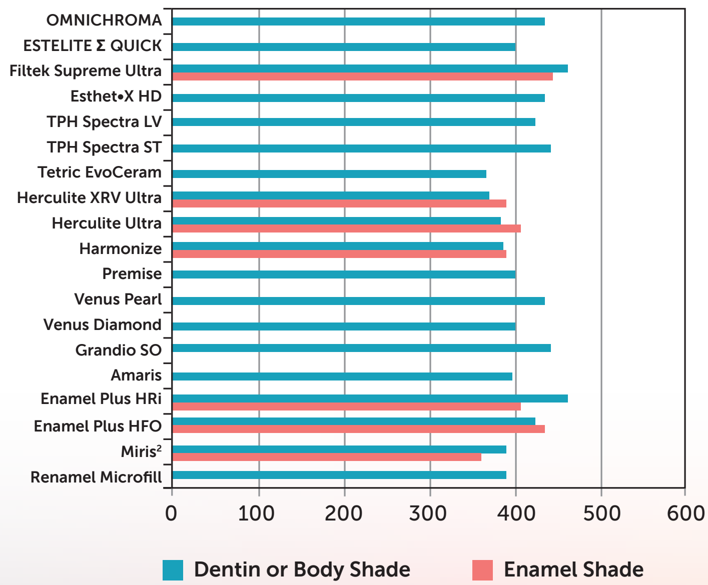


Fig. 21 Compressive strength (MPa)

4.4 Wear Characteristics

Wear resistance of the composite resin opposing a human tooth's occlusal surface was examined using the method shown in Figure 22. The comparison results detailed in Figure 23 show the resulting wear of various commercially available composites and OMICHROMA. These results show that OMNICHROMA exhibits an excellent balance between volume loss of the composite resin and wear of the human tooth. OMNICHROMA is a composite resin that is less likely to abrade opposing teeth while not easily becoming abraded itself, similar to ESTELITE SIGMA QUICK.

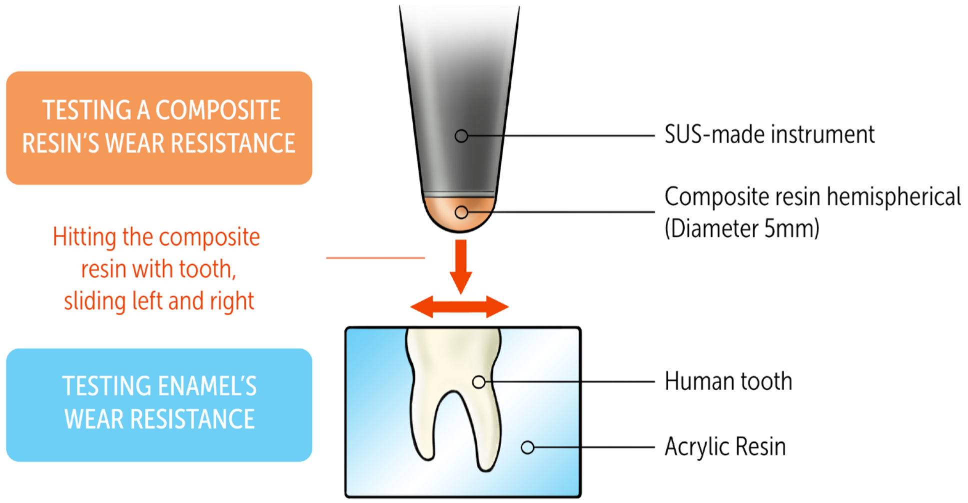


Fig. 22 Method of testing wear resistance

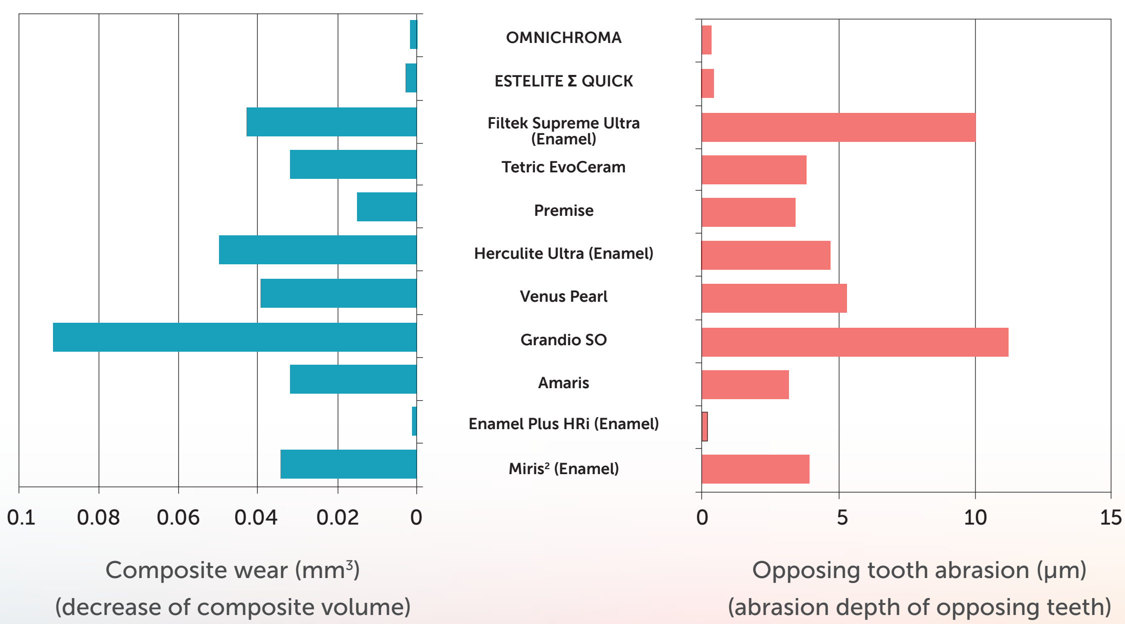


Fig. 23 Wear resistance (50,000 cycles)

4.5 Polymerization Shrinkage

Using the method illustrated in Figure 24 below, TOKUYAMA measured the polymerization shrinkage of OMNICHROMA and other composites. This method can measure shrinkage in the cavity floor when the composite resin is placed into a cavity and exposed to light in a clinical procedure. This method permits evaluation of shrinkage under conditions closer to those encountered in real clinical settings.

Figure 25 shows the linear polymerization shrinkage of OMNICHROMA and other commercially available resin composites after 3 minutes of curing light exposure.

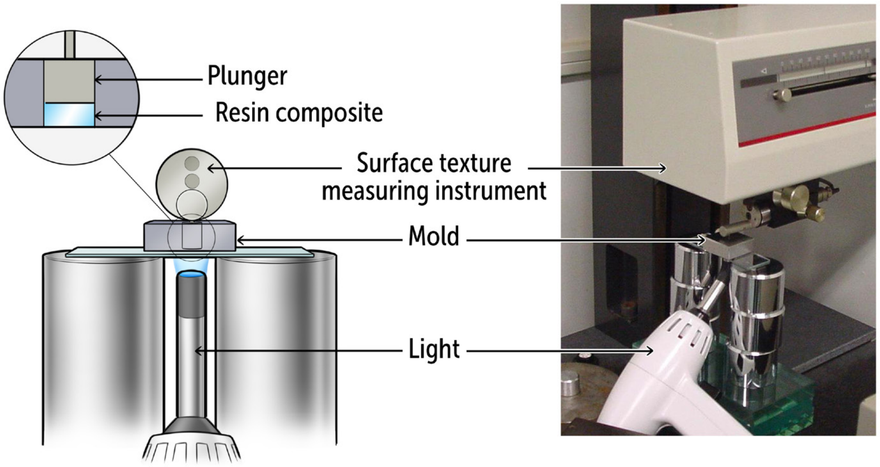


Fig. 24 Method of measuring polymerization shrinkage

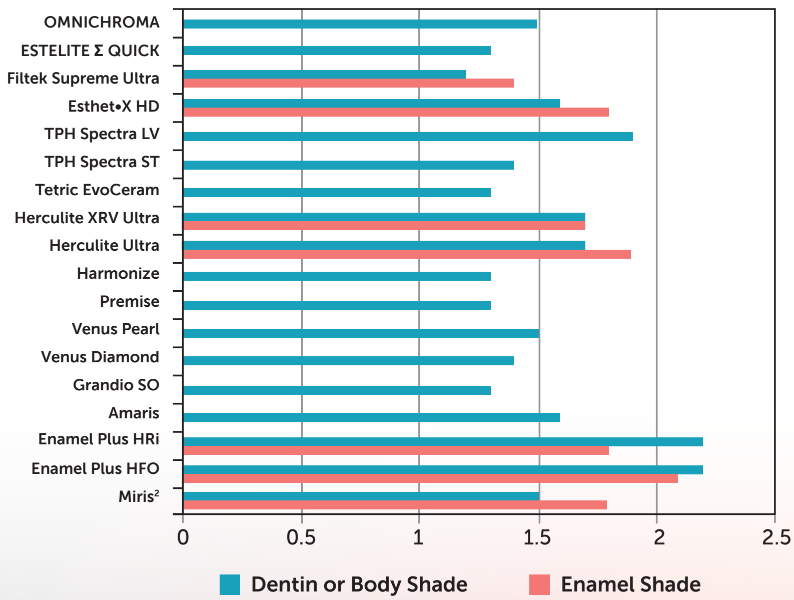


Fig. 25 Polymerization shrinkage (% linear)

4.6 Staining Resistance

If the composite resin stains more rapidly than the dentition, the resin becomes less esthetically effective. To account for this, we examined the degree of staining by coffee (immersed for 24 hours at 80°C). The stain resistance results are shown in Figure 26.

The extent of staining for OMNICHROMA after soaking in coffee was relatively low among commercially available resin composites, meaning OMNICHROMA will resist staining for the life of the restoration.

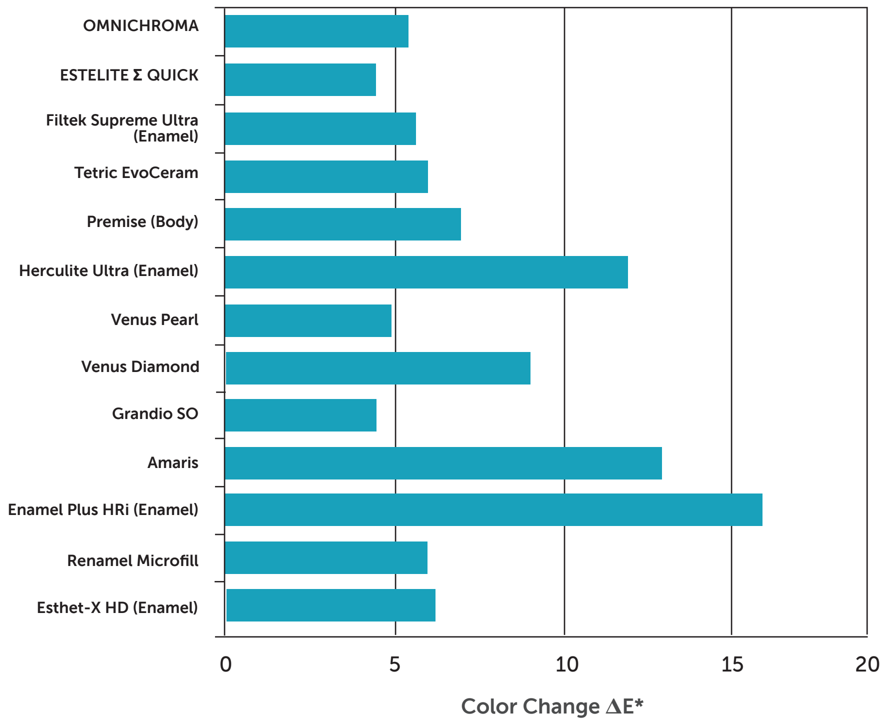


Fig. 26 Stain resistance (ΔE*)

4.7 Stability in Ambient Light

Composites are exposed to strong ambient light in the operatory setting. It is important that a composite remain workable under these conditions throughout the length of the restorative procedure. Figure 27 demonstrates the working time of OMNICHROMA and other commercially available resin composites. As is shown, OMNICHROMA offers ample working time for almost all restorative procedures.

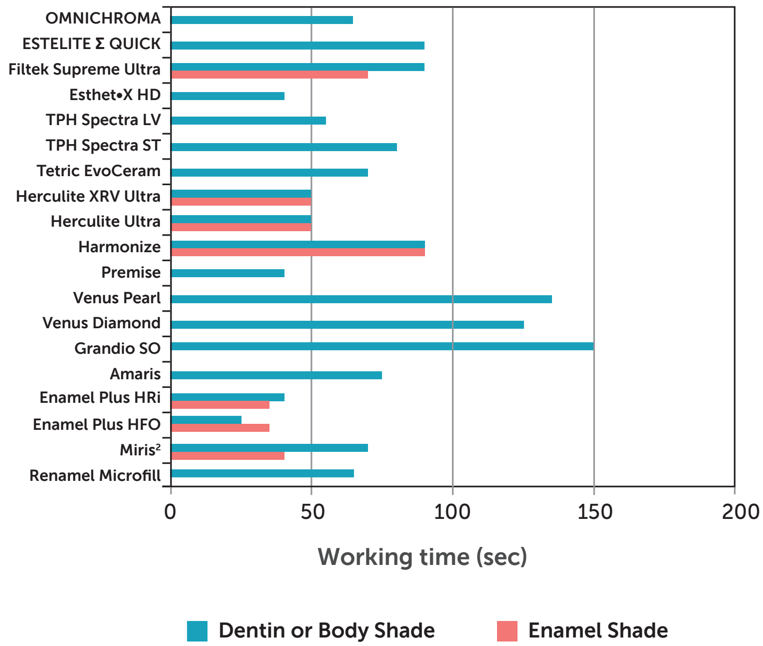


Fig. 27 Working time

4.8 Color and Translucency Before and After Curing

Typically, it is desirable that a composite maintain a similar color before and after curing to prevent errors during the shade-taking process and to provide consistently predictable results. However, as OMNICHROMA is a single shade composite with wide shade-matching ability that appears opaque-white before curing, a large change in color is measured in Figure 28 compared to other commercially available composites. Because of the nature of OMNICHROMA, this is a positive result. The initial opaque-white appearance allows doctors to easily identify the proper position for a restoration and determine where excess paste can be removed prior to curing.

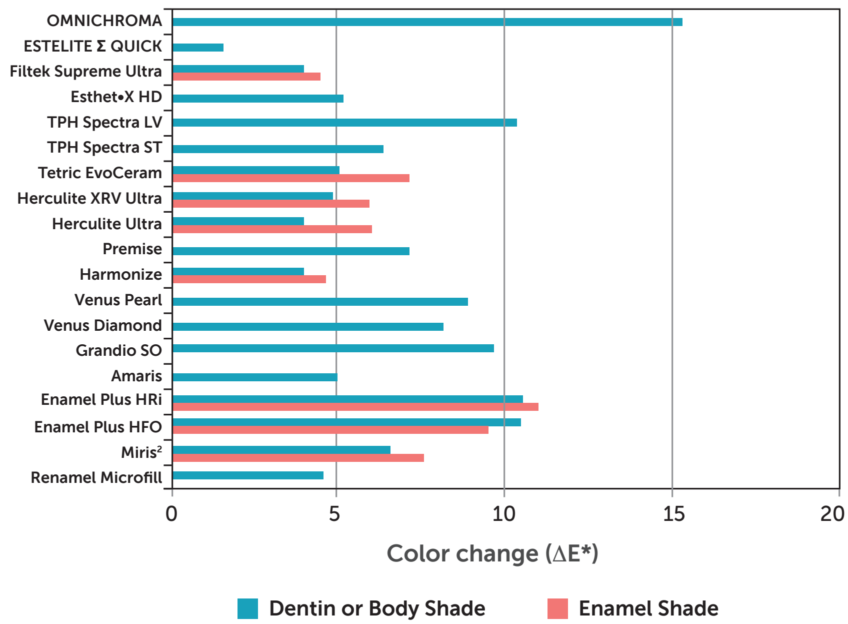


Fig. 28 Change of color before and after polymerization

Similarly, because of OMNICHROMA's opacity before curing, a strong shift in translucency is measured in Figure 29 as it transitions to semi-translucent for optimal shade matching and esthetics.

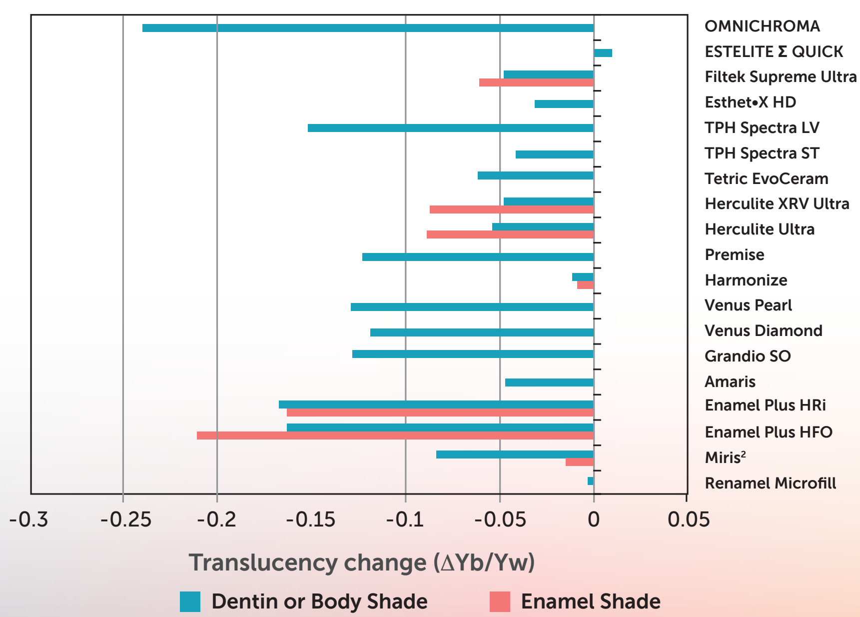


Fig. 29 Change of translucency before and after polymerization

4.9 Radiopacity

Radiopacity is determined by the composition of the inorganic filler and the composite's filler content. The radiopacity of a resin increases with the amount of high atomic number elements at higher filler content. However, fillers containing large amounts of high atomic number elements tend to have large refractive indices. Figure 30 shows the radiopacity of commercially available composite resins.

The radiopacity of OMNICHROMA is average and sufficient for prognosis observations.

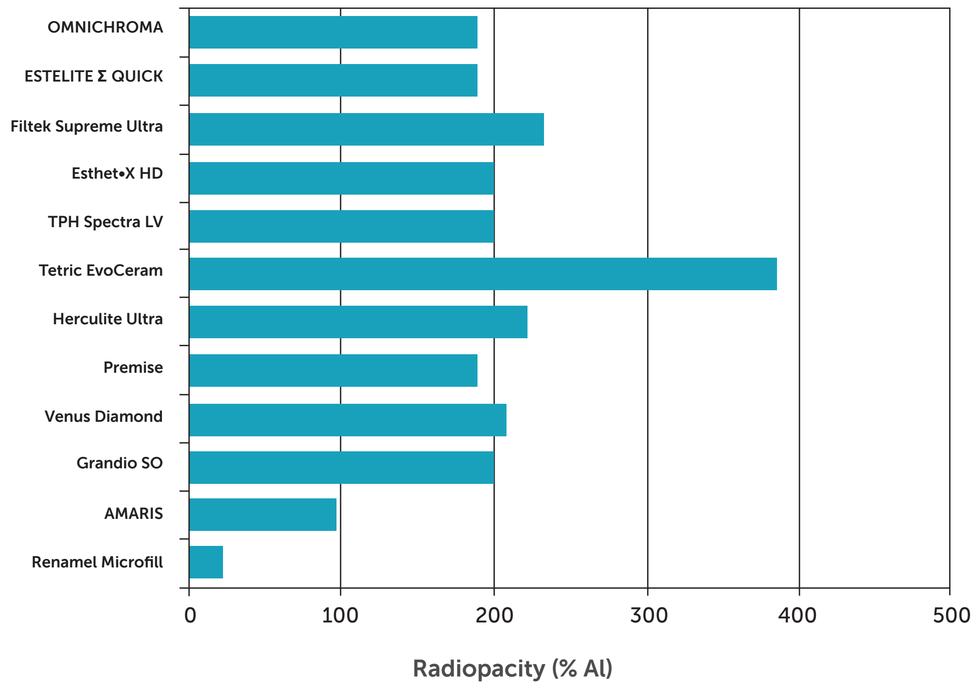


Fig. 30 Radiopacity of composite resins

5.1 The University of Texas School of Dentistry at Houston - Visual Color Adjustment Potential Analysis

A study conducted by The University of Texas School of Dentistry at Houston[2] analyzed the Visual Color Adjustment Potential (CAP-V) of resin composites through visual evaluation. Single specimen replicas of denture teeth were made using test composite shades, and dual specimens were made on mandibular right first molar denture teeth in each of VITA classical A1-D4 shades with simulated class I preparations, restored with test composite shades. Color differences were graded from 0 (perfect match) to 4 (large mismatch) on single (composite teeth vs. unrestored denture teeth) and dual (class I restorations vs. surrounding artificial tooth) specimens. CAP-V was calculated via the formula: $CAP\text{-}V = 1 - V_{dual}/V_{single}$.

Among five test shades, OMNICHROMA exhibited the highest CAP-V. The visual color differences between unrestored denture teeth and single specimens were the greatest for OMNICHROMA, signifying the largest mismatch. The rating of the color differences on class I restorations vs. surrounding artificial tooth were the smallest for OMNICHROMA, signifying the best match of OMNICHROMA with A1-D4 denture teeth. Figure 31 and Table 1 show the results of the study.

Fig. 31 Method for visual evaluation of color adjustment potential

Material	Single	Dual	CAP-V
OMNICHROMA	3.7 (0.5)	0.3 (0.4)	0.92 (0.12)
Filtek Supreme Ultra A2B	2.8 (0.6)	2.2 (0.8)	0.16(0.36)
TPH Spectra LV A2	2.6 (0.7)	1.9 (0.9)	0.21 (0.45)
Herculite Ultra A2E	2.5 (0.8)	1.6 (0.7)	0.19 (0.69)
Tetric EvoCeram A2E	2.7 (0.9)	1.5 (0.6)	0.40 (0.28)

Table 1 Results of visual evaluation of color adjustment potential

5.2 The University of Texas School of Dentistry at Houston - Instrumental Color Adjustment Potential Analysis

A study conducted by The University of Texas School of Dentistry at Houston[3] analyzed the Instrumental Color Adjustment Potential (CAP-I) of resin composites through instrumental evaluation. A simulated class I cavity, 4mm in diameter and 2mm in depth, was created on mandibular right first molar denture teeth in the 16 VITA classical shades. Replicas of denture teeth were created using each of five test shades, including OMNICHROMA. A non-contact spectro-radiometer measured the CAP-I of each with the formula as follows: $\text{CAP-I}=1-\Delta E^*_{dual} / \Delta E^*_{single}$. Single-ΔE* measured between the unrestored denture teeth and composite teeth, and Dual-ΔE* measured between the same area of unrestored denture teeth and restored denture teeth. Compared to the other test shades, OMNICHROMA's ΔE* value for Single was the greatest and the ΔE* value for Dual was the smallest. OMNICHROMA also had the greatest CAP-I, signifying the greatest Instrumental Color Adjustment Potential of resin composites. Figure 32 and Table 2 show the results of the study.

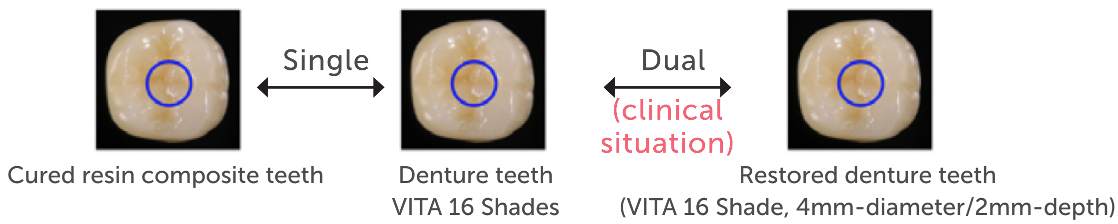


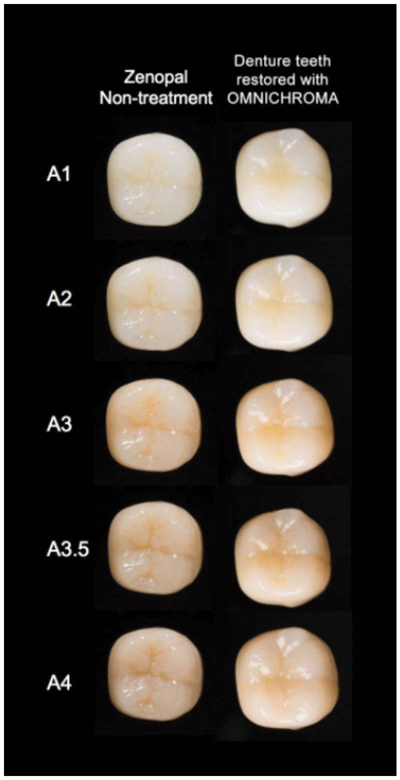
Fig. 32 Method for instrumental evaluation of color adjustment potential

Material	Single	Dual	CAP-I
OMNICHROMA	11.6 (4.0)	3.1 (0.8)	0.67 (0.20)
Filtek Supreme Ultra A2B	6.5 (2.4)	4.3 (1.2)	0.18(0.56)
TPH Spectra LV A2	6.7 (2.7)	3.9 (1.0)	0.25 (0.60)
Herculite Ultra A2E	7.0 (3.1)	4.1 (1.2)	-0.02 (1.72)
Tetric EvoCeram A2E	6.8 (2.6)	3.7 (1.4)	0.37 (0.35)

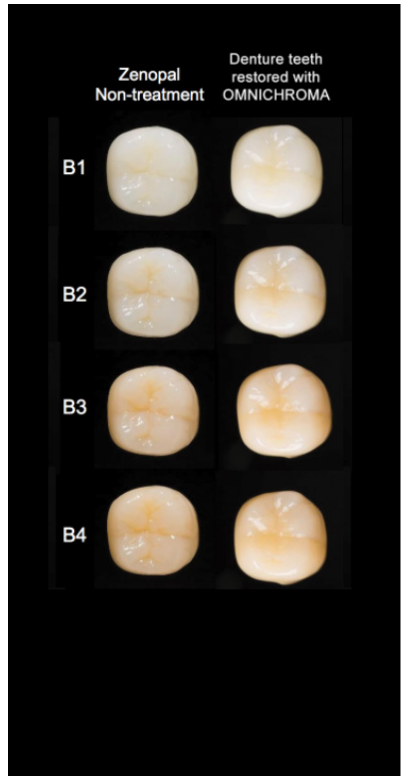
Table 2 Results of instrumental evaluation of color adjustment potential

5.2.1 The University of Texas School of Dentistry at Houston - Before & After Denture Teeth Restored with OMNICHROMA

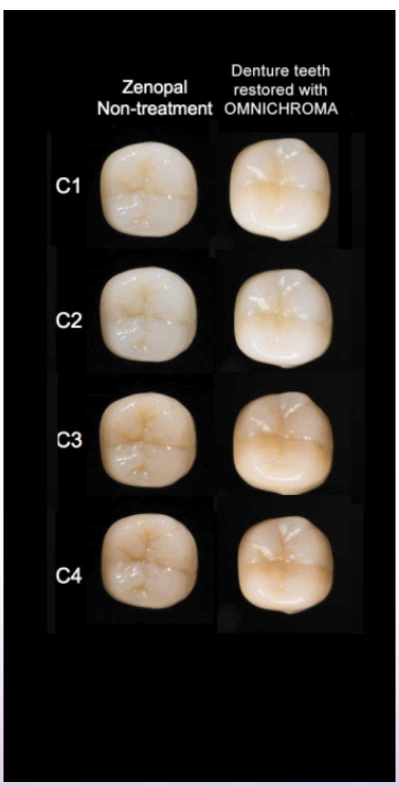
Shades A1-A4



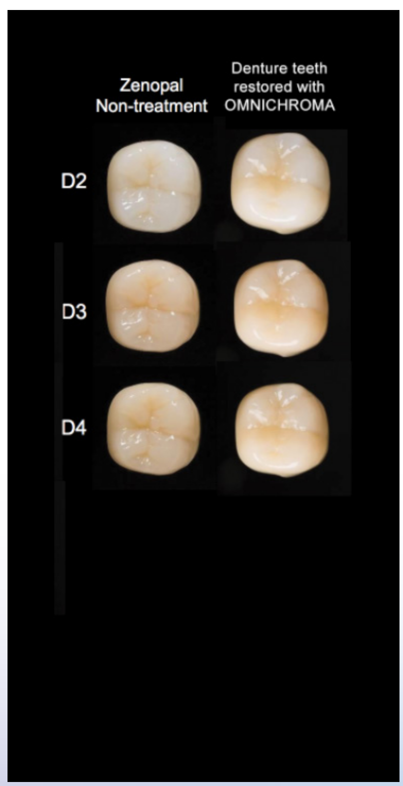
Shades B1-B4



Shades C1-C4



Shades D2-D4



5.3 Oregon Health & Science University – Physical Properties Analysis

A study conducted by the Oregon Health & Science University[4] examined seven properties of OMNICHROMA in vitro, which included:

- Polymerization Contraction Stress (Bioman)
- Flexural Strength/Modulus
- Fracture Toughness
- Compressive Strength
- Depth of Cure – Tooth Model
- Polishability – Gloss and Gloss Retention
- Color and Color Stability

5.3.1 Polymerization Contraction Stress

The Bioman stress measurement device was used to measure the polymerization contraction stress. Each of the five composites was formed into an uncured specimen disc, which was then irradiated through its thickness dimension by the LCU. The registered load was then divided by the disc area to obtain the stress values. The results are shown in Figure 33. OMNICHROMA demonstrated a clinically acceptable measure of polymerization contraction stress.

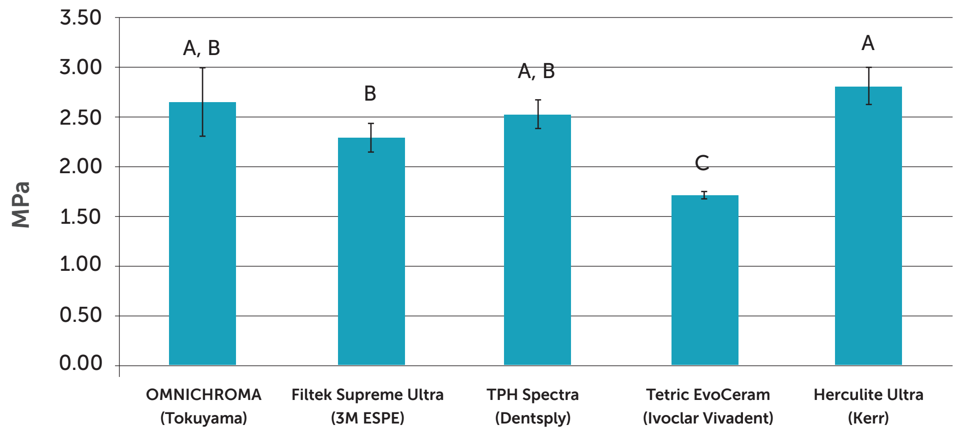


Fig. 33 Polymerization contraction stress

5.3.2 Flexural Strength/Modulus

Specimens were made in an aluminum mold and stored in water at 37°C for 24 hours. They were then tested in three-point bending on a universal testing machine. The flexural strength was measured by using the maximum load, and the flexural modulus was measured using the force-deflection curve's initial slope. The results of the study are shown in Figures 34 and 35. OMNICHROMA displayed a clinically acceptable measure of flexural strength and modulus of elasticity.

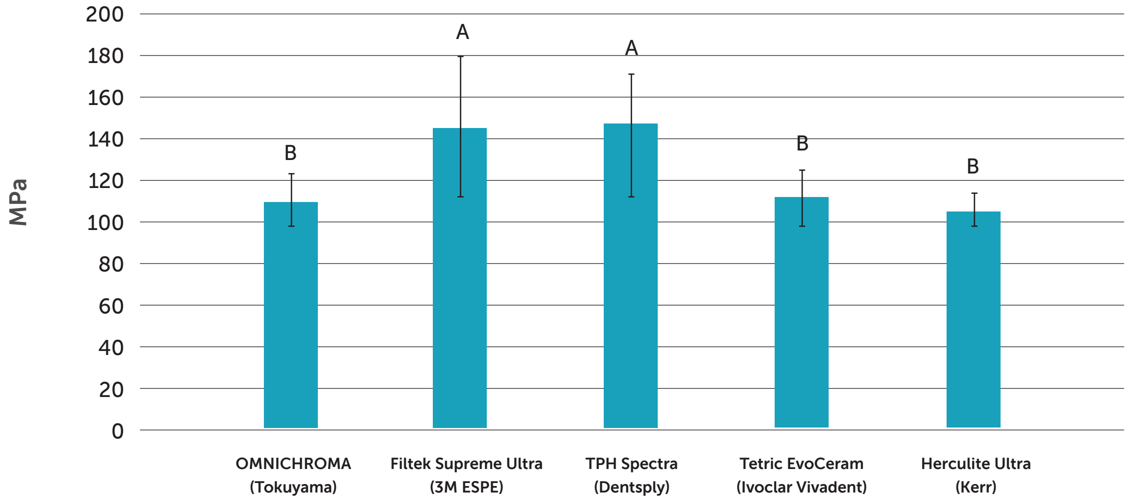


Fig. 34 Flexural strength

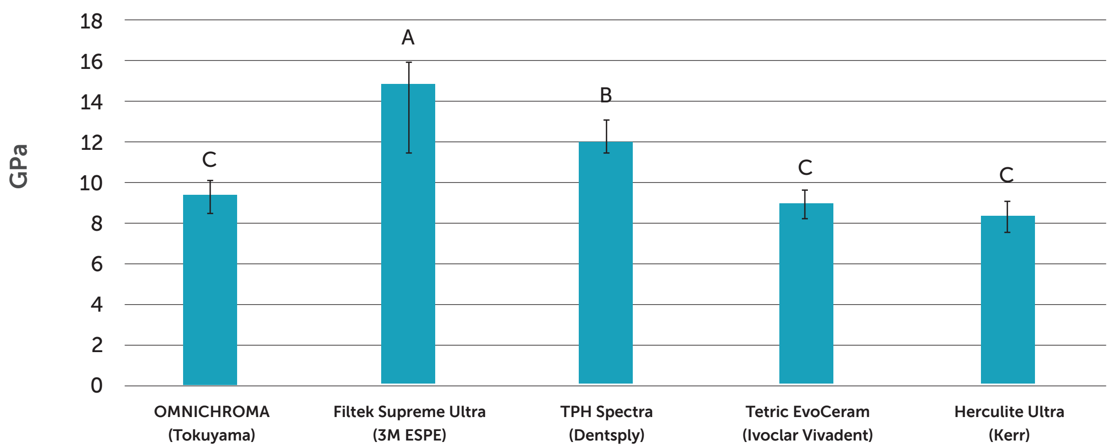


Fig. 35 Modulus of elasticity

5.3.3. Fracture Toughness

Specimens were made in stainless steel molds and stored in water at 37°C for 24 hours. They were then tested in 3-point bending on a universal testing machine. The fracture toughness was measured using the maximum load. The results of the study are shown in Figure 36. OMNICHROMA demonstrated a clinically acceptable average for fracture toughness.

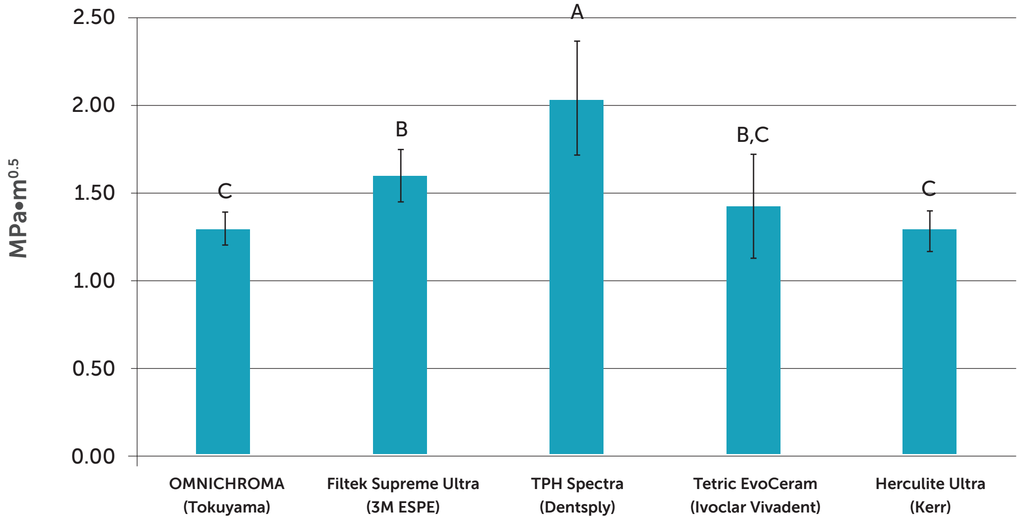


Fig. 36 Fracture toughness

5.3.4. Compressive Strength

Specimens were made in glass tubes and stored in water at 37°C for 24 hours. They were then tested in a universal testing machine with a cross-head speed of 1mm/min with a 500-kg load-cell. The results of the study are shown in Figure 37. Among the five composites tested, OMNICHROMA demonstrated the highest measure of compressive strength at 317.21 MPa.

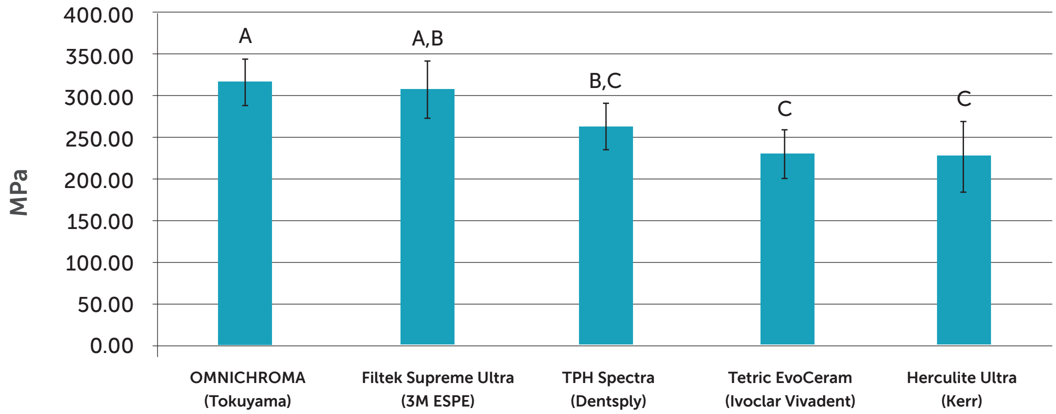


Fig. 37 Compressive strength

5.3.5. Depth of Cure – Tooth Model

A standardized, non-retentive class II cavity was made in a molar tooth. The cavity was then lubricated with petroleum jelly, a circumferential metal Toffelmire matrix applied, and the restorations using each composite completed. The restorations were cured for 20 seconds with a Demi curing light (Kerr), removed, placed in epoxy, and sectioned through the middle. The Knoop hardness was then determined in 1mm increments for each composite, with each incremental depth averaged in Figure 38. The results in Figure 38 were then calculated into the percentage of maximum hardness and was plotted versus depth, shown in Figure 39. OMNICHROMA maintained the highest level of hardness at the greatest depth of cure tested.

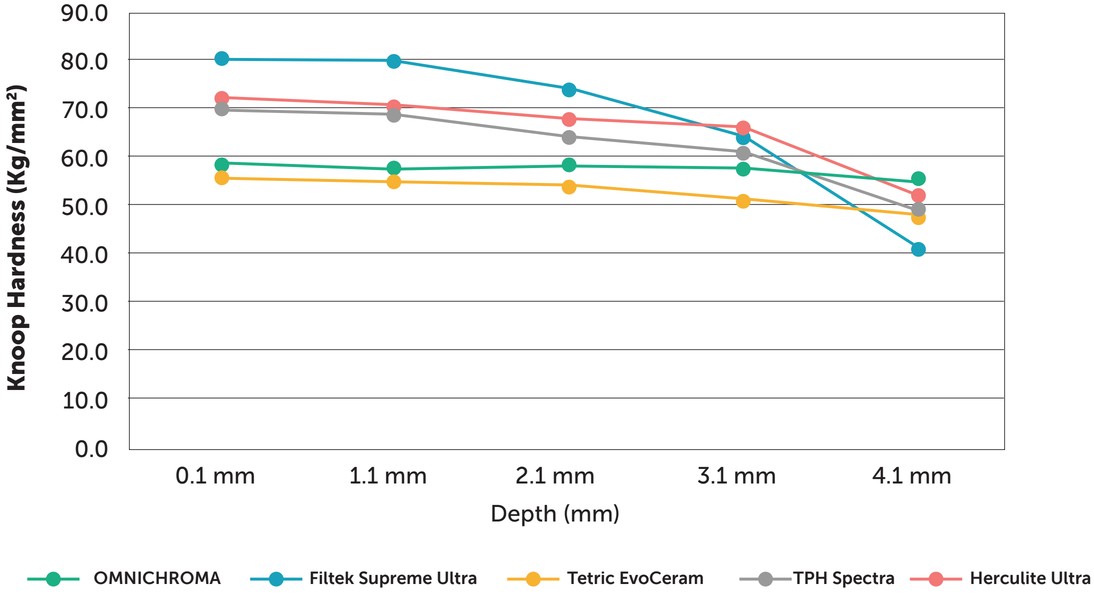


Fig. 38 Knoop hardness

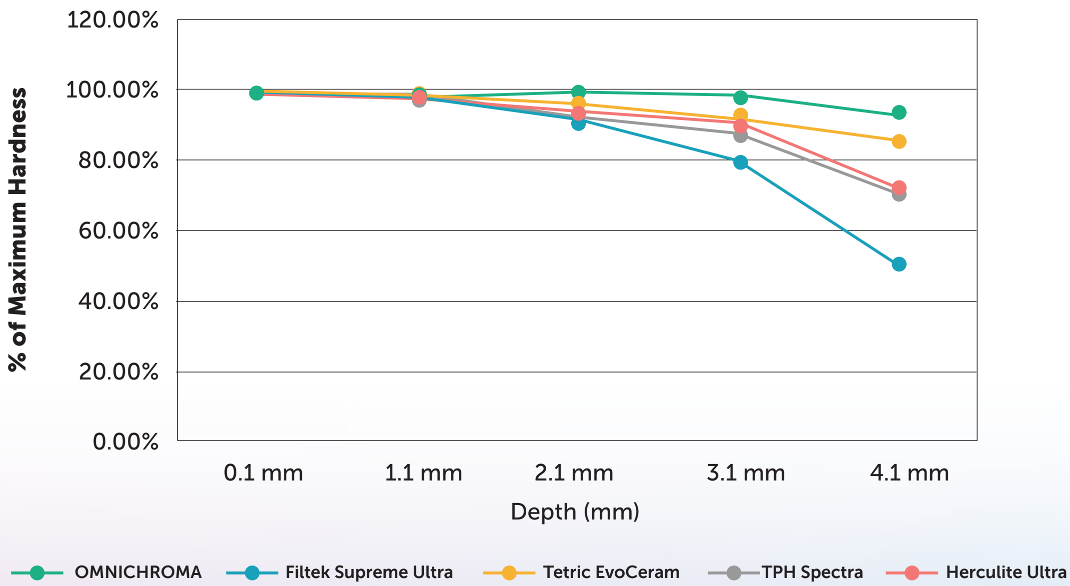


Fig. 39 Hardness top to bottom

5.4 Nihon University School of Dentistry – Color-Matching Ability

A study conducted by Nihon University School of Dentistry[5] examined the color-matching ability of OMNICHROMA and other resin composites.

Standard cavities were created within hard resin teeth of varying colors. The cavities were then filled with the resin pastes OMNICHROMA, ESTELITE SIGMA QUICK, and Filtek Supreme Ultra. The resin pastes were then compared to determine how well they matched the surrounding tooth. A Crystaleye spectrophotometer was used to analyze the colors of the resin-filled area, the incisal side of the cavity margin, and the cervical side of the artificial tooth in order to determine the Delta E values. Table 3 shows the shades of the artificial teeth, the shades of the resin pastes used to restore the teeth, and the corresponding instrumental ratings for each test. Delta E values of less than or equal to 3.2 were given a Grade A color match rating, indicating a color match that is only perceptible by skilled operators. Grade A color match is considered esthetically excellent. A Grade B color match score was given to all values between 3.2 and 6.5. Grade B color match is considered clinically unacceptable as the color difference is detectable by the average individual. A no color match score was given to values of 6.5 or greater, indicating a clinically unacceptable, highly perceptible color difference between the tooth and resin material.

Among the resin pastes used to fill the cavities, OMNICHROMA demonstrated minor Delta E values of 1.9 to 3.2 for all teeth and restoration depths, compared to ESTELITE SIGMA QUICK and Filtek Supreme Ultra which had Delta E values in the range of 2.9 to 15.4 and 2.6 to 13.4, respectively. This study demonstrates OMNICHROMA's ability to reproduce a wider range of teeth color via structural coloration technology, making it the only tested composite with clinically acceptable results for all specimens.

		OMNI	ESTELITE SIGMA QUICK				Filtek Supreme Ultra			
Depth	Artificial Tooth	Universal	A1	A2	A3	A4	A1B	A2B	A3B	A4B
1.5mm	A2	2.9 (0.4)	2.9 (0.4)	10.2 (0.5)	12.4 (1.4)	15.4 (1.0)	2.6 (0.2)	3.2 (0.2)	6.7 (0.3)	11.5 (0.7)
	A4	2.8 (0.4)	10.8 (0.9)	5.2 (0.5)	4.5 (0.6)	3.1 (0.2)	7.3 (0.7)	6.9 (0.7)	3.8 (0.3)	3.5 (0.1)
3mm	A2	3.2 (0.4)	8.2 (0.7)	11.6 (0.4)	14.3 (0.9)	18.0 (1.8)	3.3 (0.2)	4.8 (0.3)	7.7 (0.5)	13.4 (0.7)
	A4	1.9 (0.2)	11.1 (1.3)	7.9 (0.6)	6.5 (0.7)	3.9 (0.6)	9.2 (0.6)	6.9 (0.6)	6.3 (0.2)	6.0 (0.6)

Grade A color match: clinically acceptable

Grade B color match: clinically unacceptable

No color match

n=3, ():SD

Table 3 Results of color-matching ability assessment

5.5 Tokyo Medical and Dental University – Color Adaptation Analysis

In a study conducted by Tokyo Medical and Dental University[6], a colorimeter was used to analyze the color adaptation of OMNICHROMA. Ten healthy, extracted posterior teeth of different shades were selected. A cavity was created in each tooth, and then either OMNICHROMA or Estelite Asteria A3B was used to fill the cervical area cavity, and either OMNICHROMA or Estelite Asteria NE was used to fill the crown area cavity. A two-dimensional colorimeter was used to take pictures and perform colorimetry. Differences in color were calculated for the central filled part of the cavity to compare the colors before and after the cavities were created. Tables 4-7 shows the results of the calculations.

OMNICHROMA demonstrated significantly lower Delta E_{00} than the Asteria series, suggesting its superior ability in matching a patient's original tooth color. Both OMNICHROMA and the Asteria series showed lower Delta E_{00} values in the cervical area than the crown area, and OMNICHROMA also had lower Delta L* values in cervical region cavities, suggesting its profound color adaptability for cervical area cavities.

ΔL^*	OMNICHROMA	Asteria
Cervical	0.30 ± 0.21^{Aa}	0.61 ± 0.33^{Bb}
Crown	1.04 ± 0.84^{Cc}	1.51 ± 0.82^{cd}

Table 4

ΔC^*	OMNICHROMA	Asteria
Cervical	1.72 ± 1.04^{Aa}	1.96 ± 0.98^{Ab}
Crown	0.84 ± 0.72^{Ba}	1.66 ± 1.37^{Bb}

Table 5

ΔE^*_{00}	OMNICHROMA	Asteria
Cervical	0.57 ± 0.35^{Aa}	1.13 ± 0.43^{Bb}
Crown	1.15 ± 0.62^{Cc}	1.69 ± 0.57^{cd}

Table 6

Δh^*	OMNICHROMA	Asteria
Cervical	0.60 ± 0.60^{Aa}	0.91 ± 0.73^{Ab}
Crown	0.91 ± 0.51^{Ba}	1.30 ± 0.76^{Bb}

Table 7

(n=10, mean±SD)

Different superscript capital letters indicate statistical differences in that row ($p<0.05$) (Only valid within the same table)
Different superscript lowercase letters indicate statistical differences in that column ($p<0.05$)

6. Clinical Evaluations

Twenty-five doctors completed a total of 841 restorative cases. Each doctor provided ratings for OMNICHROMA based on polishability, stability under ambient light, and handling. For the ranking of polishability, 60% rated OMNICHROMA as excellent, 32% rated good, and 8% did not respond. For the ranking of stability under ambient light, 44% rated OMNICHROMA as excellent, 48% rated good, and 8% did not respond. For the ranking of handling, 52% rated OMNICHROMA as excellent, 44% good, and 4% average. The data is shown in Table 8 below, with almost all of the doctors providing a response of excellent or good for these features of OMNICHROMA.

	Polishability	Stability Under Ambient Light	Handling
Excellent	60%	44%	52%
Good	32%	48%	44%
Average	0%	0%	4%
Fair	0%	0%	0%
Poor	0%	0%	0%
No Response	8%	8%	0%

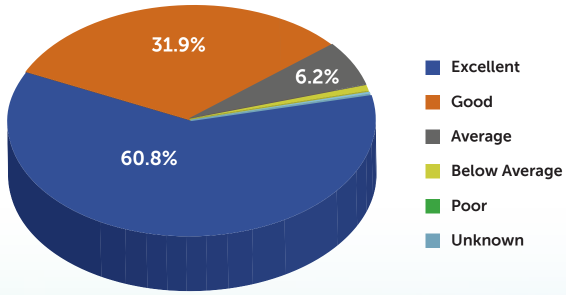
Table 8 Ratings of polishability, stability under ambient light, and handling

On the evaluation of color matching among 841 cases, consisting of all 16 VITA classical shades and a variety of all classes, the doctors rated 60.8% of the color match as excellent, 31.9% good, 6.2% average, 0.8% below average, 0.0% poor, and 0.4% unknown. The results are shown in Table 9 and Figure 40 below. Almost all of the doctors provided ratings of excellent or good for OMNICHROMA's color-matching ability.

Excellent	511	60.8%
Good	268	31.9%
Average	52	6.2%
Below Ave	7	0.8%
Poor	0	0.0%
Unknown	3	0.4%
Total	841	

Percentages rounded to nearest tenth of a percent

Table 9 Color matching ratings



Percentages rounded to nearest tenth of a percent

Fig. 40 Color matching ratings pie chart

The evaluated cases consisted of each VITA classical shade from A1 to D4. Of the 781 cases (60 of which the shades were not measured and are therefore unknown), 82.3% of the teeth shades were in the range of A1 to A5. 8.3% were in the range of B1 to B4, 6.4% in the range of C1 to C5, and 2.9% in the range of D2 to D4.

Shade	n	%		
A1	121	15.5%	643	82.3%
A1.5	15	1.9%		
A2	263	33.7%		
A2.5	20	2.6%		
A3	131	16.8%		
A3.5	58	7.4%		
A4	33	4.2%		
A5	2	0.3%		
B1	52	6.7%	65	8.3%
B2	2	0.3%		
B3	8	1.0%		
B4	3	0.4%		
C1	7	0.9%	50	6.4%
C2	13	1.7%		
C3	11	1.4%		
C4	16	2.0%		
C5	3	0.4%		
D2	15	1.9%	23	2.9%
D3	7	0.9%		
D4	1	0.1%		
Total	781			

Percentages rounded to nearest tenth of a percent

Table 10 Distribution of cases by shade

The evaluated cases consisted of a variety of each restoration class. Of the 841 cases, the restorative class types of the teeth are shown in the table below.

	Total	
	n	%
Class I	182	21.6%
Class II	259	30.8%
Class III Small	45	5.4%
Class III Large	39	4.6%
Class IV Small	58	6.9%
Class IV Large	62	7.4%
Class V	130	15.5%
Root Caries	11	1.3%
Non-Carious Cervial Lesion	19	2.3%
Tooth Wear	11	1.3%
Diastema	7	0.8%
Direct Venner	14	1.7%
PFM	1	0.1%
Unknown	3	0.4%
	841	

Total class III and IV cases: 204 (24.3%)

Percentages rounded to nearest tenth of a percent

Table 11 Distribution of cases by restoration class

7. Summary

OMNICHROMA is an innovative resin composite utilizing a single shade system that inherits and improves upon the features of TOKUYAMA's spherical fillers. OMNICHROMA's Smart Chromatic Technology is the first of its kind to take advantage of structural color technology in composite dentistry. Through the culmination of more than 35 years of research and development by TOKUYAMA, this technology allows OMNICHROMA to match the 16 VITA classical shades with just one shade of composite, simplifying the restorative procedure and reducing the potential waste of unused composite in the process.

8. References

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9. Trademarks

The following brands and materials are not registered trademarks of TOKUYAMA:

Format: Brand; Abbreviations/Alternate Names (Company/Manufacturer)

Harmonize (Kerr)

TPH Spectra ST (Dentsply)

TPH Spectra LV (Dentsply)

TPH Spectra (Dentsply)

Filtek Supreme Ultra (3M ESPE)

Filtek Supreme XTE (3M ESPE)

Filtek Supreme (3M ESPE)

Esthet•X HD (Dentsply Sirona)

Tetric EvoCeram (Ivoclar Vivadent)

Premise (Kerr)

Herculite Ultra (Kerr)

Herculite XRV Ultra (Kerr)

Venus Diamond (Kulzer)

Venus Pearl (Kulzer)

Grandio SO (VOCO)

Amaris (VOCO)

Enamel Plus HRi (Micerium S.p.A)

Enamel Plus HFO (Micerium S.p.A)

Miris^2 (Coltene)

Renamel Microfill (Cosmedent)

RC500 (PaPaLab Co., Ltd)

Sof-Lex (3M ESPE)

VITA Classical A1-D4; VITA 16 Shades; VITA (VITA North America)

Crystaleye Spectrophotometer (Olympus Corporation)