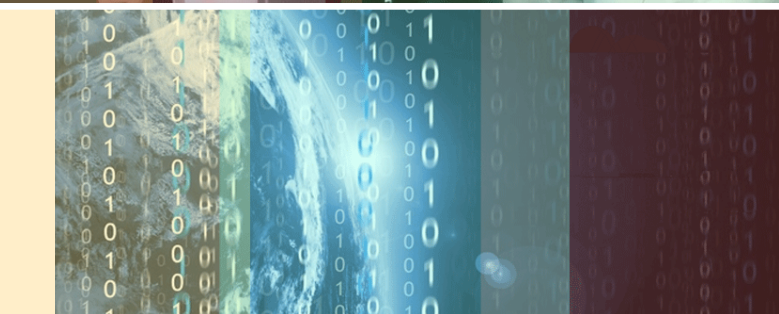




Estelite Asteria



Tokuyama Dental Italy | Technical Report



ESTELITE ASTERIA - TECHNICAL REPORT



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1 INTRODUCTION

Tokuyama Dental has developed various light-curing dental restorative composite resins that take advantage of its proprietary Supra-nano Spherical filler technology. Represented by Palfique Estelite® Paste, Estelite® Σ, and Palfique Estelite® LV, these products have acquired a reputation for outstanding aesthetics and gloss.

In 2005, Tokuyama Dental launched Estelite Flow Quick®, a new flowable composite resin, based on a new catalyst technology (RAP technology™) and a proprietary filler technology. This approach results in remarkably fast curing compared to conventional flowable resins (requiring approximately $\frac{1}{3}$ the time). Due to RAP technology™, Estelite Flow Quick® features high conversion and leading levels of filler content (71 wt%) among flowable composite resins. It offers outstanding scientific and engineering properties not found with conventional flowable composite resins.

The RAP technology™ used in Estelite Flow Quick® was applied to universal composite resins. Estelite Σ Quick®, released in 2007 and Estelite Omega®, released in 2011. Estelite Σ Quick® and Estelite Omega® provide outstanding esthetics and high polymerization activity based on Supra-nano Spherical filler technology and RAP technology.

Estelite® Asteria universal composite which applied these original technologies is focused on simplified layering restorative therapy and outstanding esthetic results.

The subsequent sections describe the technical background, features, and properties of Estelite® Asteria.

2 MATERIALS

2.1 COMPONENTS

- Bis-GMA, Bis-MPEPP, TEGDMA, UDMA
- Supra-nano Spherical filler (200nm spherical SiO₂-ZrO₂)
- Composite Filler (include 200nm spherical SiO₂-ZrO₂)
- Filler loading: 82 wt% (71 vol%)

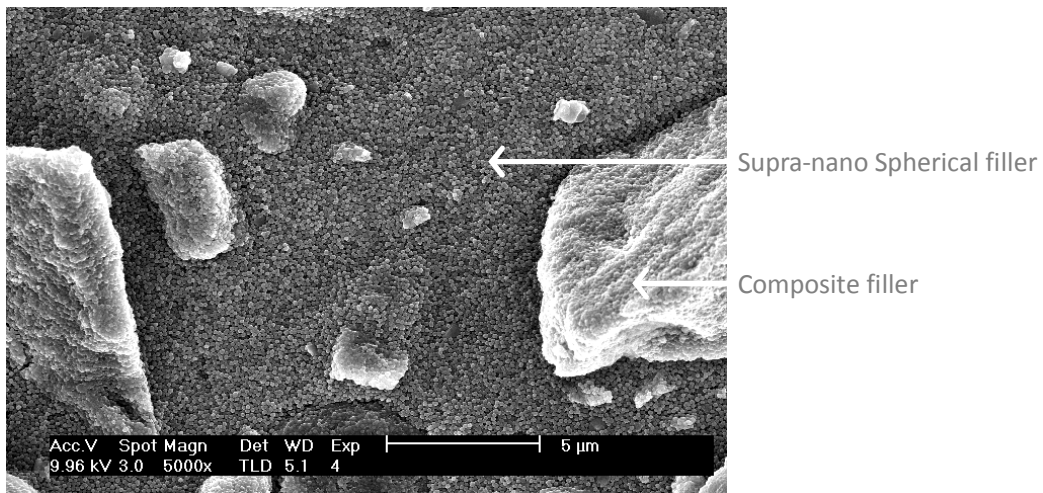


FIGURE 1 Estelite Asteria (5.000 x)

2.2 INDICATIONS

- Direct anterior and posterior restorations including occlusal surfaces
- Direct bonded composite veneer
- Diastema closure
- Repair of porcelain/composite

2.3 SHADES

Estelite® Asteria introduces a new simplified 2-step layering concept. This comprehensive system is comprised of minimal shades; just 7 Body shades and 5 Enamel shades cover the entire dental shade range. Esthetic result is obtained with simple 2-layering concept of Estelite® Asteria, because the Body shades replicate chroma and hue and Enamel shades replicate value.

The Body shades have excellent blending ability with less width of margin bevel thanks to their state-of-the-art optical properties. The Body shades provide some translucency with sufficient opacity to avoid shining through without the use of opaque or dentin shades. Therefore, an invisible margin is achieved by covering a margin with Body shades (except the incisal area) *Figure 6*. A1-A4 Body shades blend with most natural dentition. BL is designed for high value bleached teeth and B3B for yellowish teeth. *Figure 5*

The Enamel shades have compatible translucency as a substitute for natural enamel. The primary use of the NE shade is for anterior teeth and the OcE is for the posterior occlusal area. *Figures 6-7* The 3 supplemental Enamel shades (substitutes for NE) may be used for the following applications: TE is for high translucent anterior teeth, WE is for whitish enamel and YE is for discolored or orangish enamel. *Figures 5-8*.

Layering concept and shading system of Estelite® Asteria are designed by Dr. Noboru Takahashi.

- BODY Shades:

A1B
A2B
A3B
A3.5B
A4B
B3B
BL

- ENAMEL Shades:

NE
YE
TE
WE
OcE

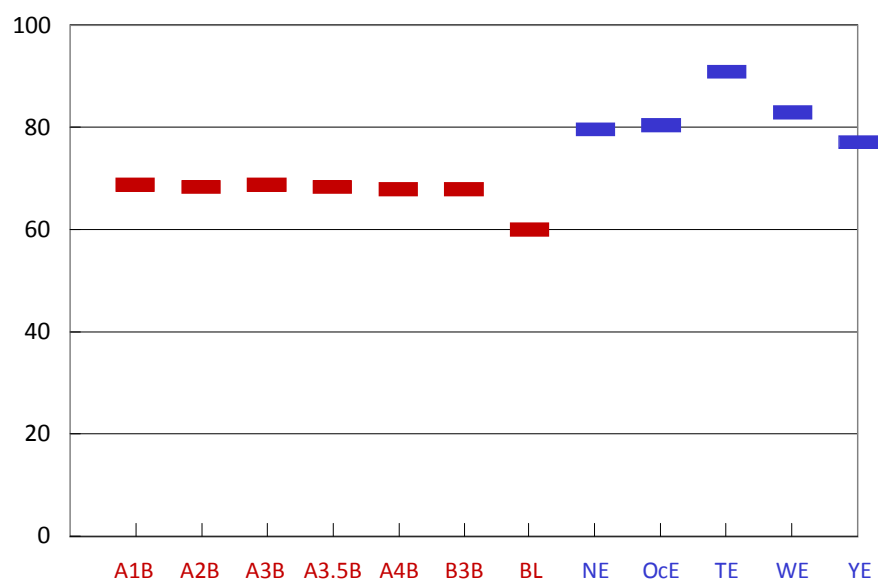


FIGURE 2 Total transmittance

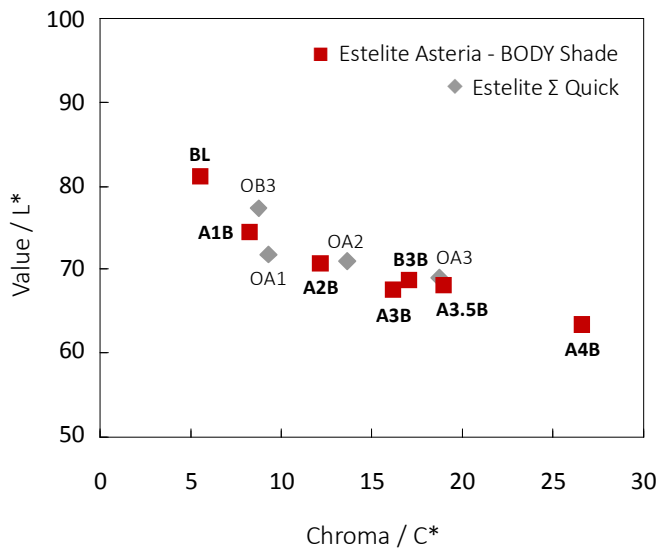


FIGURE 3 Correlation between Value and Chroma (Body Shade)

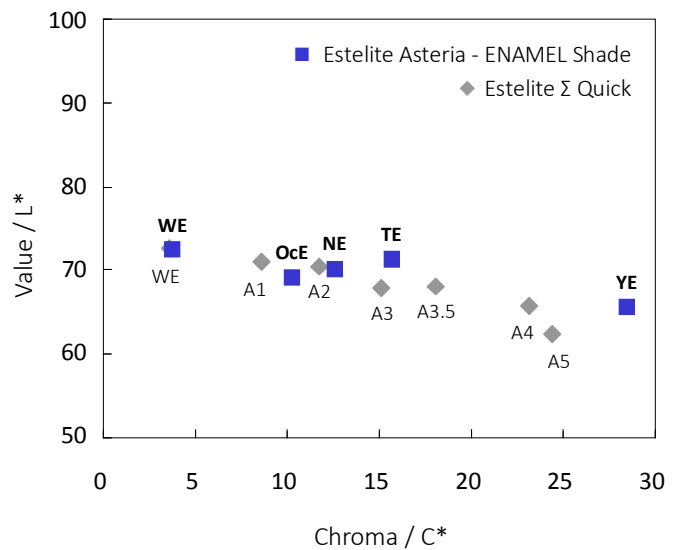


FIGURE 4 Correlation between Value and Chroma (Enamel Shade)

	SHADE	TIP
BODY	A1B - A2B - A3B - A3.5B - A4B - B3B - BL (Bleach)	BODY Shades are designed for reconstructing the dentin layer. The Body shades should cover all enamel margins except the incisal area
	NE (Natural Enamel)	NE is recommended to restore translucency in the incisal area in most cases
	WE (White Enamel)	WE is recommended for the proximal wall. WE is suggested as an alternative to NE in whiter cases
ENAMEL	YE (Yellow Enamel)	YE is designed to mimic discolored enamel
	TE (Trans Enamel)	TE is the most translucent in this system. This shade is suggested as an alternative to NE in highly translucent cases
	OcE (Occlusal Enamel)	OcE is recommended for the occlusal surface. OcE has exceptional sculptability to shape occlusal cusps and fissures

FIGURE 5 Shade structure

FIGURE 6 Class IV restoration

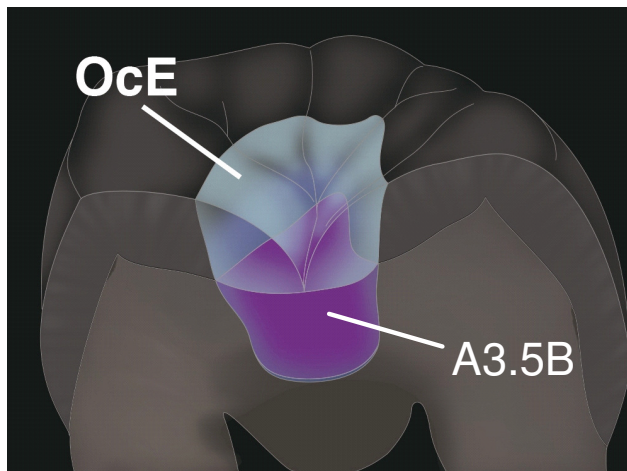
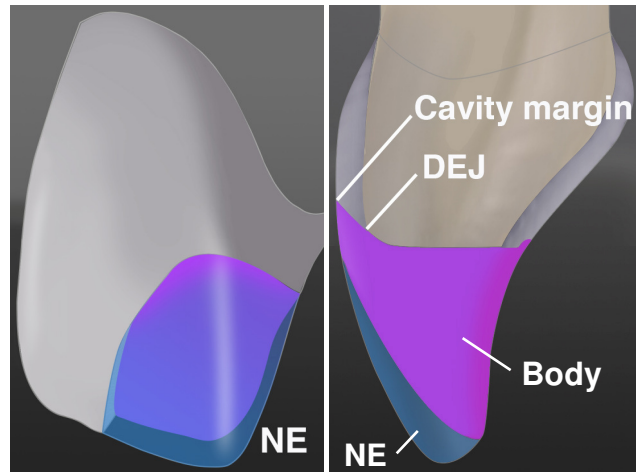


FIGURE 7 Class I restoration (3D layering)

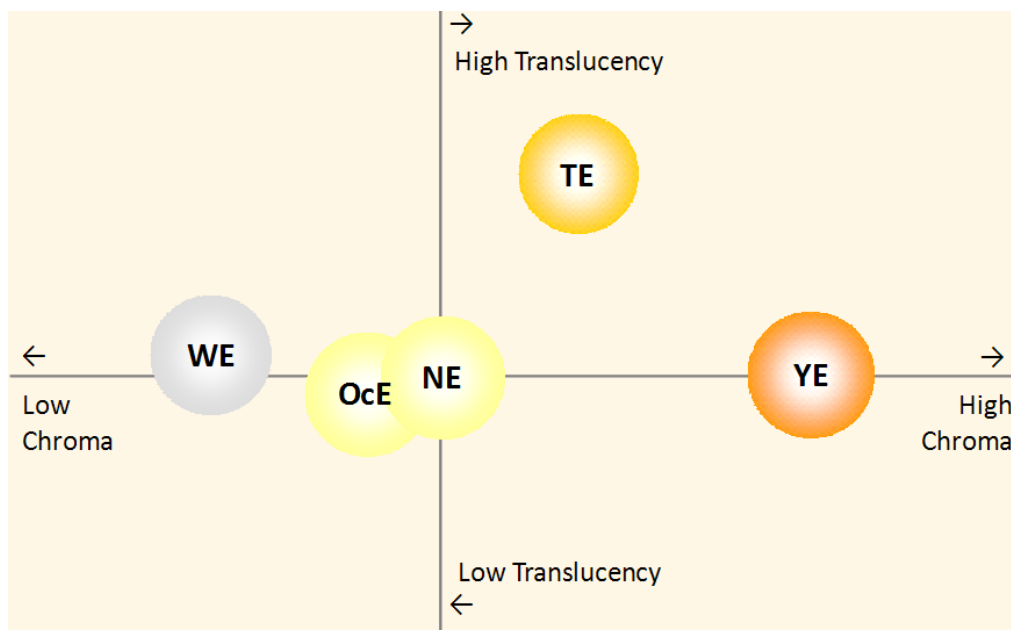


FIGURE 8 Color and translucency map of the Enamel shades

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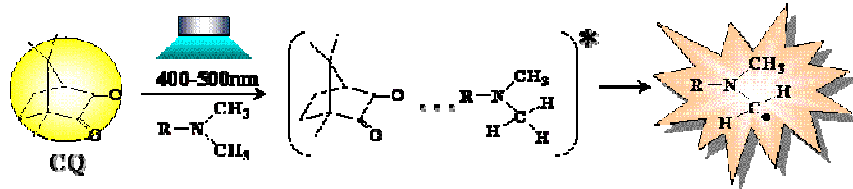
BACKGROUND TECHNOLOGY

3.1 RADICAL AMPLIFIED PHOTOPOLYMERIZATION INITIATOR

3.1.1 MECHANISM

The catalyst technology adopted for Estelite® Asteria is the Radical Amplified Photopolymerization initiator (RAP technology™) used in Estelite Σ Quick®. As a major feature, the initiator balances the high polymerization activity needed to cure the resin with short exposure times ($\frac{1}{3}$ of that required by conventional products) and stability in ambient lighting. These two traits are often regarded as mutually conflicting, since shorter curing times tend to reduce stability. However, this unique catalyst technology achieves a balance of these two factors. *Figure 9* shows a schematic diagram of RAP technology™.

Conventional Photo-Initiator



RAP Technology

Radical Amplified Photopolymerization Initiator System

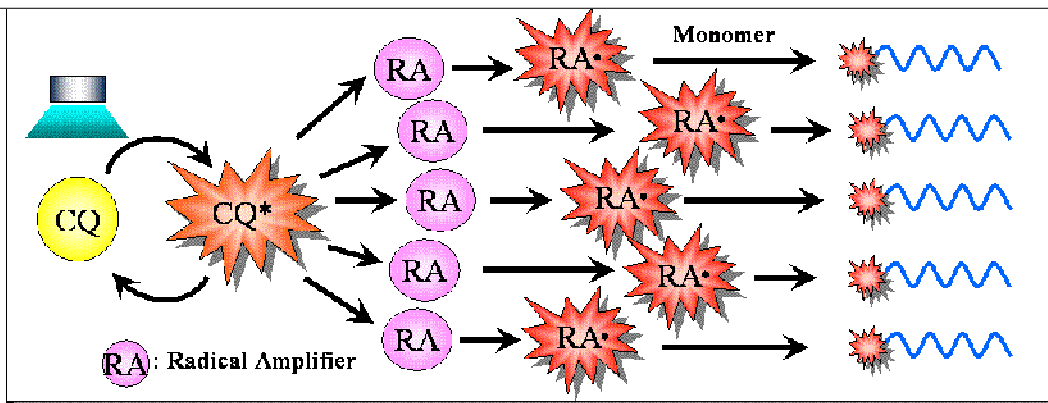


FIGURE 9 Radical amplified polymerization initiator system

Conventional photo-polymerization initiators consist of camphorquinone (hereafter abbreviated CQ) and amines. The mechanism of action involves the excitation of CQ by irradiation, followed by the abstraction of hydrogen in the alpha-position by the excited CQ, producing amine-derived radicals. The amine-derived radicals function as the polymerization initiator and react with monomers to generate polymers, ultimately producing the curing effect. In this catalyst system, CQ is consumed as it changes to CQ-H in polymerization initiator generation. Unlike CQ, CQ-H is not excited by light. This means a single molecule of CQ can only produce a single polymerization initiator molecule.

With the radical amplified photo-polymerization initiator, the initial stage of CQ excitation by light is the same as in conventional systems. However, energy is transferred to the radical amplifier (hereafter abbreviated RA); the RA is subsequently excited, and then allowed to decompose to produce RA-derived radicals. These radicals act as the polymerization initiator and react with monomers to generate polymers, producing the curing effect. After transferring energy to RA, the excited CQ returns to the ground state and is once again excited by irradiation and contributes to the reaction for polymerization initiator species generation. In other words, with RAP technology™, CQ is recycled within the polymerization initiator generation reaction, and a single CQ molecule can produce multiple initiator radicals. Thus, in addition to being highly active, RAP initiators can be used with smaller CQ volumes than conventional catalysts and improve stability in ambient lighting, including dental and fluorescent lights. The present initiator system is also free of chemical reactions between two molecule species, such as hydrogen abstraction in conventional systems, allowing shorter times from the photo-excitation of CQ to initiator radical generation.

To confirm that RAP technology™ increases polymerization rates, we compared the amount of residual monomers after a light cure for two different composite resins: Estelite Flow Quick®, which contains a radical amplified photopolymerization initiator, and flowable composite, which contains a conventional photopolymerization initiator composed of CQ and amines. *Figures 10-11* shows the results. *Figure 10* indicates that the radical amplified photopolymerization initiator significantly reduces residual monomers compared to the conventional CQ-amine photopolymerization initiator for both 10-second and 30-second exposures. This holds true even when comparing Estelite Flow Quick® after 10-seconds of exposure to conventional flowable composite after 30-seconds of exposure.

These results support the mechanism of action shown in *Figure 9*.

RAP technology facilitates a control of polymerization rate. Polymerization rate is slow and material is stable under small light intensity (ambient light such as a dental light), however, polymerization rate becomes quick under large light intensity (light irradiation unit). *Figure 12*

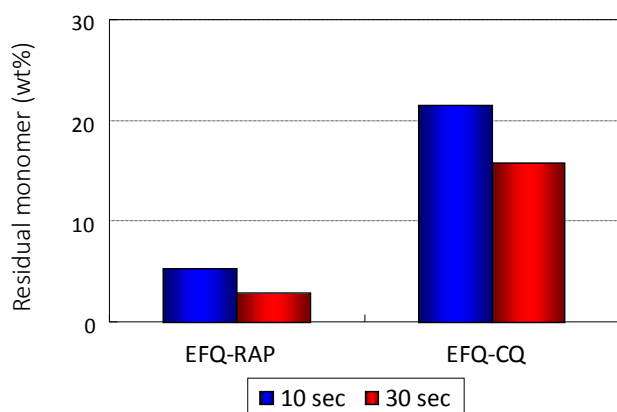


FIGURE 10 Residual monomer (wt %)

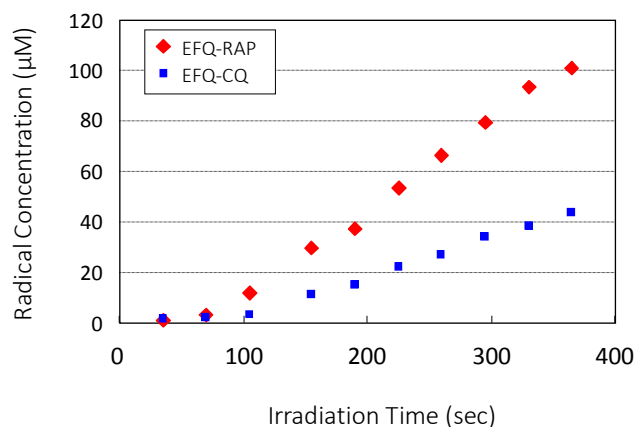


FIGURE 11 Change of radical concentration

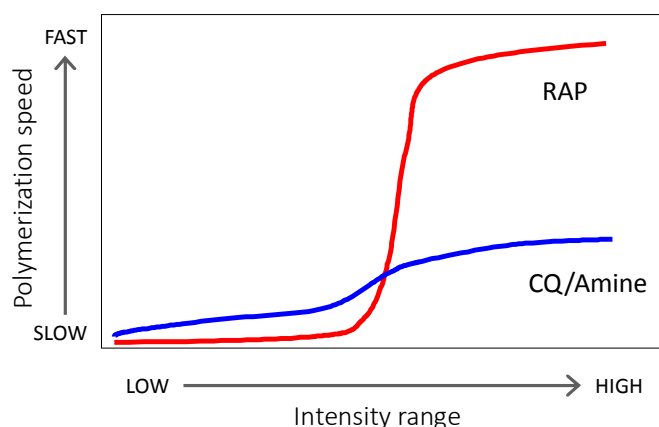


FIGURE 12 Correlation between intensity range and polymerization rate

3.1.2 STABILITY IN AMBIENT LIGHT

In the past, high polymerization activity with short exposures could only be achieved by increasing the amount of photopolymerization initiator used. However, increasing the amount of the catalyst decreases the stability of the resin in ambient light. Additionally, the viscosity of the paste may increase during the filling step in clinical services, making the resin impossible to sculpt and requiring a second filling attempt. In addition, increasing the amount of catalyst can also exacerbate changes in color before and after polymerization. While increasing the amount of photopolymerization initiator is believed to result in various undesirable effects, RAP technology™ can provide both polymerization activity and stability in ambient light, as described in detail in 3.1.1.

Figure 13 compares stability under ambient light (10,000 lx of dental light) between Estelite® Asteria and other commercially available composite resin.

As shown in Figure 13, Estelite® Asteria offers stability in ambient light equivalent to products from other manufacturers, with working times slightly longer than average. This gives clinicians more time to perform filling and other steps.

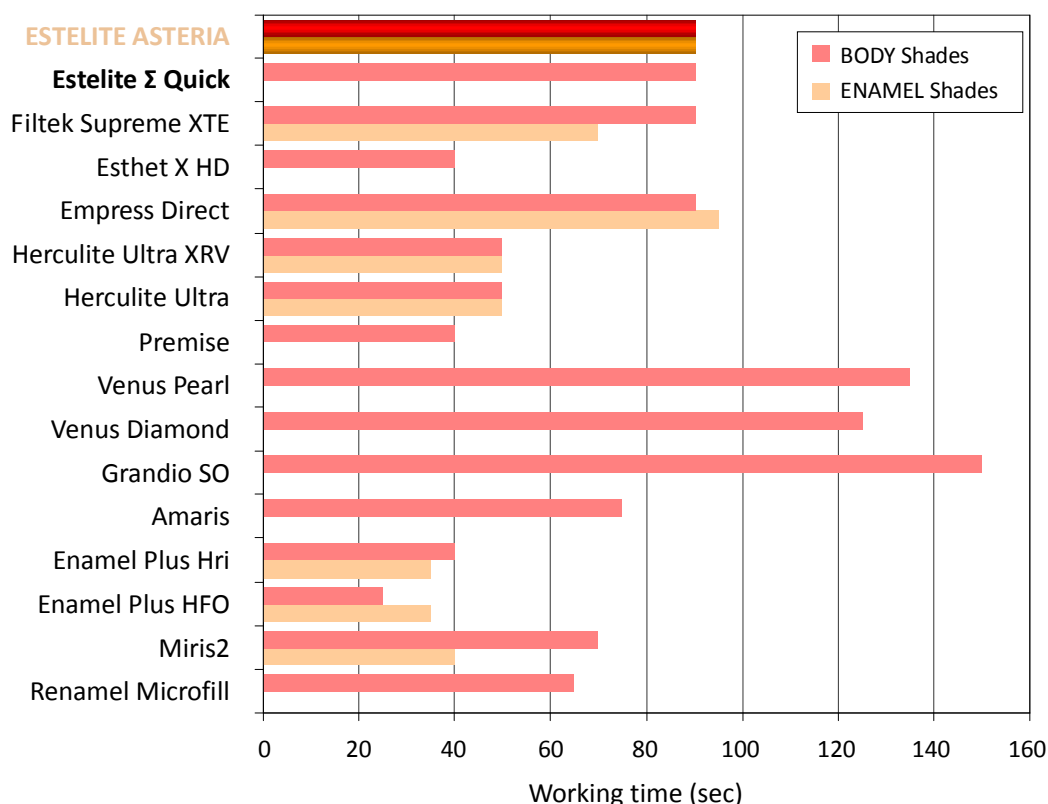


FIGURE 13 Insensitivity to light (10,000lux/dental light)

3.2 SUPRA-NANO SPHERICAL FILLER TECHNOLOGY

Tokuyama Dental synthesizes monodispersing Supra-nano Spherical fillers by a special technique called the sol-gel method. Unlike the conventional filler manufacturing method, which involves crushing glass materials, fillers with the present method are produced by creating filler cores in organic solvent and allowing the filler to grow gradually from the cores. This method makes it possible to produce uniform, spherical fillers. Figure 14

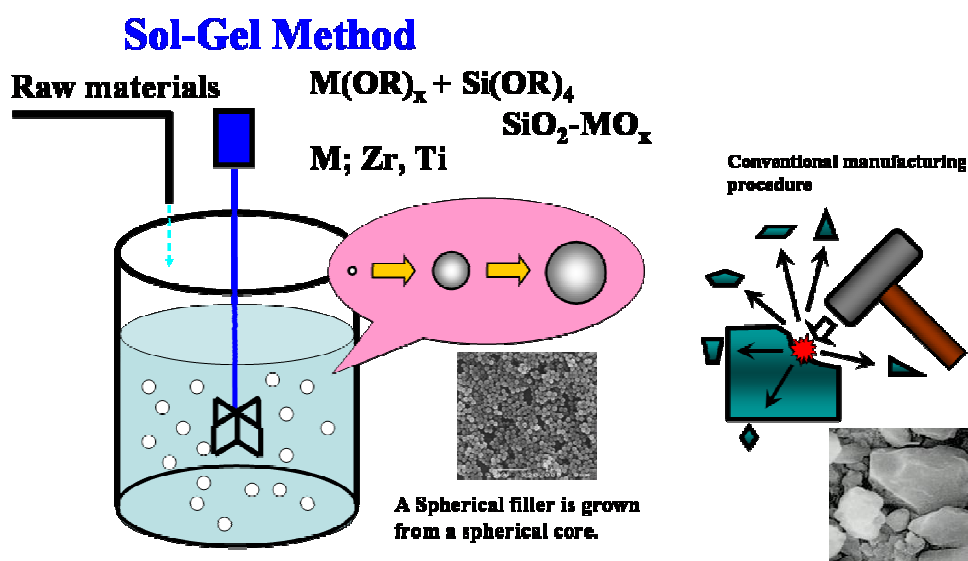


FIGURE 14 Summary of sol-gel method

A major feature of the sol-gel method is that it allows the filler size to be controlled by adjusting 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, leading to problems such as increased polymerization shrinkage and poor physical characteristics such as reduced flexural strength.

Figure 15 gives the correlation between filler particle size and filler content and compressive strength.

Figure 16 gives the correlation between filler particle size and surface roughness and hardness.

From *Figure 15*, we see that filler content begins to fall significantly below 100 nm, but is nearly constant at sizes above that. In addition, we observe maximum compressive strength at particles size ranging from 100 to 500 nm.

From *Figure 16*, we see that surface roughness decreases with particle sizes down to approx. 500 nm but remains constant at sizes below that. Surface hardness attains the highest value at particle sizes ranging from 100 to 500 nm. Based on the above results, we conclude that the best balance between esthetics and physical characteristics can be achieved by using supra-nano sized particles.¹⁾

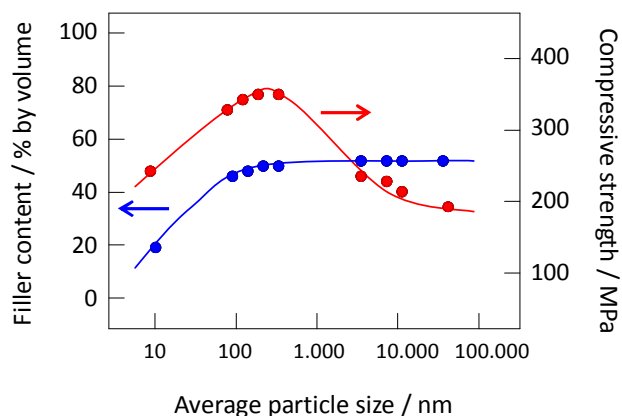


FIGURE 15 Correlation between particle size, filler content and compressive strength

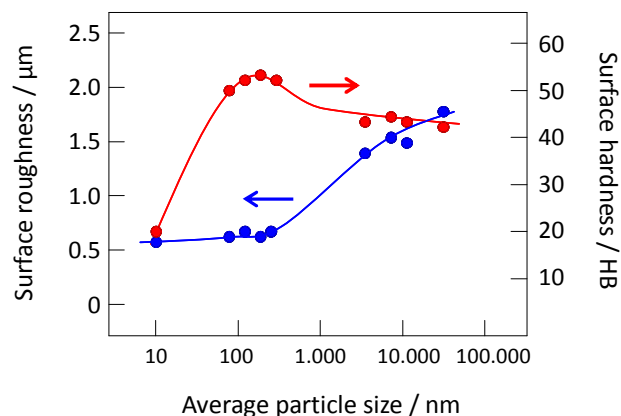


FIGURE 16 Correlation between particle size, surface roughness and surface hardness

For Estelite® Asteria, we use monodispersing spherical fillers made of silica-zirconia produced by the sol-gel method, with particle sizes of 200 nm. *Figure 17*

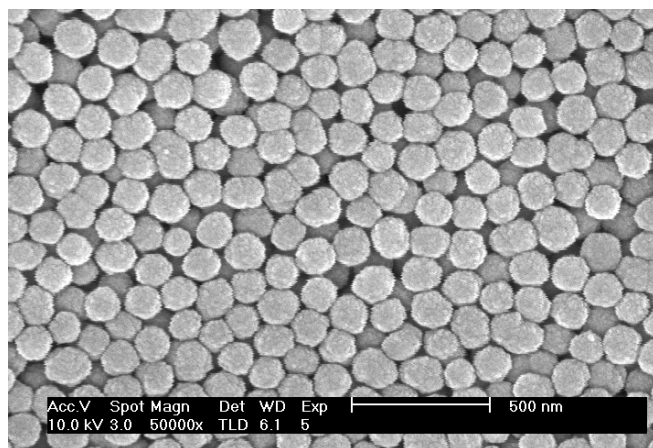


FIGURE 17 Supra-nano Spherical filler in Estelite® Asteria

Another major feature 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. Composite resins tend to show a strong relationship between the filler refractive index and that of the matrix organic resin. 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 is

filler close to the intermediate value of the refractive indices of the monomer and the polymer. *Figure 18*

refractive indices.

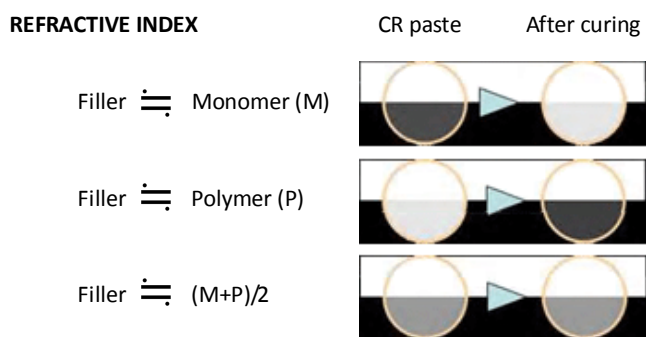
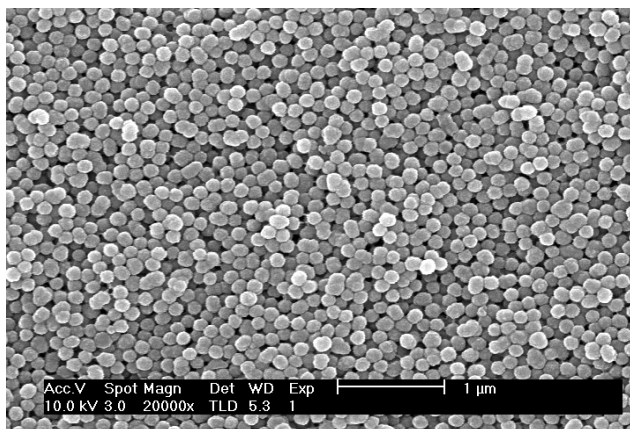
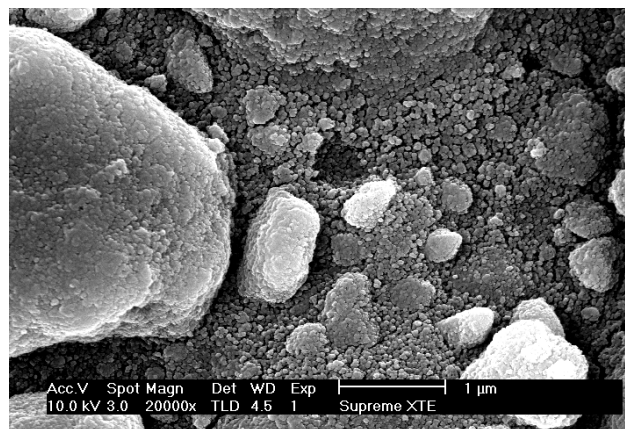


FIGURE 18 Refractive index

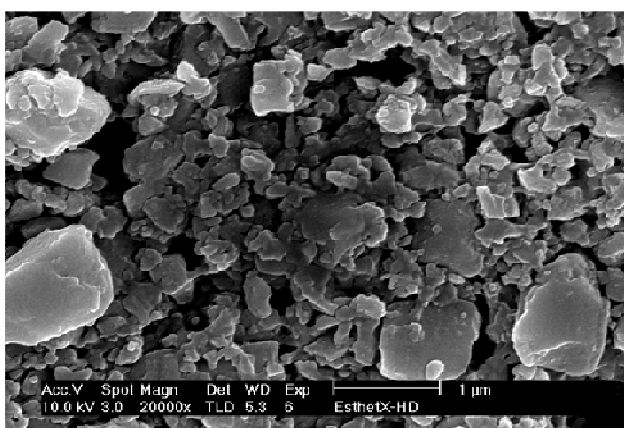
from other manufacturers.



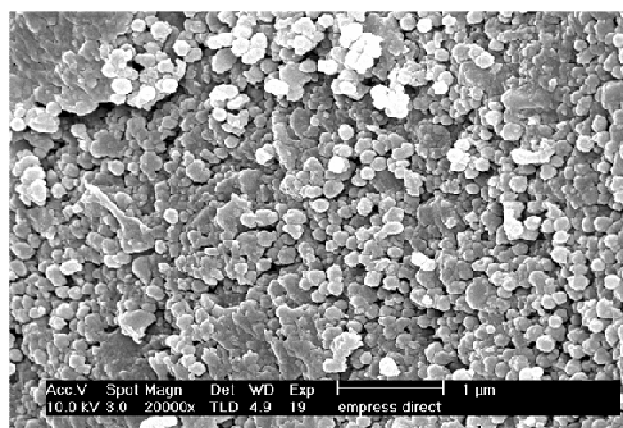
ESTELITE ASTERIA



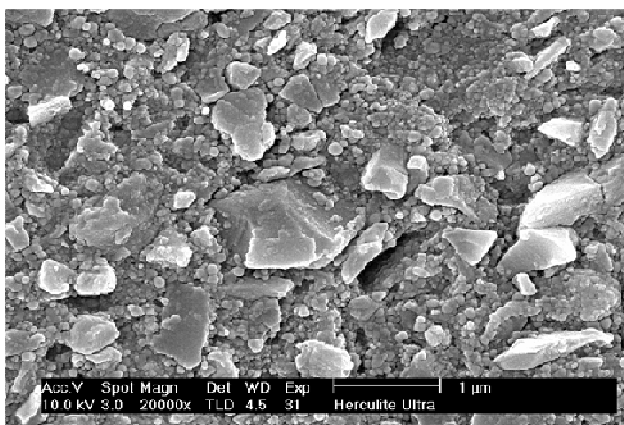
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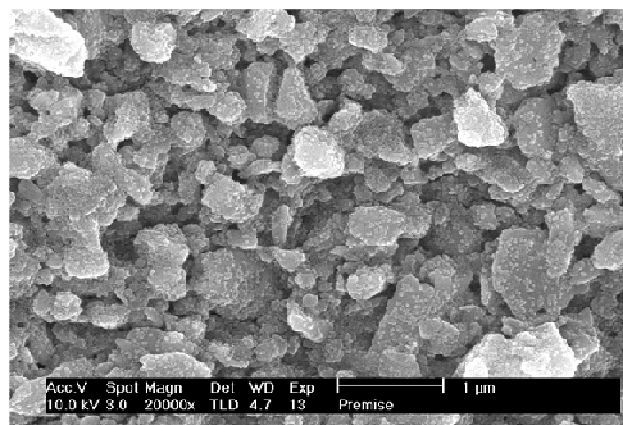
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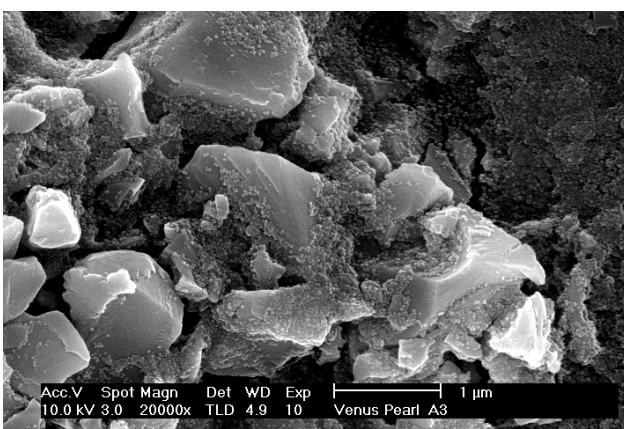
Empress Direct



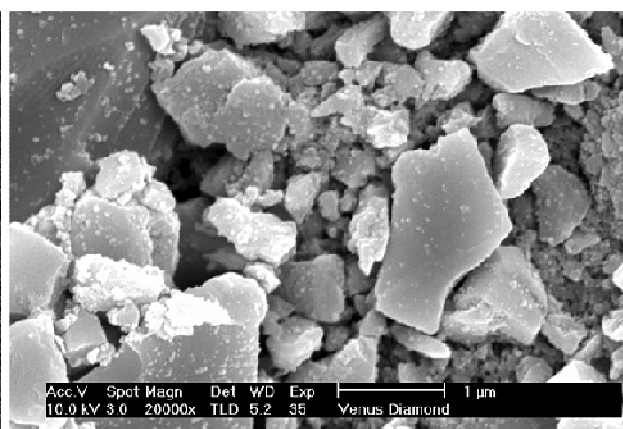
Herculite Ultra



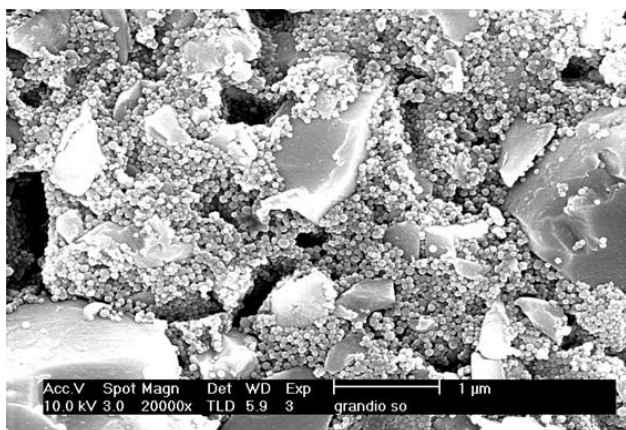
Premise



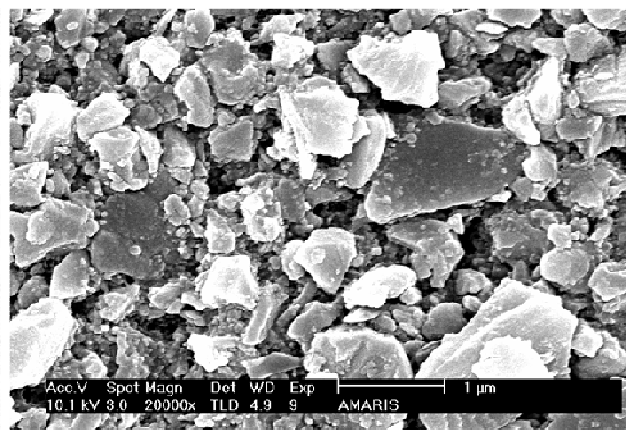
Venus Pearl



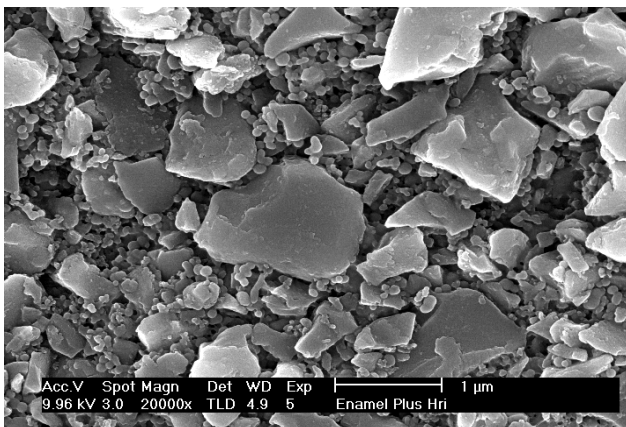
Venus Diamond



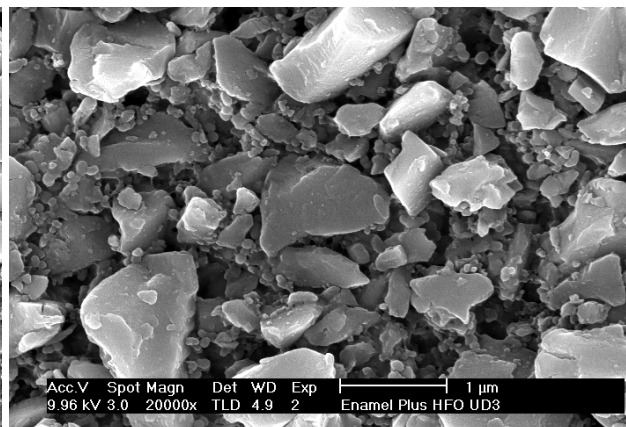
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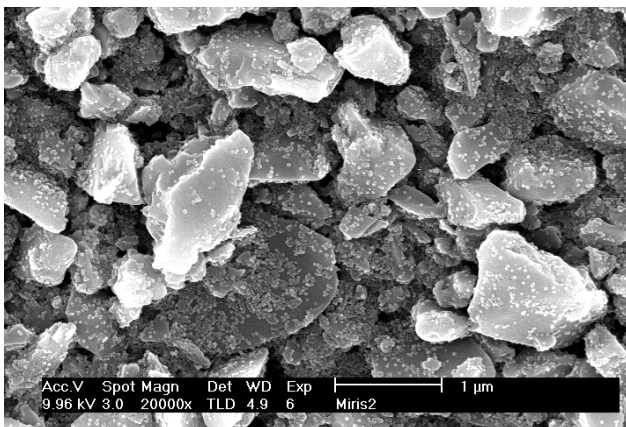
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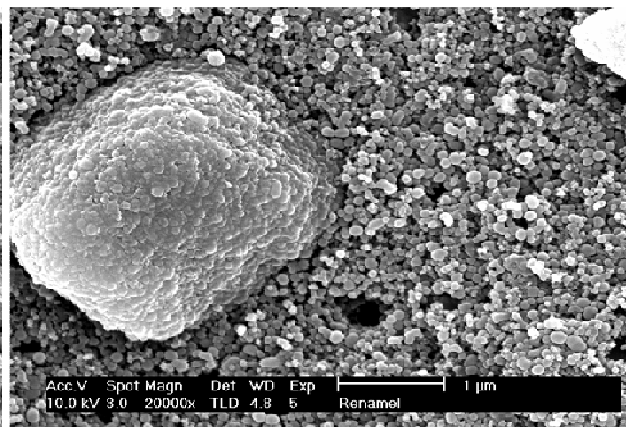
Enamel Plus Hri



Enamel Plus HFO



Miris2



Renamel Microfill

4 MATERIAL PROPERTIES

4.1 POLYMERIZATION SHRINKAGE

We measured polymerization shrinkage by our original method. *Figure 19* is a schematic diagram of the measurement method. This method can measure shrinkage in the cavity floor (interface between the composite resin and plunger in *Figure 19*) when the composite resin is placed into a cavity and exposed to light in a clinical procedure. This permits evaluation of shrinkage under conditions closer to those encountered in actual clinical settings.

Figure 20 shows the polymerization shrinkage of Estelite® Asteria and other commercially available composite resins. The graph indicates shrinkage 3 minutes after the start of light exposure.

The polymerization shrinkage of Estelite® Asteria is 1,3%, or the same as for Estelite Σ Quick®. This is the minimum level among commercially-available composite resins. This result is due to the high filler volume content made possible by the combination of Supra-nano Spherical filler and composite filler.

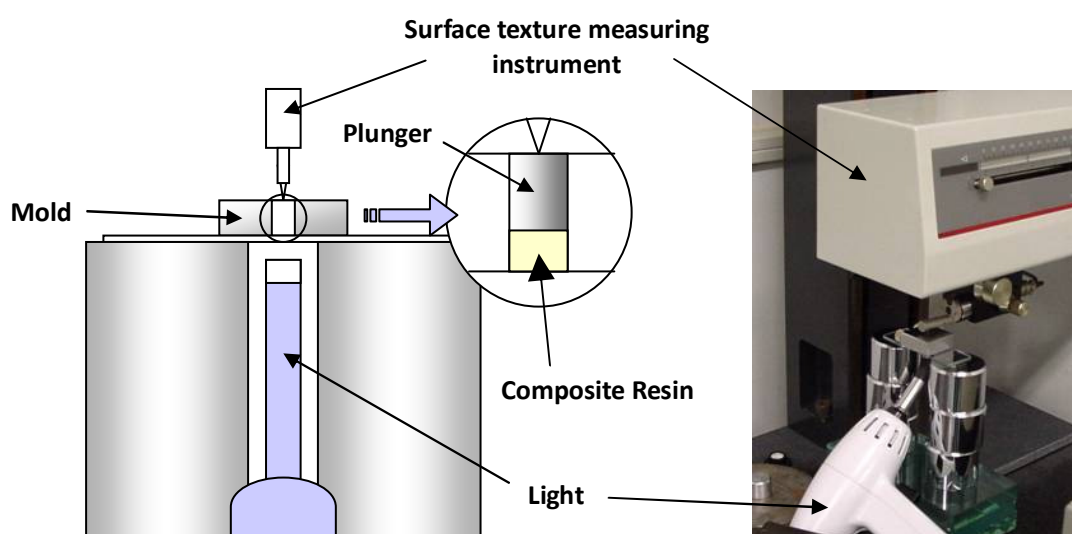


FIGURE 19 Method of polymerization shrinkage

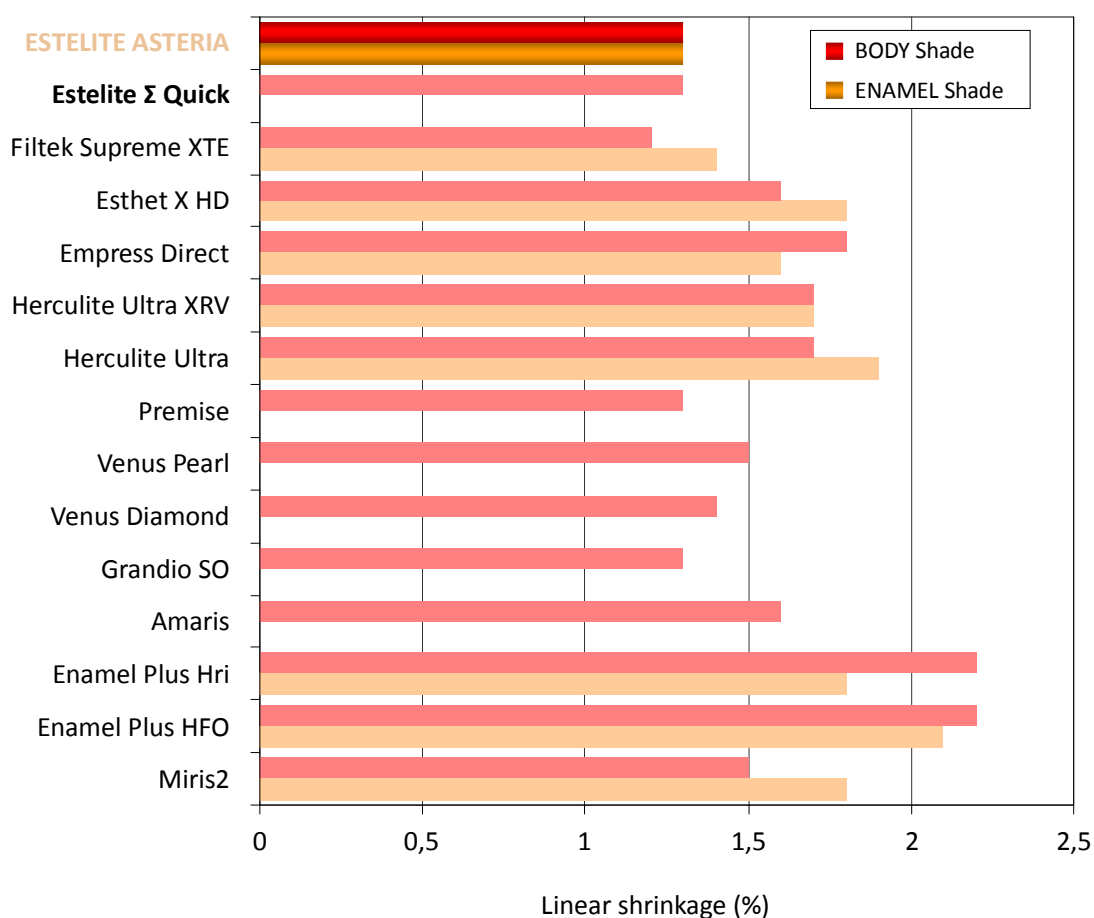


FIGURE 20 Polymerization shrinkage (linear %)

4.2 WEAR PROPERTIES

We examined the wear characteristics of composite resins in terms of wear resistance of the resin and the human tooth by the method shown in *Figure 21*.

Figure 22 gives the results. Estelite® Asteria demonstrated a good balance between volume loss of CR and wear on human teeth. As with Estelite Σ Quick®, Estelite® Asteria itself resists wear without causing unusual wear in opposing teeth.

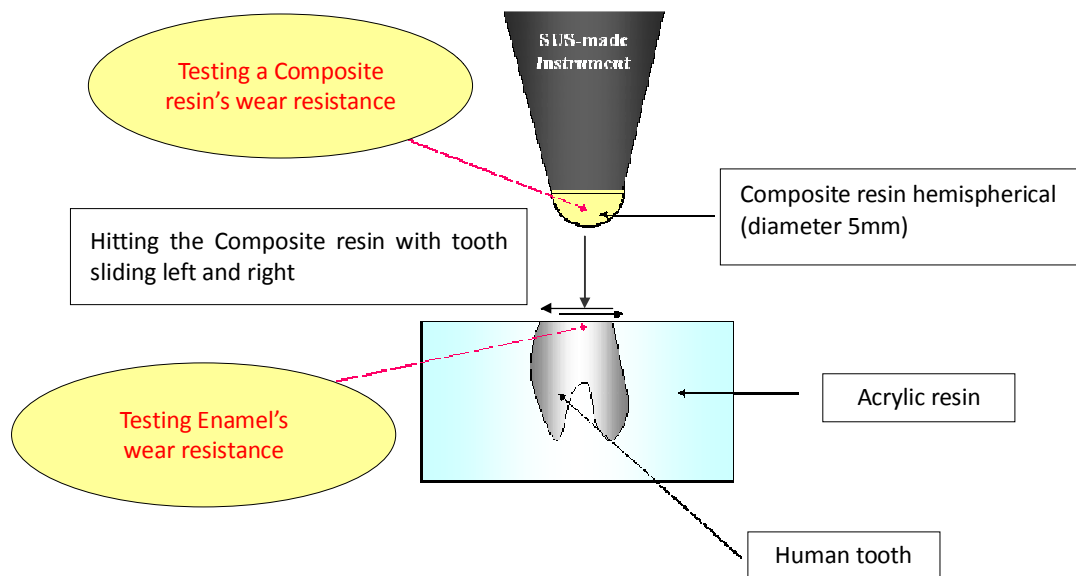


FIGURE 21 Method of wear resistance

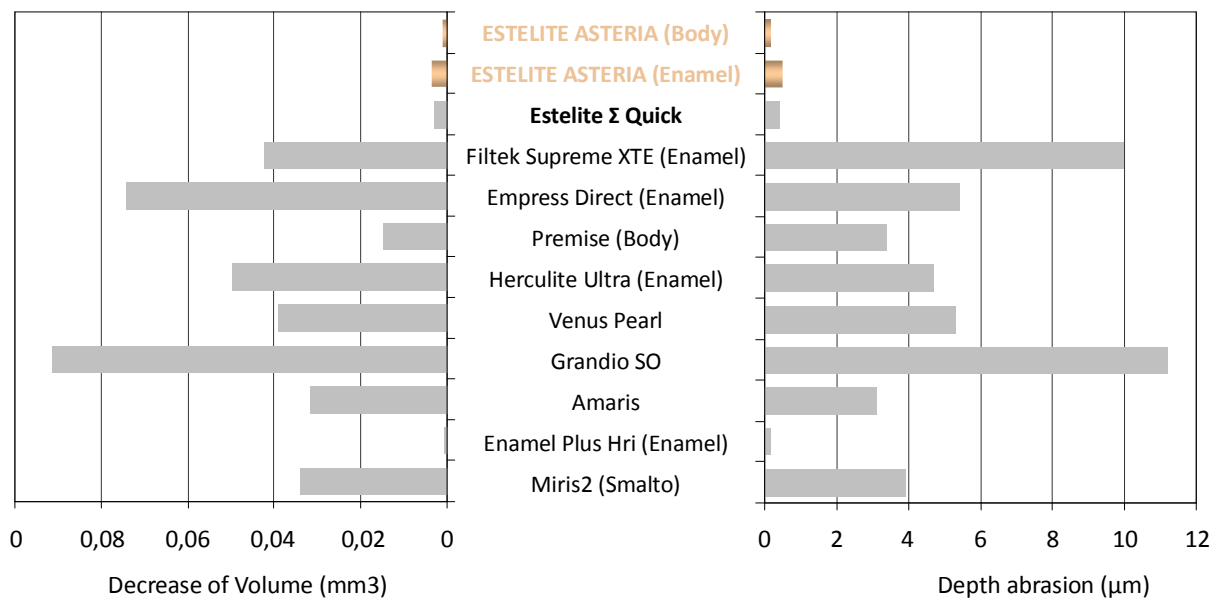


FIGURE 22 Wear resistance (50,000 cycle)

4.3 FLEXURAL STRENGTH AND COMPRESSIVE STRENGTH

Figure 23 presents the flexural strength and Figure 24 presents the compressive strength of Estelite® Asteria and other commercially available composite resins.

The flexural strength and the compressive strength of Estelite® Asteria are ranked as average among commercially available composite resins.

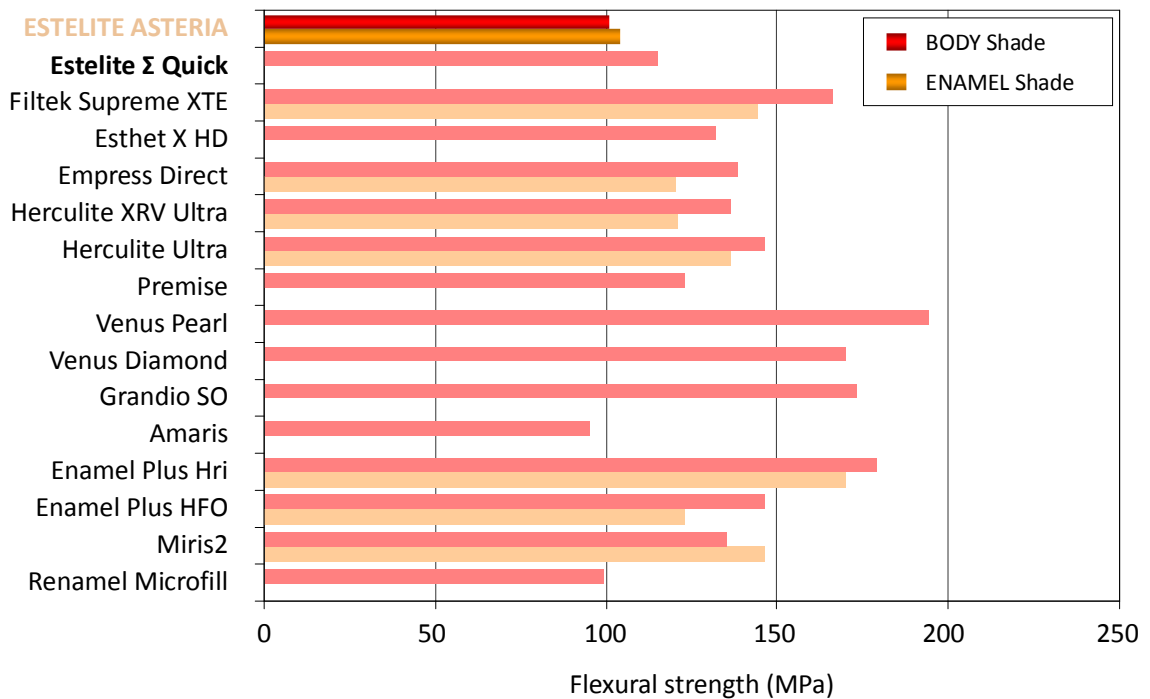


FIGURE 23 Flexural strength

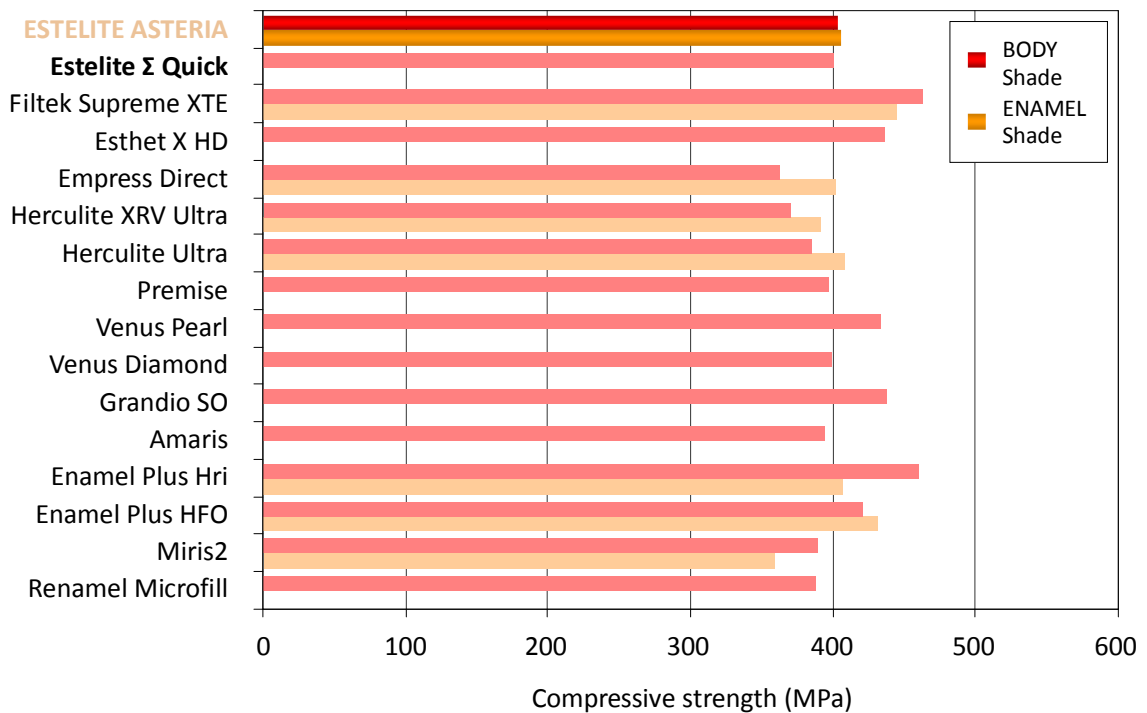


FIGURE 24 Compressive strength

4.4 SURFACE GLOSSINESS

Figure 25 shows surface gloss after the surface of cured CR is polished with waterproof abrasive paper (#1.500) followed by Soflex super fine (for 60 seconds under running water). Figure 26 shows the relationship between polishing time and surface gloss. The results show that like Estelite Σ Quick®, Estelite® Asteria produces extremely high gloss in short polishing sessions.

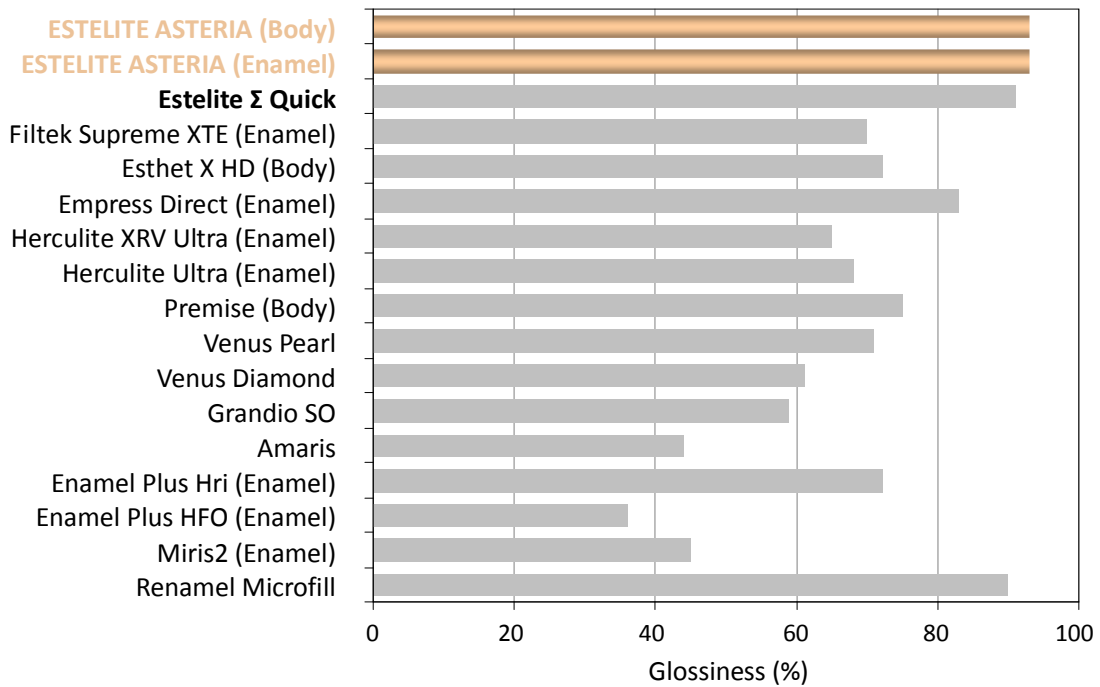


FIGURE 25 Surface glossiness

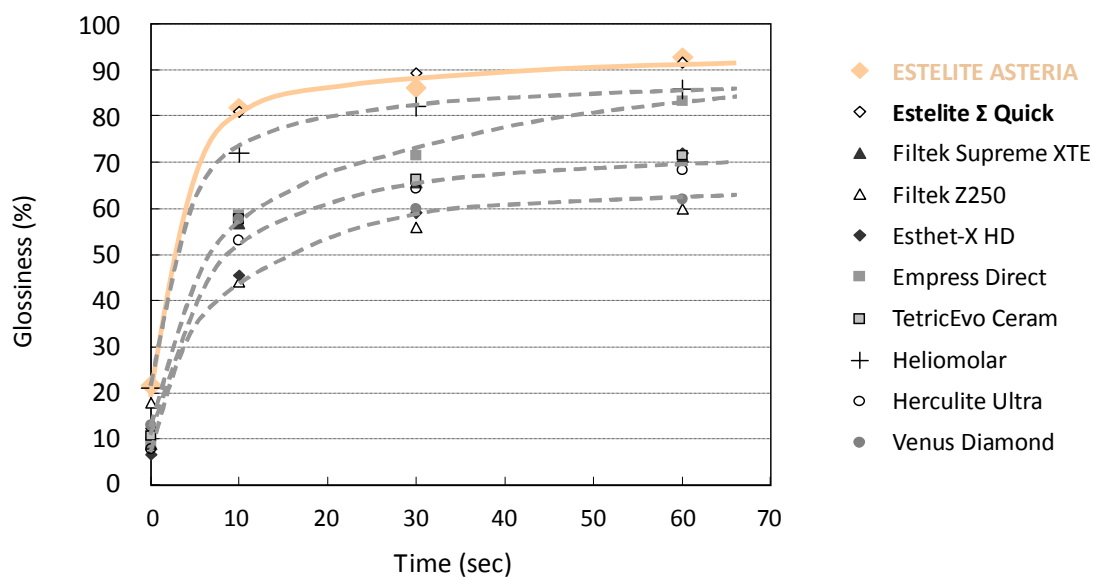


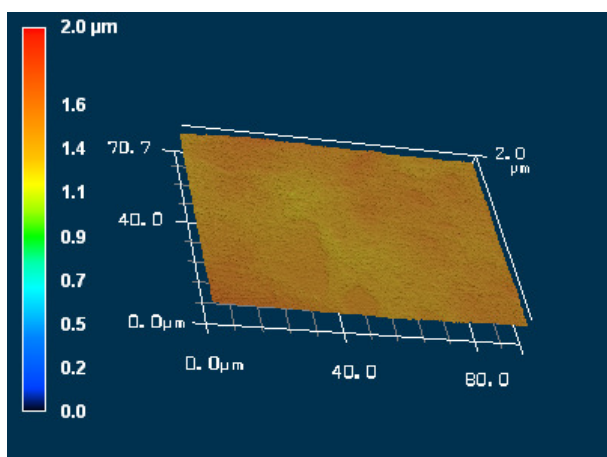
FIGURE 26 Relationship of glossiness and polishing time (Soflex superfine)

4.5 GLOSS RETENTION

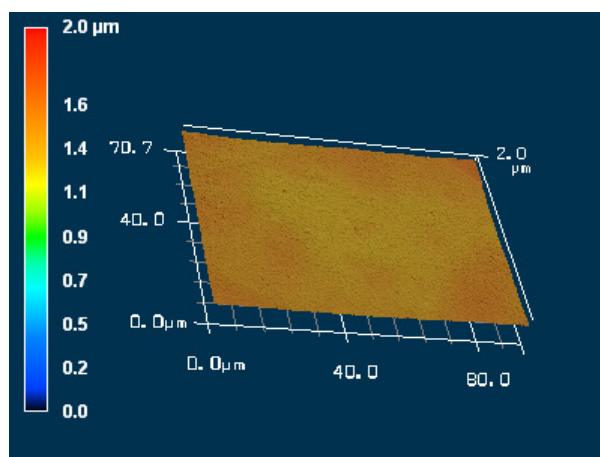
In addition to exhibiting extremely high gloss with relatively short polishing, Estelite® Asteria features a remarkably persistent gloss.

These figures show 3D-images of the surface of cured resin after 10,000 times thermal cycle test (4°C - 60°C).

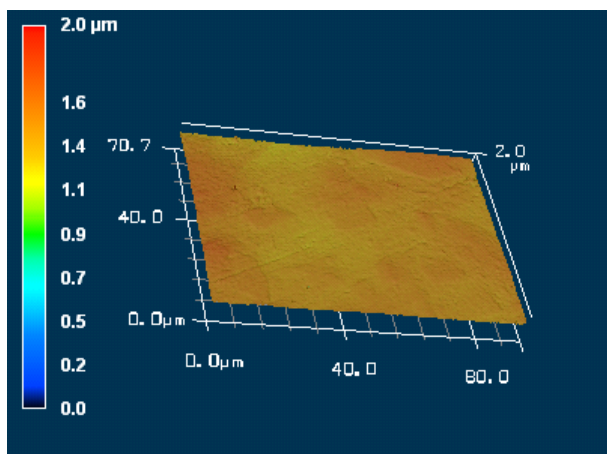
These pictures show that Estelite® Asteria keeps its surface smoothness, resulting in glossiness over time (self-shining effect).



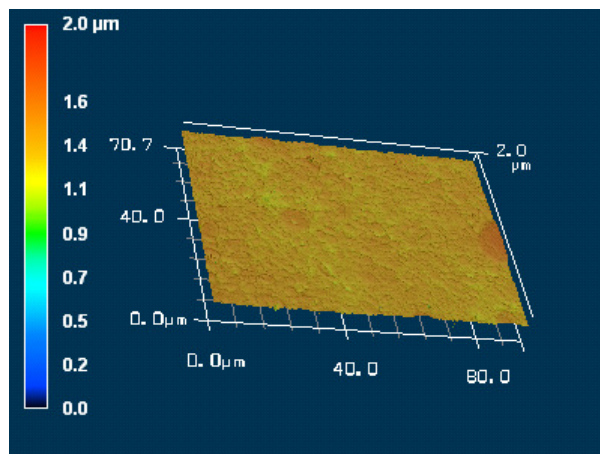
ESTELITE ASTERIA (Body)



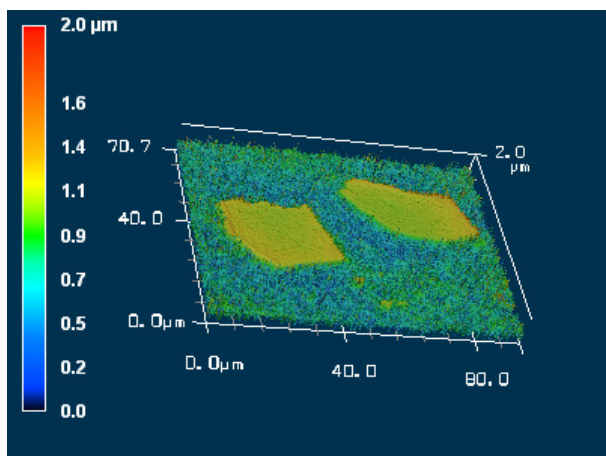
ESTELITE ASTERIA (Enamel)



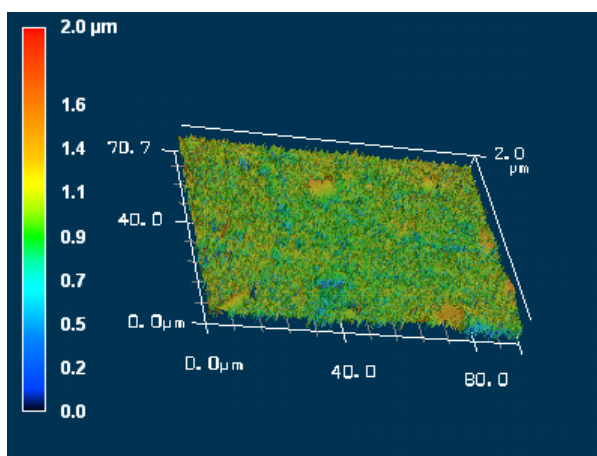
ESTELITE Σ QUICK



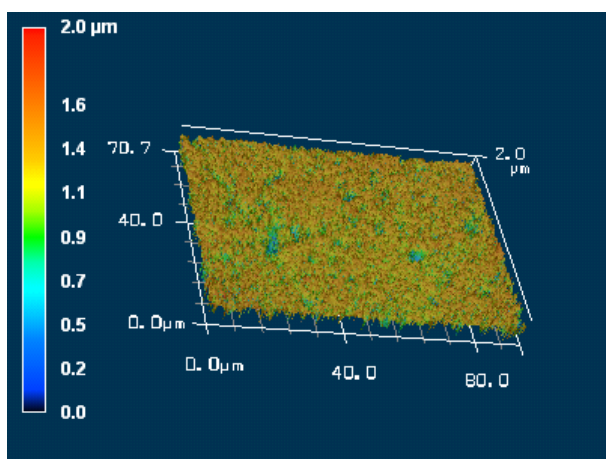
Filtek Supreme XTE



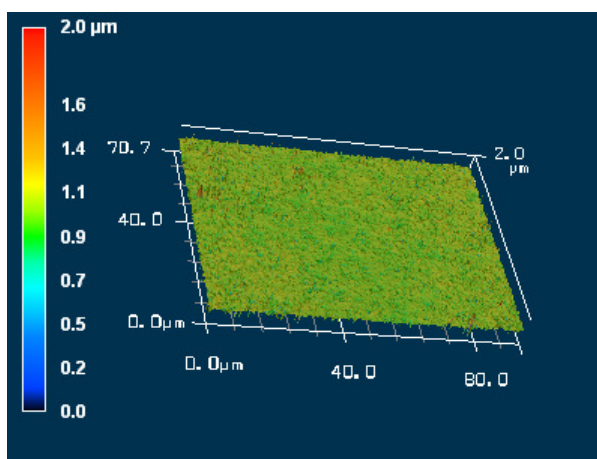
Venus Pearl



Venus Diamond



Grandio SO



Enamel Plus Hri

4.6 CHANGES IN COLOR AND TRANSLUCENCY BEFORE AND AFTER POLYMERIZATION

With respect to the shade matching of a composite resin, a resin associated with significant color changes before and after polymerization can present significant restoration issues for color matching, since the actual tooth and the resin cannot be assessed before polymerization. If the color of the composite resin fails to match the color of the tooth substance, the filling must be removed and refilled, a labor-intensive procedure. Estelite® Asteria features relatively low changes in color and translucency before and after polymerization, permitting rough color matching before polymerization.

Figures 27-28-29 show the changes in color and translucency for Estelite® Asteria and other commercially available composite resins. As indicated in the figures, Estelite® Asteria offers low change in both color and translucency, making shade-matching for Estelite® Asteria especially easy. Estelite® Asteria can reduce failures caused by colors that diverge significantly after curing.

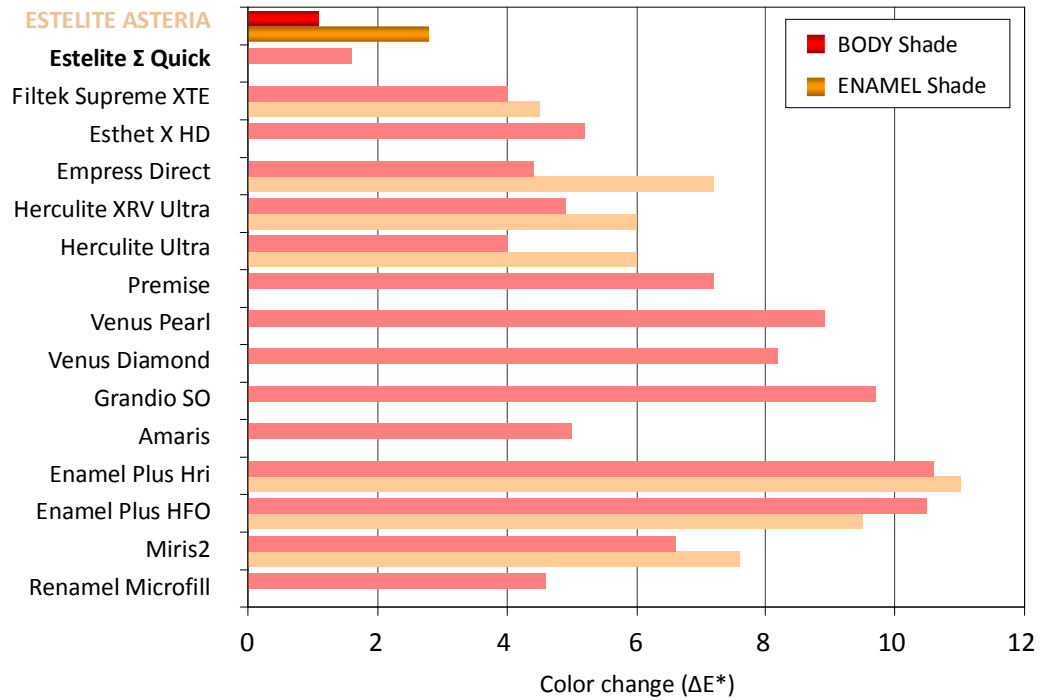


FIGURE 27 Variation of color tone before and after polymerization

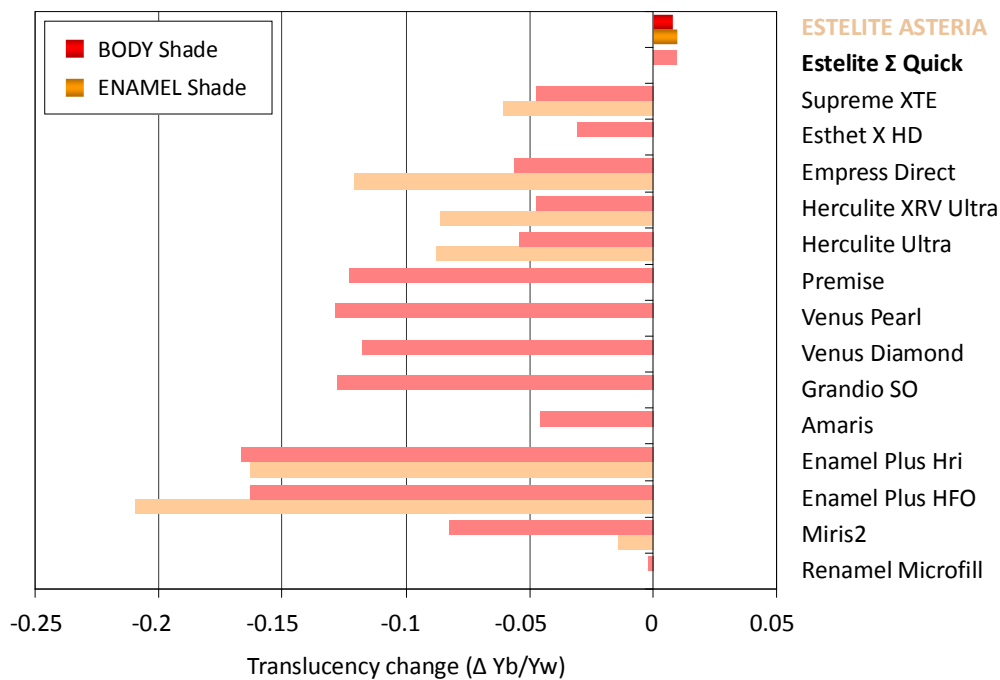


FIGURE 28 Variation of translucency before and after polymerization

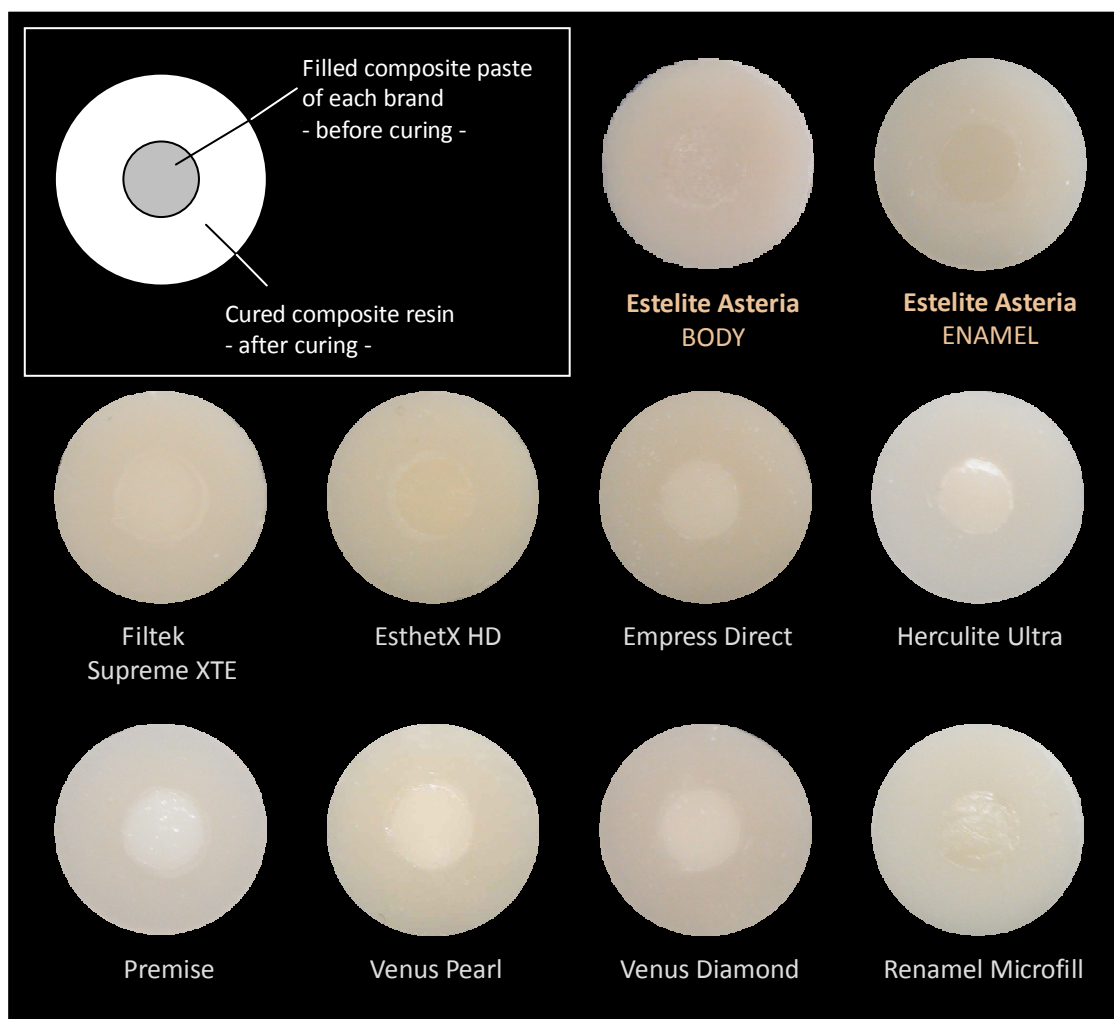


FIGURE 29 The images of color change before and after polymerization

4.7 STAINING BY COFFEE

A composite resin used in the oral cavity degrades over time due to exposure to various food and drink substances. If this change is pronounced relative to actual teeth, the effect is noticeable and unsightly. Here, we examined potential staining by coffee (24 hours soaking at 80 degrees Celsius). *Figure 30* shows the results.

The extent of staining for Estelite® Asteria after soaking in coffee was relatively low among commercially available composite resins. We believe Estelite® Asteria will retain its color at the time of restoration over a long term.

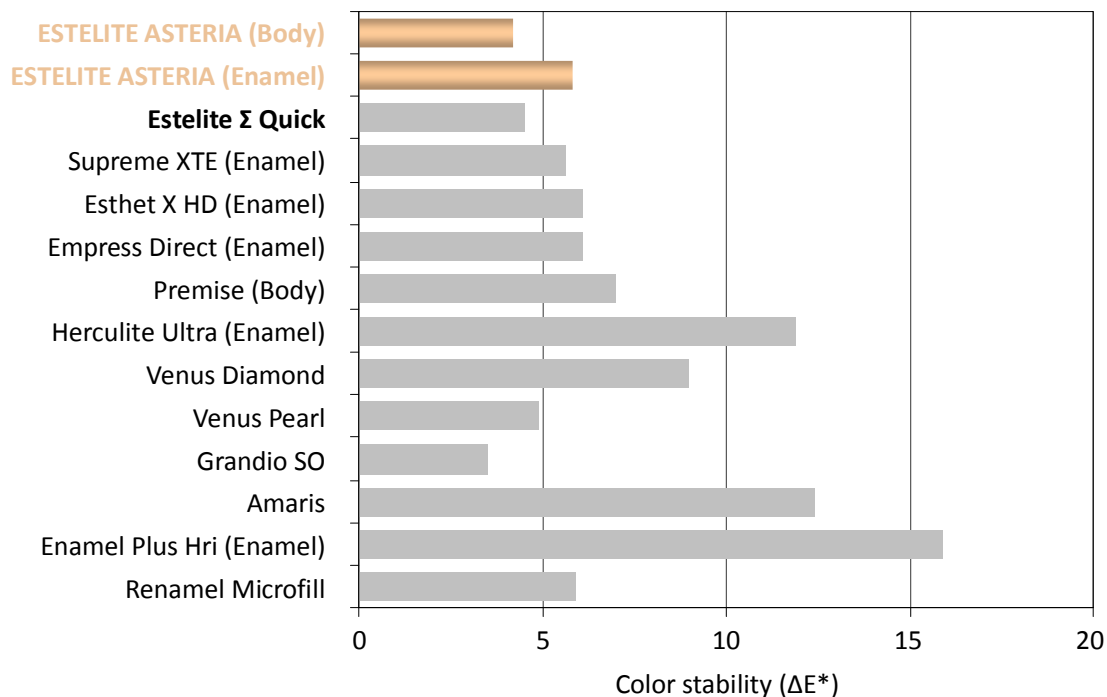


FIGURE 30 Color stability

4.8 RADIOPACITY

Radiopacity is determined by the composition of the inorganic filler and its filler content. The radiopacity of a resin is higher if the composition of the resin includes larger amount of elements with high atomic numbers at higher filler content. However, a filler containing large amounts of elements with high atomic numbers is associated with large refractive indices and significant changes in color and translucency before and after polymerization.

As indicated in paragraph 3.2, the inorganic filler used in Estelite® Asteria is designed to minimize changes in color and translucency from before to after polymerization and to maximize radiopacity under this constraint.

Figure 31 shows the radiopacity of commercially-available composite resins.

The radiopacity of Estelite® Asteria is ranked as average among commercially available composite resins, and it meets the levels required to observe prognoses.

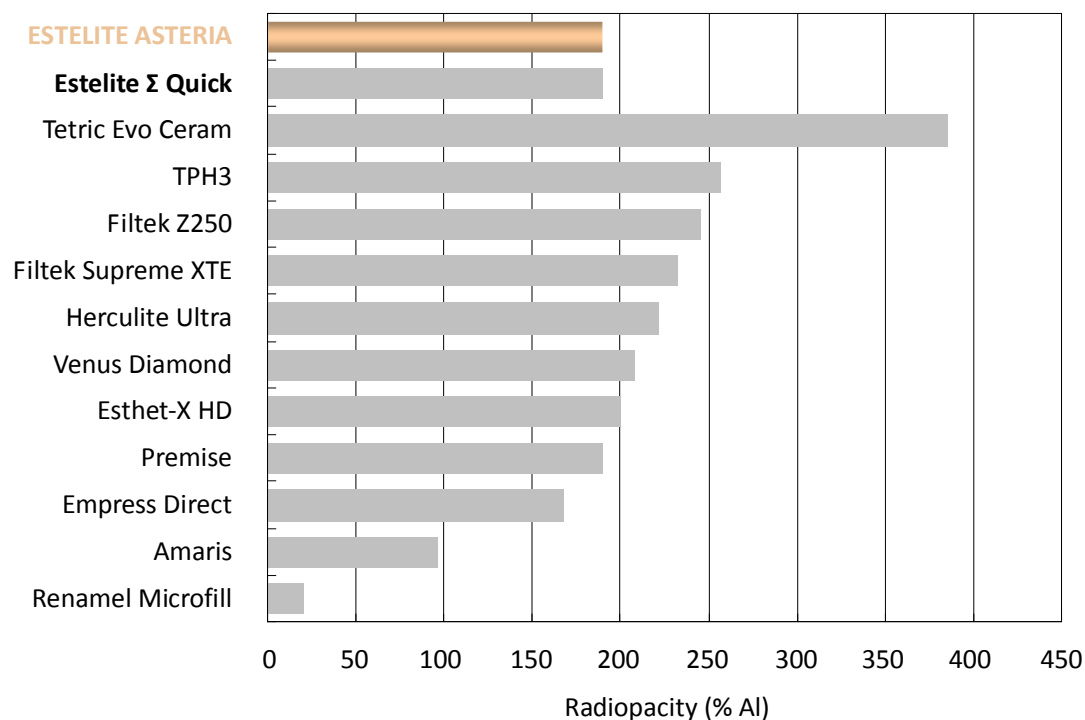


FIGURE 31 Radiopacity

5 CUSTOM SHADE GUIDE

Estelite® Asteria Custom Shade Guide is a shade guide kit for making your own custom shade guides. Since the shade guide of two kinds of form is producible with this kit, a shade can be checked with the form similar to clinical case.

One is deep and narrow form and is suitable for production of the body shade. Another is shallow and large form and is suitable for production of the enamel shade.

Moreover, the produced shade guide tip can be equipped and saved in a holder.



FIGURE 31 Custom shade guide



FIGURE 32 Example (NE, A2B)

6 SUMMARY

Estelite® Asteria is a composite resin offering various outstanding traits, including desirable levels of polymerization activity and cosmetics thanks to the polymerization catalyst technology (RAP technology) and the Supra-nano Spherical filler technology. Moreover, Estelite® Asteria introduces a new simplified 2-step layering concept.

1 Outstanding esthetics

- Estelite® Asteria has optimal shades for 2-step layering concept
- Estelite® Asteria provides high gloss with little polishing
- Estelite® Asteria exhibits high gloss retention
- Estelite® Asteria exhibits minimal changes in translucency and color before and after polymerization

2 Fast curing

- Estelite® Asteria cures in approximately $\frac{1}{3}$ the exposure time required for conventional composite resins
- Estelite® Asteria does not require a specific type of light source for the light-curing unit; it cures rapidly under halogen, LED, or Xenon light sources

3 Excellent mechanical properties

- Estelite® Asteria features low shrinkage
- Estelite® Asteria offers superior characteristics with respect to wear resistance and opposing tooth wear

4 Easy of use

- Estelite® Asteria is less sensitive to ambient light than conventional products
- Readily sculpted

7 REFERENCES

1 Shigeki Yuasa, "Composite oxide spherical particle filler"

DE, No. 128, 33-36 (1999)

ESTELITE ASTERIA Packages



ESTELITE ASTERIA ESSENTIAL KIT

Kit Contents:

- 5 syringes Estelite Asteria, 4.0g each
Body Shade: A1B - A2B - A3B - A3.5B - A4B
- 2 syringes Estelite Asteria, 4.0g each
Enamel Shade: NE - OcE



ESTELITE ASTERIA SIRINGHE 1 syringe, 2.1mL (4.0g)

- **Body Shades:**
A1B - A2B - A3B - A3.5B - A4B - B3B - BL
- **Enamel Shades:**
NE - OcE - WE - YE - TE

notes





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