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Full Length Research Paper

The effect of different bleaching methods on the surface roughness and hardness of resin composites

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This study evaluated the effects of 4 different bleaching agents with 2 different bleaching methods (2 in-office bleaching systems: 38%HP Opalescence Xtra Boost and 35% HP Beyond Maxx; 2 home bleaching systems: Opalescence PF 35% CP and Beyond 6% HP) on the micro hardness and surface roughness of 4 different resin composites (Aelite-hybrid, Grandio-nanohybrid, Clearfil Majesty-nano superfilled, Siloran-silorane based). One hundred square samples, with A3 shading, were prepared with 10 mm in diameter and 2 mm in depth. Samples were divided into 20 test groups (n=5). 5 samples of each of the 4 different resin composite samples were selected for baseline surface roughness measurements (with a non-contact, 3D, optical, surface profilometer) and surface micro hardness tests (with Vickers instrument) as control groups. The appropriate bleaching procedure was performed on the top surface of test groups for 14 days. Surface roughness and hardness were tested at the end of the duration. Statistical calculations were performed with NCSS 2007 program for Windows. The statistical significance level was established at $p<0.05$. Significance levels of the 4 treatments were as follows: Beyond home bleaching agent ($p= 0.0005$), Beyond office bleaching agent ($p=0.0007$), Opalescence home bleaching agent ($p= 0.0005$) and Opalescence Xtra Boost office bleaching agent ($p=0.0006$). After the exposure duration described above, there was a significant difference between the micro hardness of the tested composite groups. In response to exposure to beyond home bleaching agent, there was a significant difference among the surface roughness (Sa) within the tested composite groups ($p=0.03$). After exposure to Opalescence office bleaching agent, there is a significant difference between the surface roughness (Sa) of the tested composite groups ($p=0.0007$). Clinical relevance: The conditions of this study included a 2-week bleaching regimen with high peroxide, concentrated either in a dental office or at home. Bleaching agents affected the roughness and hardness of hybrids, nano hybrids, nano super filled, and silorane composites. Nano-based composites were affected less than the hybrids and siloranes.

Key words: Laser profilometer, micro hardness, nano-composites, siloranes, surface roughness.

INTRODUCTION

Bleaching teeth is one of the effective, comparatively safe, aesthetic treatments in dentistry (Dadoun and Bartlett, 2003). Many systems are available in clinical practice that has a peroxide mechanism. The American Dental Association developed guidelines for the acceptance of bleaching products (Council on Dental Therapeutics, 1994). Peroxide-containing tooth whitening products are classified into three categories: professional in-office agents, professionally supervised agents for use by patients at home, and over-the-counter (OTC) bleaching products (Kihn, 2007). Although peroxide has different forms, such as hydrogen peroxide, carbamide peroxide and sodium per carbonate, and the methods of application vary with

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such options as gels in trays, strips, films, or paint-on gels, all of them have been shown to be sufficient (Silva et al., 2006).

In office bleaching, a bleaching agent gel of 35- 38% hydrogen peroxide is applied at the tooth surface and allowed to remain on the teeth for 30-45 min. A chemically activated bleaching agent, or usually a visible light curing lamp, is used to enhance the bleaching process (Taher, 2005). Home bleaching, called night guard vital bleaching, and was first described by Haywood and Heymann (1989). At home, the patient uses custom-fitted trays to apply a gel to lighten his/her teeth (Haywood and Heymann, 1989).

Tooth-colored restorative materials, especially composite resin, have become an important part of modern dentistry. Composite resin has been used for nearly 50 years as a restorative material. Use of this material has recently increased because of consumer demands for esthetic restorations (Yap and Wattanapayungkul, 2002). Newly developed composites with different matrix types, such as siloranes and filler types such as nano composites are used in clinical practice more often than hybrids. Nano composite studies have shown that they have high translucency, high polish, and good polish retention, similar to microfill composites, while maintaining physical properties and wear resistance equivalent to those of several hybrid composites. The strength and esthetic properties of the nano composites allow dentists to use it for both anterior and posterior restorations (Sumita et al., 2003). Silorane is a cationic, ring-opening, hybrid, monomer system that contains both siloxane and oxiranes. The silorane-based resin composites have shown low polymerization shrinkage and stress (Weinmann et al., 2005) and good stability and insolubility in biological fluid stimulants (Eick et al., 2006).

The effect of bleaching on dental restorative materials has been reviewed recently (Attin et al., 2004). Due to their organic matrix, composite resin materials, especially, tend toward chemical alteration compared to ceramic restorations (Hannig et al., 2007). Bleaching agents may change the surface morphology, as well as the chemical and physical properties of composite resins. Chemical softening from bleaching may affect the clinical longevity of the composite restoration (Stein et al., 2005).

Although the use of bleaching agents is widespread, studies investigating the effect of bleaching treatments on the micro hardness (Bailey and Swift, 1992; Turker and Biskin, 2002; Mujdeci and Gokay, 2006) and surface roughness (Silva et al., 2006; Turker and Biskin, 2003; Moraes et al., 2006; Polydorou et al., 2006) of restorative materials, including hybrid, microfill and nanohybrid composites, are described controversially in the literature. Either decreases or increases in surface micro-hardness induced by bleaching application have been found, whereas other studies revealed no significant alteration in the micro-hardness (Baily and Swift, 1992; Turker and Biskin, 2002; Okte et al., 2006).

There are no reports in the literature about surface roughness and micro hardness of siloranes after exposure to bleaching agents. Only gloss retention of the silorane was investigated by Fruse et al. (2008). Ilie and Hickel (2009) reported that the mechanical properties, measured at macro-, micro- and nano-scale, of the silorane-based composite were comparable to clinically successful methacrylate-based composite materials, encouraging the clinical use of the new composite material (Ilie and Hickel, 2009).

The purpose of this study was to investigate the effect of 4 different bleaching agents (35% light activated HP and 38% chemically activated HP-based office bleaching agents, and 35% CP and 7% HP-based home bleaching agents) on the surface roughness and micro hardness of four different resin composites - hybrid, nano hybrid, nano super filled and silorane — over a 14-day period of exposure.

METHODS AND MATERIALS

This study used four different bleaching agents and four resin composites. Tables 1 and 2 list the materials, product names, manufacturers, and compositions.

Specimen preparation

One hundred square samples were prepared by using Teflon molds (10x10 mm and 2 mm thickness). The color corresponding to shade A3 was used for every material. The Teflon molds were positioned on a transparent plastic matrix strip lying on a glass plate. The composite materials were placed in 2 mm increments. After inserting the materials into the Teflon mold, a transparent plastic matrix strip was put over them and a glass slide was secured in order to flatten the surface. Every sample was light cured for 40 s in 2 steps, using a light-emitting diode (Freelight 2, 3M ESPE, Seefeld, Germany). The samples were polished with medium, fine, and superfine disks (Soflex, 3M ESPE, St. Paul, MN, USA) on a slow hand piece, in accordance with the manufacturer's instructions. After polishing, samples subjected for 2 min to ultrasonic cleaning with distilled water to remove any surface debris. All samples were stored in distilled water at room temperature for 24 h before the initiation of any procedure. All samples were, then, divided into 20 test groups (n=5). 5 samples of each of the 4 different resin composite samples were selected for baseline surface roughness measurements (with the optical surface profilometer) and surface micro hardness tests (using Vickers Instrument) as control groups.

Exposure to the superficial treatment

The appropriate bleaching procedures were performed on the top surfaces of the test groups shown in Table 3. The amount of bleaching agent must cover all surfaces of the samples. At the end of every bleaching procedure, the treated specimens were washed, first, under flowing distilled water with a soft toothbrushes, and then, in an ultrasonic cleaner for 5 min. Then they were placed in fresh distilled water until the next application. The distilled water was replaced every day.

Table 1. Restorative materials evaluated.

Resin composites	Product name, Manufacturer	Resin composition	Filler %weight (volume)	Filler size
Universal hybrid composite	Aelite™ All Purpose Body Bisco, Inc., Schaumburg, IL	Bis EMA, TEGDMA	73 (53)	0.7 µm
Nano hybrid composite	Grandio® VOCO GmbH, Cuxhaven Germany	Bis-GMA ve TEGDMA	87 (71.4)	1 µm glass particules 20-60 nm SiO^{2} particules
Nano super filled composite	Clearfil Majesty ™ Posterior Kuraray Medical Inc. Okayama, Japan	Bis-GMA, TEGDMA, hydrophobic aromatic dimethacriylates and di-CQ	92 (82)	Glass filler 1.5 µm Nano filler 20 nm
Silorane Composite	Filtek ™ Silorane 3M ESPE Dental Products, St.Paul USA	Siloxan and oxiran	76 (55)	0.47 µm

Table 2. Bleaching agents and techniques evaluated.

Materials		Product name, manufacturer	% active ingredient	Activation system	Application procedure
Bleaching agents	Office bleaching systems	Opalescence® Xtra® Boost ™ Ultradent Products Inc. South Jordan, UT	38% HP	Chemically activated	1st and 7th day for 45minutes each, totally 90 minutes
		Beyond ™ Max BEYOND Technology Corp. Nanchang Nanchang, Jiangxi, China	35% HP	Beyond Whitening Accelerator Powerful 150 watt halogen bulb emits a high-intensive blue light (480-520 nm wavelength)	1st and 7th day for 90 minutes each that was activated with Beyond Whitening Accelerator, totally 90 min
	Home bleaching systems	Opalescence® PF % 35 CP Ultradent Products Inc. South Jordan, UT	35% CP	-	1/2 h a day for 14 days.
		Beyond % 6 HP BEYOND Technology Corp. Nanchang Nanchang, Jiangxi, China	6%HP	-	1 h a day for 14 days.

At-home bleaching materials, Opalescence® /Dr. Kit (Ultradent Products Inc. South Jordan, UT), with 35% carbamide peroxide, and Beyond™ Home (BEYOND Technology Corp. Nanchang Nanchang, Jiangxi, China), with 6% hydrogen peroxide, as indicated in Table 2, were coated on both surfaces of the 5 specimens of each material. the specimens were stored at room temperature in a light proof container for 1/2 h for Opalescence and for 1 h for Beyond, as recommended by the manufacturer. The specimens were then washed and stored in distilled water. This procedure was repeated for 15 days. Surface roughness and hardness were tested at the end of the duration.

At-office bleaching materials, Opalescence® Xtra® Boost™ (Ultradent Products Inc. South Jordan, UT), with 38% hydrogen peroxide, and Beyond™ Maxx (BEYOND Technology Corp. Nanchang Nanchang, Jiangxi, China), with 35% hydrogen peroxide, as indicated in Table 3, were coated on both surfaces of the 5 specimens of each material. Opalescence Xtra Boost was applied twice (1st and 7th day) for 45 min each. Beyond Max was applied twice (1st and 7th day) for 45 min each with Beyond™ Whitening Accelerator (BEYOND Technology Corp. Nanchang Nanchang, Jiangxi, China) that was positioned for each surface of the specimen; each surface was exposed to three steps of treatment at 15 min intervals, as recommended by the manufacturer. The samples were tested for surface hardness after 15 days.

Table 3. Summary of control and experimental groups: Bleaching systems and bleaching procedures on tested resin composites.

Bleaching system		Composites			
		Hybrid composite Aelite	Nano Hybrid composite Grandio	Nano superfilled composite Clearfil Majesty	Siloran composite Filtek Siloran
Control	Control 2 week	Group 1-1 n=5	Group 2-1 n=5	Group 3-1 n=5	Group 4-1 n=5
Office bleaching	Opalescence Xtra Boost	Group 5 n=5	Group 6 n=5	Group 7 n=5	Group 8 n=5
	Beyond Max	Group 9 n=5	Group 10 n=5	Group 11 n=5	Group 12 n=5
Home bleaching	Opalescence PF%35CP	Group 13 n=5	Group 14 n=5	Group 15 n=5	Group 16 n=5
	Beyond %6 HP	Group 17 n=5	Group 18 n=5	Group 19 n=5	Group 20 n=5

Surface roughness and micro hardness tests

Surface roughness measurements were performed on the experimental groups and on the non contaminated specimens as controls after the exposure of the specimens to the bleaching agents. The Uniscan model OSP100A is a 3D Laser Profilometer designed for non-contact measurement of surface topography profiles, forms, and textures. Utilising a laser displacement sensor, the OSP100A (Uniscan OSP 100A, AG Electro Optics UK) measures surface topography in the range of 10's of millimetres to sub-micrometers, over area's up to 100 x 75 mm. Surface profiles of the specimens were recorded at regular intervals during testing, using a non-contacting laser profiler (Uniscan OSP 100A, AG Electro Optics UK). In the current study, scanning was performed at 20 mm intervals on a region 6x8 mm^2. The sample rate during scanning was 500 Hz at a scan speed of 10 mm/s.

To record roughness, three measurements were taken on the surface of the materials. The roughness average was defined as the mean height, calculated over the entire scan area. Average surface roughness (Sa) of the samples was calculated, according to the laser profilometer formula, as;

$$S_a = \frac{1}{MN} \sum_{j=1}^{N} \sum_{i=1}^{M} |\eta(x_i, y_i)|$$

M is the number of samples per Line,
N is the number of Lines,
i is an index used to identify a particular point on a line,
j is an index used to identify a particular line,
and η(xi, yj) equates to the difference between the height at point xi, on line yj, and the mean height of all the points on the surface.

Surface hardness of the specimens was measured with micro hardness tester HVS-1000 (Bulut Makine Sanayi, İstanbul, Türkiye) using a 100 g load and 20 s dwell time at room temperature. The diagonal length impressions were measured and the hardness number (H) was caculated according to a standart formule, $H= 1.854\ P/d^2$.

In this formula, p shows the indentation load and d is the diagonal length impression. In each specimen, three indentations were made on the top surface, not closer than 1 mm to the adjecent indentations or the margins of the specimen, and an average value was determeined as a single value for each specimen.

Statistical analysis

Statistical calculations were performed with NCSS 2007 program for Windows. Besides standard descriptive statistical calculations (mean and standard deviation), the Kruskal Wallis test was used in the comparison of groups, the post Hoc Dunn's multiple comparison test was utilized in the comparison of subgroups, and the Mann Whitney U test was used in the comparison of two groups. The statistical significance level was established at p<0,05.

RESULTS

Vicker's micro hardness

Tables 4 and 5 show the means and standard deviations of the Vickers surface micro hardness testing of the specimens at control 2 weeks, after office bleaching and home bleaching of Beyond and Opalescence.

After exposure to Beyond home bleaching agent (p= 0.0005) and Beyond Maxx office bleaching agent (p=0.0007), there was a significant difference between the micro hardness of the tested composite groups. In Dunn's multiple comparison test, the Beyond home bleaching results for the Nano Kuraray group had the highest VHN in all groups (P < 0.05) and the average hardness of the Nano Vaco group was significantly greater than that of the Siloran 3M group (P < 0.001). In office-bleaching groups, the hardness of Nano Kuraray

Table 4. Comparison VHN of the Beyond office and home bleaching applied tested composites and non contaminated specimens served as controls.

Beyond	Hibrit Bisco means and sd	Nano Kuraray means and sd	Nano Voco means and sd	Siloran 3M means and sd	KW	p
Control 2 weeks	59.59 (4)	133.73 (4.06)	99.7 (1.53)	62.89 (3.57)	16.42	0.0009
Office bleaching	62.17 (3.15)	120.6 (4.1)	81.21 (1.86)	59.22 (1.96)	17.10	0.0007
Home bleaching	70.31 (1.42)	131.95 (3.23)	104.06 (1.64)	62.67 (3.74)	17.85	0.0005
KW	9.62	9.62	12.02	4.39		
P	0.008	0.008	0.002	0.111		

Table 5. VHN of the Opalescence office and home bleaching applied tested composites and non contaminated specimens served as controls.

Opalescence	**Hybrid Bisco** means and sd	**Nano Kuraray** means and sd	**Nano Voco** means and sd	**Siloran 3M** means and sd	KW	p
Control 2 weeks	59.59±4	133.73±4.06	99.7±1.53	62.89±3.57	16.42	0.0009
Office bleaching	63.62±3.61	121.77±4.15	96.95±6.86	59.88±3.52	16,71	0.0006
Home bleaching	75.27±5.12	138.23±2.54	91.87±1.55	65.59±2.71	17.83	0.0005
KW	9.98	10.64	6.98	5,65		
P	0.006	0.004	0.039	0,06		

Table 6. Comparison of VHN of composite materials due to bleaching type.

Bleaching regimen	Composite materials	Beyond means and sd	Opalescence means and sd	MW	*p*
Home bleaching system	Aelite	70.31 (1.42)	75.27 (5.12)	3	0.056
	Clearfil majesty	131.95 (3.23)	138.23 (2.54)	2	0.032
	Grandio	104.06 (1.64)	91.87 (1.55)	0	0.008
	Filtek Silorane	62.67 (3.74)	65.59 (2.71)	6	0.222
Office bleaching system	Aelite	62.17 (3.15)	63.62 (3.61)	7	0.310
	Clearfil majesty	120.6 (4.1)	121.77 (4.15)	10	0.690
	Grandio	81.21 (1.86)	96.95 (6.86)	0	**0.008**
	Filtek Silorane	59.22 (1.96)	59.88 (3.52)	11	0.841

was significantly greater than Hybrid Bisco ($P < 0.05$) and 3M Siloran ($P < 0.01$).

After exposure to Opalescence home bleaching agent (p= 0.0005) and Opalescence Xtra Boost office bleaching agent (p=0.0006), there was a significant difference between the micro hardness of the tested composite groups. In Dunn's multiple comparison test, for Opalescence home bleaching results; the hardness of Nano Kuraray was significantly greater than that of Hybrid Bisco ($P < 0.05$) and 3M Siloran ($P < 0.001$) and the average hardness of the Nano Voco group was significantly greater than that of the Siloran 3M group ($P < 0.05$). In Opalescence Xtra Boost office bleaching groups, the hardness of Nano Kuraray was significantly greater than Hybrid Bisco ($P < 0.05$) and 3M Siloran ($P < 0.01$).

Table 6 shows that there was no significant difference between Opalescence and Beyond home bleaching agents on hardness of Hybrid Bisco (p=0.056) and 3M Siloran composite (p=0.222). The hardness of the Nano Kuraray group, which was exposed to the Opalescence home bleaching agent, was greater than the Nano Kuraray group, which was exposed to Beyond home bleaching agent (p=0.032). The hardness of the Nano Voco group, which was exposed to Beyond home bleaching agent was greater than that of the Nano Voco group, which was exposed to Opalescence home bleaching agent (p=0.008). There is no significant

Table 7. A typical 3D profile of the control group and the tested composites surfaces with a non-contacting laser profiler (Uniscan OSP 100, AG Electro Optics UK).

Control	Office bleaching systems		Home bleaching systems		Resin composites
	Beyond Maxx	Opalescence Xtra boost	Beyond Home 6% HP	Opalescence PF %35 CP	
Figure 1	Figure 1a	Figure 1b	Figure 1c	Figure 1d	Hybrid Aelite
Figure 2	Figure 2a	Figure 2b	Figure 2c	Figure 2d	Nano super filled Clearfil Majesty
Figure 3	Figure 3a	Figure 3b	Figure 3c	Figure 3d	Nano hybrid Grandio
Figure 4	Figure 4a	Figure 4b	Figure 4c	Figure 4d	Siloran Filtek Siloran

Table 8. Surface roughness as Sa (standard deviations) of the composite materials after exposure to different bleaching agents for 14 days.

Groups	Bleaching type	Aelite means and sd	Clearfil Majesty means and sd	Grandio means and sd	Filtek Silorane means and sd	KW	*p*
Control	Distilled water	16.81 (1.17)	13.74 (5.11)	20.58 (3.11)	35 (1.78)	14.98	0.0018
Opalescence	Office bleaching	27.81 (6.98)	17.67 (2.56)	20.7 (2.31)	39.78 (15.1)	12.05	0.0007
	Home bleaching	20.97 (5.13)	17.09 (4.61)	23.48 (6.12)	21.74 (4.9)	3.93	0.260
Beyond	Office bleaching	24.48 (6.44)	28.08 (14.44)	21.64 (4.93)	36.76 (6.68)	6.83	0.07
	Home bleaching	22.4 (6.65)	13.91 (4.61)	21.34 (5)	29.77 (9.23)	8.87	0.03

difference between Opalescence and Beyond office bleaching agents on the hardness of Hybrid Bisco (p=0.310), Nano Kuraray (p=0.690) or 3M Siloran composite (p=0.841). The hardness of the Nano Voco group, which was exposed to Opalescence office bleaching agent, was greater than that of the Nano Voco group, which was exposed to Beyond office bleaching agent (p=0.008).

Surface roughness

Figures 1 to 4 show a typical 3D profile of the control group and the tested composites. Surfaces with a non-contacting laser profiler (Uniscan OSP 100, AG Electro Optics UK) (Table 7)

Table 8 shows the means and standard deviations of Vickers surface micro-hardness of the specimens at control 2 weeks, after office bleaching and home bleaching of Beyond and Opalescence.

After exposure to Beyond home bleaching agent there is a significant difference between the surface roughness (Sa) of the tested composite groups (p=0.03). In Dunn's multiple comparison tests, for beyond home bleaching, the surface roughness (Sa) of the Nano Kuraray group was significantly less than that of the Siloran 3M group ($P < 0.05$) and there were no significant differences between other composite groups ($p > 0.05$).

After exposure to Opalescence office bleaching agent, there was a significant difference between the surface roughness (Sa) of the tested composite groups (p=0.0007). In Dunn's multiple comparison test, for Opalescence office bleaching, the surface roughness (Sa) of the Nano Kuraray group was significantly less than that of the Siloran 3M group ($P < 0.01$).

Table 9 shows that there was no significant difference between Opalescence and beyond, for either home or office bleaching agents, on the surface roughness (Sa) of Hybrid Bisco, Nano Kuraray, Nano Voco and 3M Siloran composite groups ($p > 0.05$).

DISCUSSION

Although the efficacy of whitening products is known, their effect on restorative materials is a controversy from *in vitro* studies (Attin et al., 2004). Tooth whiteners remove stain by oxidizing organic substances within the tooth structure by the release of free radicals which was proved to be safe and have the minimal effect on the dental materials (Dadoun and Bartlett, 2003).

Hydrogen peroxide has capacities for oxidation and reduction to generate free radicals (Wattanapayungkul and Yap, 2003). In addition to its reactivity, hydrogen peroxide demonstrates ability for diffusion (Cooper et al., 1992). Bleaching agents may result in a softening and reduction in micro-hardness and free radicals

Table 9. Comparison of Sa of composite materials due to bleaching type

Bleaching regimen	Composite materials	Beyond means and sd	Opalescence means and sd	MW	p
Home bleaching system	Aelite	22.4 (6.65)	20.97 (5.13)	10	0.69
	Clearfil Majesty	13.91 (4.61)	17.09 (4.61)	6	0.222
	Grandio	21.34 (5)	23.48 (6.12)	9	0.548
	Filtek Silorane	29.77 (9.23)	21.74 (4.9)	6	0.222
Office bleaching system	Aelite	24.48 (6.44)	27.81 (6.98)	7	0.31
	Clearfil Majesty	28.08 (14.44)	17.67 (2.56)	9	0.548
	Grandio	21.64 (4.93)	20.7 (2.31)	9	0.548
	Filtek Silorane	36.76 (6.68)	39.78 (15.1)	12	0.998

induced by peroxides may affect the resin-filler-interface and cause filler-matrix debonding (Wattanapayungkul and Yap, 2003). This may cause microscopic cracks, resulting in an increase in surface roughness, as shown in the scanning electron microscopic pictures (Attin et al., 2004; Polydorou et al., 2006) (Wattanapayungkul and Yap, 2003). The differences in the composites' roughness and micro hardness values obtained after the same bleaching regime may be related to the different polymers in their organic matrix, and their filler content and particle size (Hubbezoglu et al., 2008; Hannig et al., 2007).

In the literature, few studies were found about the effect of office bleaching on the surface and hardness of the new resin composites (Hannig et al., 2007; Polydorou et al., 2006; Wattanapayungkul and Yap, 2003). Polydorou (2006) reported that the effect of bleaching on the surface texture was material- and time-dependent (Polydorou et al., 2006). Another study claimed that bleaching softened subsurface layers of the restorative materials examined and that, due to the fact that deeper layers are also affected, polishing probably did not suffice for re-establishing the physical properties of the filling material (Hannig et al., 2007). In our study, nano super filled composites and nano hybrid composites showed similar surface roughness and hardness results. Nanocomposite samples showed no significant alteration (color and microhardness) after bleaching as previous study states (Simone et al., 2009). In addition, hybrid Bis-GMA composite and micro hybrid silorane composite also showed similar result with the literature (Prabhakar et al., 2010) showing that bleaching gels caused reduction in hardness of composite materials. The filler matrix relation plays an important role in the effect of bleaching agent on the composite resins. The filler weight and volume ratio determine this effect (Hannig et al., 2007). Roughnesses of all test groups were increased after bleaching procedure except home bleaching application of siloranes., it seems to be reasonable that, after polishing, the fillers extending on the rougher surface were dissolved by hydrogen peroxide attack and smoother surfaces were produced (Dogan et al., 2008).

The Sa parameter was chosen to indicate the surface roughness of the test specimens according to the non-contact, optical, laser profilometer. Resin composites were prepared square in order to scan their surface. In most surface roughness studies, the mechanical profilemeter was used to determine the surface roughness as a Ra value (Turker and Biskin, 2003; Moraes et al., 2006; Gurgan and Yalcin, 2007; Wattanapayungkul et al., 2004; Basting et al., 2007). One of its disadvantages is that the sensor needle of the mechanical profilometer cannot penetrate all the irregularities of the specimens (Yazici et al., 2007). In this study, the optical laser profilometer provided a non-contact, non-destructive, quick quantitative measurement for surface roughness (Joniot et al., 2000).

Application times of bleaching materials on restorative materials show different results in every study. Some of them preferred clinical application times while the others preferred exaggerated application times (Polydorou et al., 2006). In the present study, all the materials were applied according to manufacturers' guides for clinical usage. Four formulations of whitening products have been used in this study. The first, a chemically activated formulation, using 38% hydrogen peroxide, has been shown to be an effective bleaching agent in office bleaching. The second formulation, with 35% hydrogen peroxide, was activated by whitening accelerator. The third formulation was a highly concentrated, 35% carbamide peroxide, home bleaching agent that was applied for half an hour for 14 days. The fourth formulation was a 6% hydrogen peroxide home bleaching gel, applied for one hour for 14 days. All of these concentrations were highly concentrated bleaching agent formulations. Home bleaching agents showed more differences than office bleaching agents on roughness and hardness. The differences may be due to the fact that the contact time between bleaching products and resin surfaces for home bleachings is much longer than those for other products where 60 and 90 min bleaching treatment. Our results are paralel with previous studies (Dogan et al., 2008).

Conclusion

Within the limitations of this study, the following conclusions were drawn:

1. Nano composites shows the highest surface hardness and the least surface roughness compaired to hybrid and siloranes.
2. Siloranes show the highest surface roughness and lowest surface hardness after exposure to the bleaching agents.
3. No significant difference was found between nano superfilled composite and nano hybrid composite for surface roughness and hardness.
4. No significant difference was found between bleaching agents (Opalescence and Beyond) for surface roughness of the tested composites.

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