

# Stain Resistance of Various Composite materials After Surface Sealant Application

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## ABSTRACT

**Objective:** Long- term color stability of esthetic restoration considered a vital property. Our study was aimed to evaluate the color stability of composite restorative materials after surface sealant application.

**Materials and Methods:** Two brands of composite resin material used which include G-aenial Posterior (GC, USA) and Ceram.x SphereTEC one (Dentsply, USA). Forty eight composite specimen were prepared by using metal rings (10 mm in diameter, 2 mm in thickness). Finishing of all samples were done with Enhance (Rubber Point, Dentsply Caulk, Milford, DE, USA). The samples of the tested composite were randomly divided into three groups, one of these groups were etched for 20 seconds by Ultra-Etch phosphoric acid 35% (USA), washing with water for 20 seconds was done, then dried by absorbent paper and of air. Apply a thin coat of PermaSeal (Ultradent, USA) on the external surface of the samples for 5 seconds using a Microbrush (Ultradent, USA), then gently air thinned and cured for 20 seconds. All samples except control immersed in 5 mL black tea (Lipton, Unilever, Istanbul, Turkey) for 15 minute daily for 14 day.

**Results:** Color changes ( $\Delta E$ ) in the whole tested groups was higher than 3.3, which means that immersion of composite samples in tea causes a clinically unacceptable color change when compared to control. The highest color change ( $\Delta E$ ) was observed with ceram.x SphereTEC one composite after immersion in tea with or without PermaSeal application.

**Conclusions:** Addition of surface sealant was not provide stain resistance for composite.

**Keywords:** Surface Sealant, Color Stability, Nanohybrid composite.

## INTRODUCTION

Although improvements in esthetic restorative materials have been achieved during recent years, discoloration represents a significant problem for direct tooth-colored restorations<sup>(1)</sup>. Changes in color can be the result of intrinsic discoloration due to physicochemical reactions in the deep portions of the restoration or the result of extrinsic discoloration due to accumulation of plaque

and stains<sup>(2)</sup>. Color changes depend on several factors, such as the staining agent, the surface roughness, contact time with or immersion in coloring environments, and the type of composite resin used<sup>(3)</sup>. Resin composites are prone to color changes in in-vivo and in-vitro environments when exposed to common colored materials such as beverages, coffee and tea<sup>(4)</sup>. Sealants are used to fill the surface roughness on the surface of

composite restorations to improve surface luster, marginal seal and abrasion resistance. The use of surface sealants may also affect the absorption of pigments and the color stability of composite restorations (5). The purpose of the present study was to determine the outcome of surface sealant on color stability of different types of resin composites.

## MATERIALS AND METHODS

### Samples preparation

Two kinds of composite resin material used in this study which include G-aenial Posterior (GC, USA) and ceram.x SphereTEC one (Dentsply, USA). Forty eight composite specimen were prepared by using metal rings (10 mm in diameter, 2 mm in thickness). Types of composite used in the present study were described in (table 1). Vita shade A2 was used for each type of composite. All composite were polymerized according to manufacturers' instructions. Composite inserted directly to the metal ring, a glass was used to cover the external surface of the composite to get an even surface. Then, polymerization of the composites were done with Woodpecker (China) light cure device with the intensity of 800 mw / cm<sup>2</sup> for 40 s. Before polymerization was started, the intensity of the output light of the device was checked by the radiometer device. All specimens were incubated at 37°C for 24 h. The upper surfaces of all samples were finished with Enhance (Rubber Point, Dentsply Caulk, Milford, DE, USA) which consist of 40 µm particles of aluminum oxide) without using spray

of water and the pressure should be light and intermittent for 15 s with speed of a hand piece of 10,000 rpm, then washed and dried for 10 s. Polishing was done by the same person for all the samples to avoid interpersonal variances. The specimens of every composite type were randomly divided into three groups, one of these groups etched for 20 seconds by Ultra-Etch phosphoric acid 35% (USA), then rinsed by water for 20 seconds, and dried by absorb paper and air. Rub a thin coating of surface sealant PermaSeal (Ultradent, USA) on the outer surface of the samples for 5 seconds using a Micro brush (Ultradent, USA), then gently air thinned and cured for 20 seconds. All samples except control immersed in 5 mL black tea (Lipton, Unilever, İstanbul, Turkey) for 15 minute daily for 14 day.

### Groups classifications

A1 : G-aenial composite without immersion in tea (control).

A2 : G-aenial composite with immersion in tea without PermaSeal treatment.

A3 : G-aenial composite with immersion in tea and PermaSeal treatment.

B1 : ceram.x SphereTEC one composite without immersion in tea (control).

B2 : ceram.x SphereTEC one composite with immersion in tea without PermaSeal treatment.

B3 : ceram.x SphereTEC one composite with immersion in tea and PermaSeal treatment.

**Table 1.** Types of composite used in this study

Resin composite	Classification	Type	Volume	size	Resin Matrix	Shade/Lot number
G-aenial GC	Microhybrid	silica	65	0.01-0.04 µm	UDMA and dimethacrylate co-monomer	P-A2/180913A
Ceram.x SphereTEC one	Nanohybrid	The Sphere TEC fillers (≈15 µm Nonagglomerated barium glass fillers (≈0.6 µm), Ytterbium fluoride (≈0.6 µm) (Methacrylic polysiloxane nanoparticles)	59-61	15 µm	Reduced resin matrix content	A2/1812000433

\*Bis-GMA: Bisphenol A-glycidyl methacrylate, UEDMA: Urethane dimethacrylate.

### Color Measurement

Measurements of Color for all composite specimens were achieved by a spectrophotometer (Vita Easyshade Advance, Germany) according to the CIE L\*a\*b\* system. All specimens were rinsed with distilled water, and dried using absorbent paper. Calibration of spectrophotometer was done in accordance to the company's guidelines before measurements. Three readings were obtained at the midpoint of every sample in contrast to a white background and the mean value was obtained. CIE system uses three-dimensional colorimetric measurements: L\* values correspond to the color brightness, a\* values to the red-green content, and b\* values to the yellow-blue content. The color formation depend on three aspects: the source of light, the object and the viewer (6). The difference of color between the two specimens in this system is obtained by the ΔE value from the following calculation,  $\Delta E = (\Delta L^2 + \Delta a^2 + \Delta b^2)^{1/2}$ . When ΔE value <3.3 considered clinically satisfactory in the current study (1)(7)(8). Comparison of Color measurements for the tested groups with control group were done.

## RESULT

Descriptive statistic (mean, SD) shown in table (2). Data were analyzed by SPSS version 20. One - way ANOVA were achieved for every group individually, if result was significant, Paired t-test was also done. In these tests P > 0.05 (Non significant), P ≤ 0.05 (Significant), P < 0.001 (Highly significant).

Color changes (ΔE) in the whole groups was greater than 3.3 table (3), which showed that immersion of composite samples in tea produces a clinically unacceptable alteration in color compared to control. The highest color change (ΔE) was observed with ceram.x SphereTEC one composite after immersion in tea with or without PermaSeal application, there was no significant difference (P > 0.05) between samples if surface sealant was applied or not. The minimal color changes were recorded for G-aenial composite after immersion in tea with or without PermaSeal application, addition of surface sealant did not differ significantly.

**Table 2.** Descriptive statistic (mean, SD)

Groups	N	Color system	Mean	Std. Deviation
A1	8	a*	0.03	0.18
A2	8	a*	0.39	0.62
A3	8	a*	0.44	0.49

A1	8	b*	5.80	3.11
A2	8	b*	6.61	1.99
A3	8	b*	9.86	2.75
A1	8	l*	88.14	1.80
A2	8	l*	87.38	1.66
A3	8	l*	84.05	4.99
B1	8	a*	-0.58	0.10
B2	8	a*	1.93	1.13
B3	8	a*	0.000	0.41
B1	8	b*	9.41	3.62
B2	8	b*	19.18	7.66
B3	8	b*	18.65	6.25
B1	8	l*	92.88	2.73
B2	8	l*	77.70	7.62
B3	8	l*	77.25	5.79

**Table 3.**  $\Delta E$  for all group

	$\Delta E$
A2	4.35
A3	5.78
B2	18.22
B3	18.16

## DISCUSSION

Color changes of composite affected by many factors such as the matrix, ratio of filler particles, the adsorption and absorption of pigments<sup>(1,9)</sup>. Surface sealant is a material that contain no filler can improve color stability of many types of composite resins, which include BIS-GMA, UDMA and TEG-DMA. The viscosity of sealant is little and its functionality is high<sup>(10,11)</sup>. Surface sealing agents used to seal the microstructural defects on the surface and also decreasing irregularities and voids. Several observations on sealant, that develop properties of composite surface, increase the color stability and the external composite resin characteristics<sup>(12,13)</sup>. CIE L \* a \* b system combined with spectrophotometer used to measure  $\Delta E$  in most studies<sup>(4,14,15,16)</sup>. To measure color, the spectrophotometer, dissimilar with the calorimeter, utilize a standard light in a dark element away from the ambient light, therefore the readings are confident, definite and repeatable. In the clinical field,  $\Delta E > 3.3$  considered unacceptable<sup>(4,9,18)</sup>. Our study showed that the immersion in tea of both types of composite materials (G-aenial Posterior and ceram.x SphereTEC one) resulted in significant color changes comparing to control group (initial color without tea immersion)  $P \leq 0.05$ , this in accordance with the result of many studies that confirmed that tea solution one of the most coloring drinks that produce sever color alterations of composite fillings<sup>(4,14,22)</sup>.  $P$  values attained for L, a, b showed a statistically significant differences before and after immersion in tea ( $p < 0.05$ ). In this study, Group A2 (G-aenial composite without PermaSeal treatment) showed the lowest color alteration which is not clinically acceptable ( $\Delta E \geq 3.3$ ) even after application of PermaSeal (A2).

Group B3 (ceram.x SphereTEC one composite with PermaSeal treatment) showed the highest color changes. Many reasons responsible for color changes in both types of composites treated with surface sealant, one of these reasons is that surface sealant contain an elevated hydrophilic comonomers level<sup>(3)</sup>. In addition, the surface sealant resin matrix unlike resin composites, contain no filler particles; the filler particles are neutral and donot have the ability to absorb the fluid or colorant<sup>(8)</sup>. These findings were in accordance with the studies of the Catelan *et al.*, Valentini *et al.*, Lee *et al.* which

demonstrated the influence of surface sealant application on stain resistance of the composite<sup>(16,17,26)</sup>. Catelan *et al* established that the surface properties of the composite is more related to effect of the sealant on composite than the properties of sealant. Colorfulness of surface sealant is due to the type of monomer<sup>(16)</sup>.

Valentini *et al.* showed that application of sealant on the surface of composite after treatment with coffee didn't decrease color changes. They stated that debonding and degradation of the sealant from composite may cause this result<sup>(17)</sup>. Possibly the other reason is that, the surface sealant resin matrix unlike resin composites, contain no filler particles; the filler particles are neutral and donot have the ability to absorb the fluid or colorant<sup>(17)</sup>.

An additional reason that may diminish the effectiveness of sealants is the composite's thickness. According to Lee *et al.* application of greater thickness of surface sealant on the composite surface will be more prone to alterations of color, because of the properties which include viscosity and wetting, it is not advisable to put the sealant coat to the similar standard as the entire composite superficial layer<sup>(25)</sup>.

In comparing the two types of composites used ceram.x SphereTEC one composite presented the highest color changes which is due to this composites comprise organically modified ceramic nanoparticles and glass fillers and these nanoceramic particles and nanofillers have methacrylate group available for polymerization<sup>(23)</sup>. The highest color change of nanoceramic composites can be related to structural difference. A study showed that Ceram.x did not has superior quality of its surface in comparison to other nanofilled composites. This was explained by low filler content (volume) of this composite and porosities noticed on surface of Ceram.x samples. Irregular /Rough surface has been shown mechanically preservation of stains more than smooth surface<sup>(24)</sup>. Our findings are in accordance with those of Celik *et al.* and Jung *et al.*<sup>(23,24)</sup>.

## CONCLUSIONS

The use of surface sealant cannot provide stain resistance for nano-hybrid (ceram.x SphereTEC one (Densply, USA) and microhybrid composites (G-aenial Posterior (GC, USA). Microhybride composites had higher color stability than nanohybrid composites.

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