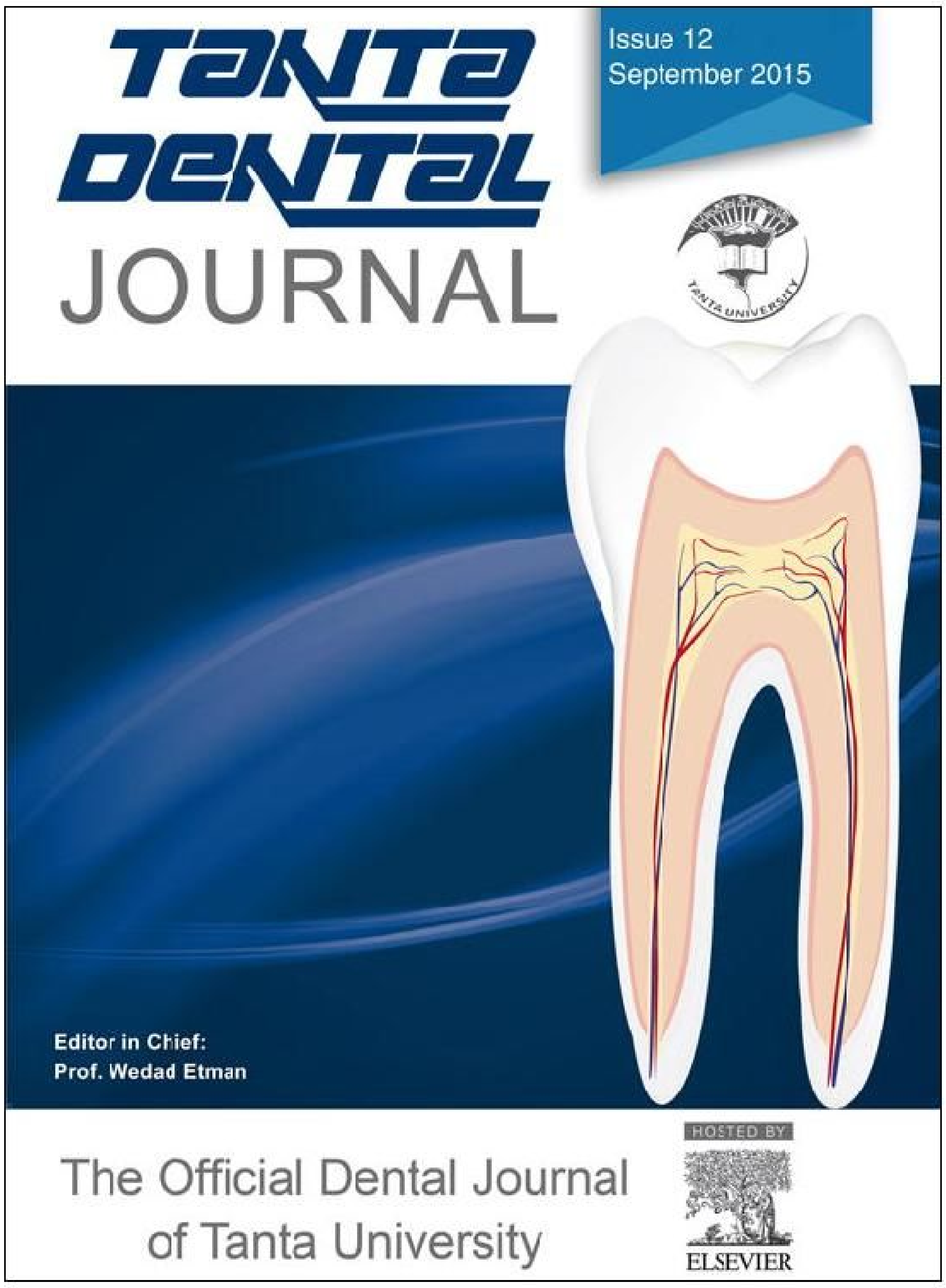
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Evaluation effect of an in-office zoom bleaching gel agent on the surface texture of three contemporary restorative materials

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Abstract

This in vivo study evaluated the effects of an in-office Bleaching Zoom gel agent on the surface texture of three contemporary restorative materials; an appropriate bleaching procedure was performed on the specimens of each group. Scanning electron micrographs were produced at 60x, 200x, 1500x, and 2000x magnifications of the respective areas of the samples.

The results showed that the effect of bleaching on the surface texture was material and time-dependent. Within the limitations of this study, it was concluded that bleaching with Zoom gel (25% hydrogen peroxide) did not cause major surface texture changes on the restorative materials.

Keywords: Bleaching; Surface texture; Beautifil II; IPS empress direct; Ceram.x.mono; Replica impression

1. Introduction

The public interest and demand for "aesthetic dental procedures" has never been greater, and a beautiful smile has become a kind of business card nowadays [1]. Aesthetics, by definition, is the science of beauty; that particular detail of an animate or inanimate object that is appealing to the eye which has witnessed it [2]. The main objective of restorative dentistry is to replace damaged tooth structures with materials that possess biological, physical, and functional properties similar to those of natural teeth [3].

Attractive teeth have always been the typical patient's primary concern. In the past, dentists were often dismayed by a patient's disappointment with a "perfect restoration," painstakingly crafted from the finest gold or other material with minimized enamel reduction and long-lasting preservation of function. The patient, of course, had hoped the restoration would mimic the appearance of the original teeth. Todays, by taking full advantage of new materials and techniques, dentists can often meet or even exceed such expectations [2,4].

Bleaching is now one of the most common aesthetic treatments for adults (Anderson, 1991); but bleaching is not new. The earliest efforts to lighten teeth through bleaching in clinical practice took place more than 2 centuries ago, with bleaching agents painted directly

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onto the tooth or packed inside a non-vital tooth. The most effective material was considered hydrogen peroxide [5]. This bleaching agent made bleaching treatments efficient at removing intrinsic stains. Most of the present-day vital bleaching materials contain hydrogen peroxide in some form, or as carbamide peroxide, which breaks down into hydrogen per-oxide [6]. Various methods of vital bleaching have been developed and used over the years. In-office bleaching has been the most common technique during the last 20 years [7]. In-office bleaching is useful for removing discolorations by using a high concentration of hydrogen peroxide (35–38%). The dentist is in complete control of the process throughout the treatment. This provides the advantage of being able to terminate the bleaching process at any time. Studies have shown that higher concentration materials bleach teeth faster. These materials usually work so rapidly that visible results can be observed even after a single visit [8–10].

One important consideration with regard to a restorative material is that the appearance of a restored tooth can be spoiled by the restoration having a matt surface finish, thus making it stand out from the rest of the teeth. The simplest way to assess this is by visually using an impression replica examined under a light microscope or a scanning electron microscope (SEM). It can also be numerically assessed by using a profilometer.

Swift [11] and Haywood [5] reported that bleaching techniques have no significant effects on the color or physical properties of porcelain or other ceramic materials, as well as amalgam or gold. Using a scanning electron microscope [5,11], Bailey and Swift (4) observed slight surface changes in microfilled and hybrid composites after immersion for 4 h daily in fresh bleaching gel [4]. The SEM observations of Turker and Biskin [12] showed only slight changes on the surface of the restorative materials after home bleaching. In a study by Wattanapayungkul et al. [13], the SEM images showed numerous cracks on the surface of the restorative materials after home bleaching The authors Turker and Biskin [12] and Wattanapayungkul and Yap [14] also studied the effects of bleaching on the surface roughness of restorative materials, and found no significant difference in roughness between the control and bleached groups.

To date, no literature data exists on bleaching with 25% hydrogen peroxide, or on the effects of bleaching on currently-used dental restorative materials. Therefore, this in vivo study evaluated the effects of in-office bleaching agents on the surface morphology of three different aesthetic restorative materials.

2. Methods and materials

2.1. Patient selection

The research proposal and study design were approved by the Aesthetical Committee of Research and the IRB at Beirut Arab University. A total of 15 subjects, 18–45 year olds with one or more defective class IV restoration or class IV caries, including the labial surface of the maxillary anterior teeth, were included in the study. Institutional Review Board (IRB) consent forms were obtained from the patients.

The subjects were selected from the outpatient clinic of the Faculty of Dentistry at the Beirut Arab University according to the following exclusion criteria:

1. Subjects who had used bleaching products in the past three years.
2. Subjects who were smokers.
3. Subjects who had had periodontal surgery or scaling carried out in the previous six months.
4. Subjects with chronic periodontitis or signs of pathological origin, or with radiographic signs of pulpal or periapical pathology.
5. Subjects with severe medical complications that would interfere with the study (liver disease, sensitivity to peroxide products etc.).
6. Subjects with systemic diseases or who were taking medication that caused tooth discoloration or Xerostomia.
7. Subjects with severe bruxism, tooth clenching, or unstable occlusion.
8. Subjects with tetracycline stains.
9. Subjects with a previously developed sensitivity to hydrogen peroxide products (H_2O_2).
10. Any cavities where the gingival wall surpassed the cement-enamel junction to ensure all the cavity walls were on the enamel, or if a carious pulp exposure with obvious bleeding occurred.

The preoperative clinical evaluation included complete medical and dental histories, anterior maxillary per apical radiographs, an assessment of pulp vitality and tooth sensitivity, or any history of pain. The subjects were informed about all the details of this investigation and they signed IRB consent forms to participate in this study.

2.2. Grouping

All 15 subjects (36 restorations) were evaluated before bleaching (baseline) after one week of restorations prior to the bleaching treatment and then two days, three months, six months, and one year after bleaching. Evaluation was performed on the replica

Table 1
Number of restorations evaluated at each recall examination.

Materials	T_0	T_1	T_2	T_3	T_4
Bea	12	10	10	10	10
IPS	12	10	10	10	10
Cer	12	10	10	10	10

Bea: Beautifil II group, IPS: IPS Empress Direct group, Cer: Ceram.x.mono group, T_0: Before bleaching, T_1: After two days of bleaching, T_2: After 3 months of bleaching, T_3: After 6 months of bleaching, T_4: After one year of bleaching.

impression for the restoration specimens in the patient's mouth by using scan electron microscopy (SEM).

Out of the 15 subjects (36 restorations), only 12 subjects (30 restorations) remained; this number was the basis for the statistical evaluations during the follow-up periods. Three subjects were excluded for not returning for examination two days after bleaching: The first subject had Beautifil II, the second had Ceram.x.mono, and the third had IPS Empress Direct composite resin restorations. The number of restorations evaluated at each recall is presented in Table 1. The twelve subjects consisted of nine males and three females between the ages of 28–30 years old.

The minimum specimen size required was ten restorations in each group. Each group (n = 4 subjects) consisted of three subjects, who had three upper anterior teeth defective class IV restorations, or class IV caries, and one subject had one upper anterior teeth lesion. They were restored with the same restoration material type, and divided into three groups according to the type of restoration material. Three groups of resin composite materials were used in this study: Beautifil II[1], IPS Empress Direct[2] and Ceram.x.mono[3].

2.3. Cavity preparation

The conservative cavity preparations were set to be conservative in outline, just to include the defective areas which were prepared using number 330 Carbide Burs. The class IV preparations all had margins in the dentin, they had butt-joint preparations, and all the enamel margins were beveled. No base or liner was used, except in deep cavities, where, based on our judgment, an indirect pulp capping was considered necessary. In these cases, the deepest part of the cavity was covered with a thin layer of calcium hydroxide [7]. Shade A_1 was selected for all the restorations to counter any tooth color changes after bleaching; the cavity was etched with 37% phosphoric acid[4] was applied and left undisturbed for 20 s, the air was thinned for 5 s, and the light cured for 40 s using a light curing unit[5] with an intensity of 350 mW/cm^2 [15].

Then the cavities were restored incrementally using the three above mentioned restorative materials, and were placed according to the manufacturer's instructions under complete rubber dam isolation.

Finishing and polishing of the restoration was carried out during the same visit using medium, fine, and superfine polishing discs[6] with a slow-speed hand piece rotating in one direction using the three-step technique [16]. The restored teeth were checked for high points with articulating paper (Table 1). All the subjects underwent oral prophylaxis within two weeks before the placement of the restorations.

2.4. Surface texture measurement

To eliminate bias, The SEM evaluations were performed by one blind examiner; they were evaluated and classified into three categories: Without any change (−), with minor/slight changes (+), or with major/severe changes (++). The criteria that differentiated the minor from the major changes are as follows: Minor/slight changes were those that showed negligible changes in surface texture. These changes would not require any replacement of the restorations in clinical practice.

Major/severe changes were those that showed a loss of resin parts, or even surface cracks in addition to an alteration in surface morphology. A washing out of the composite surface meant a major change in surface morphology. The major changes were those that were detrimental to the material, and would require replacement of that material if used in a restoration [17–19].

[1] Bisphenylglycidyl Dimethacrylate (Bis-GMA), 7.5% Triethylenglycol Dimethacrylate (TEGDMA), 5% Aluminofluoro, 70% Al2O3 (borosilicate glass), DL-Camphorquinone, (Shofu Dental Corporation, USA).

[2] Is a paste of Dimethacrylates, copolymer 20–21%wt, barium glass 77.5–79%wt, (550 nm), initiators, stabilizers, and pigments, (Ivoclar Vivodent, USA).

[3] Is made up of methacrylate modified polysiloxane, dimethacrylate resin, Ba–Al-borosilicate glass 70%, pyrogenic SiO2 57%, camphorquinone, ethyl-4-diemthylamino benzoate, a UV stabilizer, and butylated hydroxy toluene, (DeTrey, Dentsply, Germany).

[4] (Dentsply Detrey) for 15 s and then rinsed with water for 20 s and blot dried. Prime and Bond NT (Dentsply Detrey).

[5] (GNATUS, Fotopolimerizador optilight plus, Brazil).

[6] (Sof-Lex system; 3M ESPE).

The replica surface[7] had no preliminary information about the type of restorations. The surface morphology of the restorative materials was evaluated by using the replica at the following times: Before bleaching, then two days, three months, six months, and one year after bleaching. The measurements were recorded according to the timetable as shown in Table 1.

The selection of a tooth specimen in each subject was randomly assigned for either Beautifil II, IPS Empress Direct, or Ceram.x.mono composite restoration (Table 1).

2.5. Replica Impresion technique

The replica impressions were taken from each patient; a primary impression was taken of the maxillary arch using alginate[8], into which stone[9] was poured.

The resulting cast was used to construct a special perforated tray without palatal coverage to ensure consistent positioning of the replica impression into the subject's mouth by using heavy body impression materials, and then then by reapplying this trial impression into the subject's mouth filled with light body impression materials[10]. If the catalyst and paste were mixed too vigorously, air bubbles might have accumulated in the replica. To correct this problem a very thin layer was applied initially. This was followed by a second layer over the original layer in order to strengthen and ensure a flatter base to the replica, into which epoxcy[11] was poured, thus ensuring that all points in any given area were within working distance of the analyzer. This technique provided an image of the surface topography of each specimen.

2.6. Bleaching procedures

Bleaching was performed using (Zoom bleaching gel) at 25% H_2O_2 and a Zoom Light Source[12], according to the manufacturer's instructions. After the last cycle, all the bleach gel material was removed from the subject's mouth using high-speed suction; the teeth were rinsed with water for about 30 s [20]. At the end of every follow-up test procedure (before bleaching, two days after bleaching, three months after bleaching, six months after bleaching, and one year after bleaching time); the specimens' replica were attached to aluminum stub faces around the samples for better light reflection during the SEM procedures [21,22]. The specimens' replica were then sputter-coated with carbon, and the representative areas were examined, with the surface topography evaluation recorded under a scanning electron microscope[13] at different magnifications.

3. Results

3.1. Surface texture analysis

Scanning electron microscope (SEM) examinations of the restorative materials after bleaching showed observable surface changes on the bleached surfaces and after various application times. Regarding the bleaching agents, their effect on surface texture of the three restorative materials differed according to the type and the time of the follow up.

Surface texture was classified as a percentage of change in surface roughness using a three-category scale where (−) was no change, (+) was minor changes, (++) was major changes. (P_1) represents the comparison between the three composite resin groups (Bea, IPS, and Cer) at the same time period, while (P_2) represents the comparison between the same composite resin group at different time periods in relation to the baseline. A Chi-square test (χ^2) was used to test the qualitative data (Table 2) and SEM micrographs were also presented (Figures 1 to 9).

Comparison between the three composite resin groups (P_1):

There was a statistically highly significant difference in the percentage of change in surface texture among the three composite resin groups after bleaching at all the time periods ($P<0.01$).

Comparison within the group at the different time periods in relation to the baseline before bleaching (P_2):

The Bea group revealed a statistically significant difference in the percentage of change in surface texture after bleaching at all the tested time periods. The IPS group did not show a statistically significant difference at all the time periods, except at one year there was a statistically significant change. The Cer group did not show a statistically significant difference in the percentage of change in surface texture at all the tested time periods (Table 2).

[7] (Epoxy resin, Quick mast 105, Ayla Construction Chemicals, DCP).
[8] (Major Prodotil Dentari, S.P.A, Italy).
[9] (Elite Stone, Italy).
[10] (3M ESPE, Express™ Registration Material, 6160J).
[11] (Quickmast 105, Ayla Constraction Chmicals, DCP).
[12] (Discus Dental, USA).
[13] (Seron Technologies, AIS2100C).

Table 2
Chi-square test results [P1 comparison between the three groups (Bea, IPS and Cer) at the same time period, P2 comparison between the same group at the different time period in relation to baseline].

Groups	T_0				T_1			
	−	+	++	P_2	−	+	++	P_2
Bea	100%	0	0	$P > 0.05$	80%	20%	0	$P = 0.031$*
IPS	100%	0	0	$P > 0.05$	90%	10%	0	$P = 0.305$
Cer	100%	0	0	$P > 0.05$	100%	0	0	$P > 0.05$
P_1	$P > 0.05$				$P < 0.01$**			
Groups	**T_2**				**T_3**			
	-	+	++	**P2**	-	+	++	**P_2**
Bea	80%	20%	0	$P = 0.031$*	70%	30%	0	$P = 0.017$*
IPS	90%	10%	0	$P = 0.305$	90%	10%	0	$P = 0.305$
Cer	100%	0	0	$P > 0.05$	100%	0	0	$P > 0.05$
P_1	$P < 0.01$**				$P < 0.01$**			
Groups	**T_4**							
	-	+	++	**P_2**				
Bea	70%	30%	0	$P = 0.017$*				
IPS	80%	20%	0	$P = 0.031$*				
Cer	90%	10%	0	$P = 0.305$				
P_1	$P < 0.01$**							

*Significant difference at $p < 0.05$ level, **High significant difference at $P < 0.01$ level.
Bea: Beautifil II group, IPS: IPS Empress Direct group, Cer: Ceram.x.mono group.
score (−): Without any change, score (+): With minor/slight change, score (++): With major/severe change.
T_0: Before bleaching, T_1: Two-days after bleaching, T_2: Three-months after bleaching, T_3: Six-months after bleaching, T_4: One-year after bleaching.

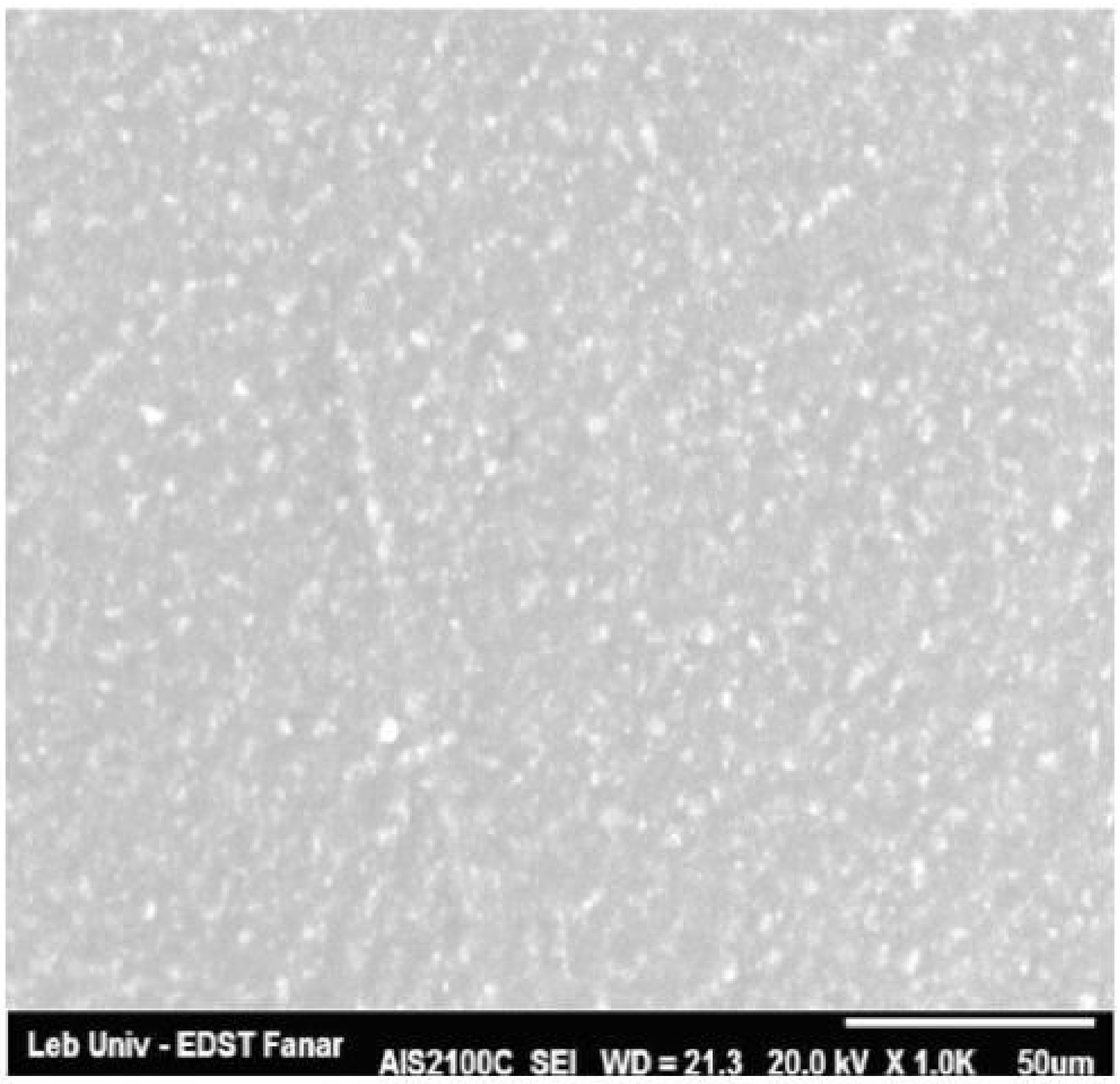

Fig. 1. SEM micrograph of Beautifil II replica before bleaching (1000x magnification).

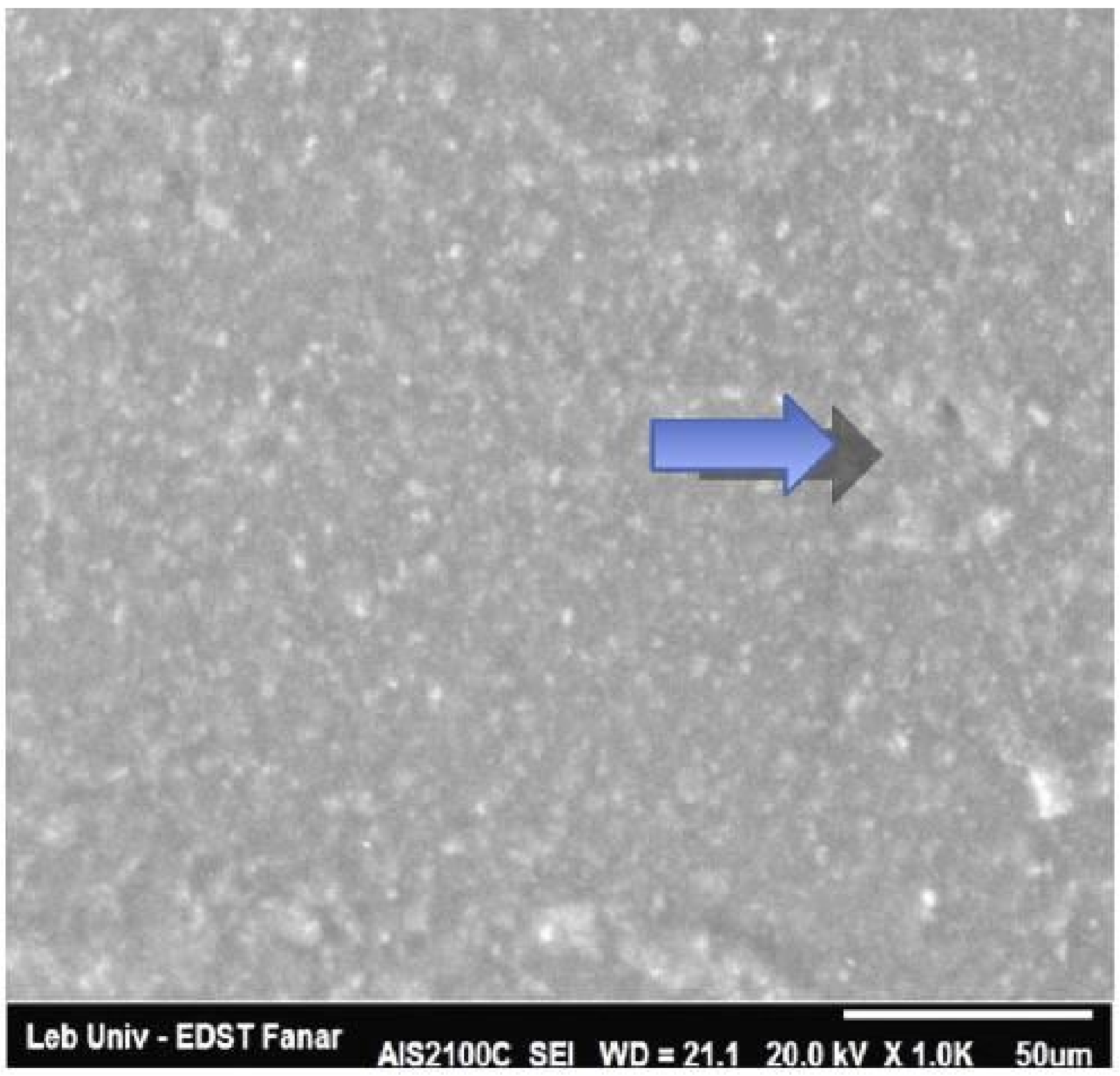

Fig. 2. SEM micrograph of Beautifil II replica two-days after bleaching (1000x magnification).

Figures (1−9) show representative SEM micrographs of the surface textures of the replicas of each group before bleaching, two days after bleaching, and at 1 year at same magnification (1000x). No major changes were found for all the composite resin groups at all the time periods after bleaching. However, some minor changes were found for each group when compared to the before bleaching micrographs.

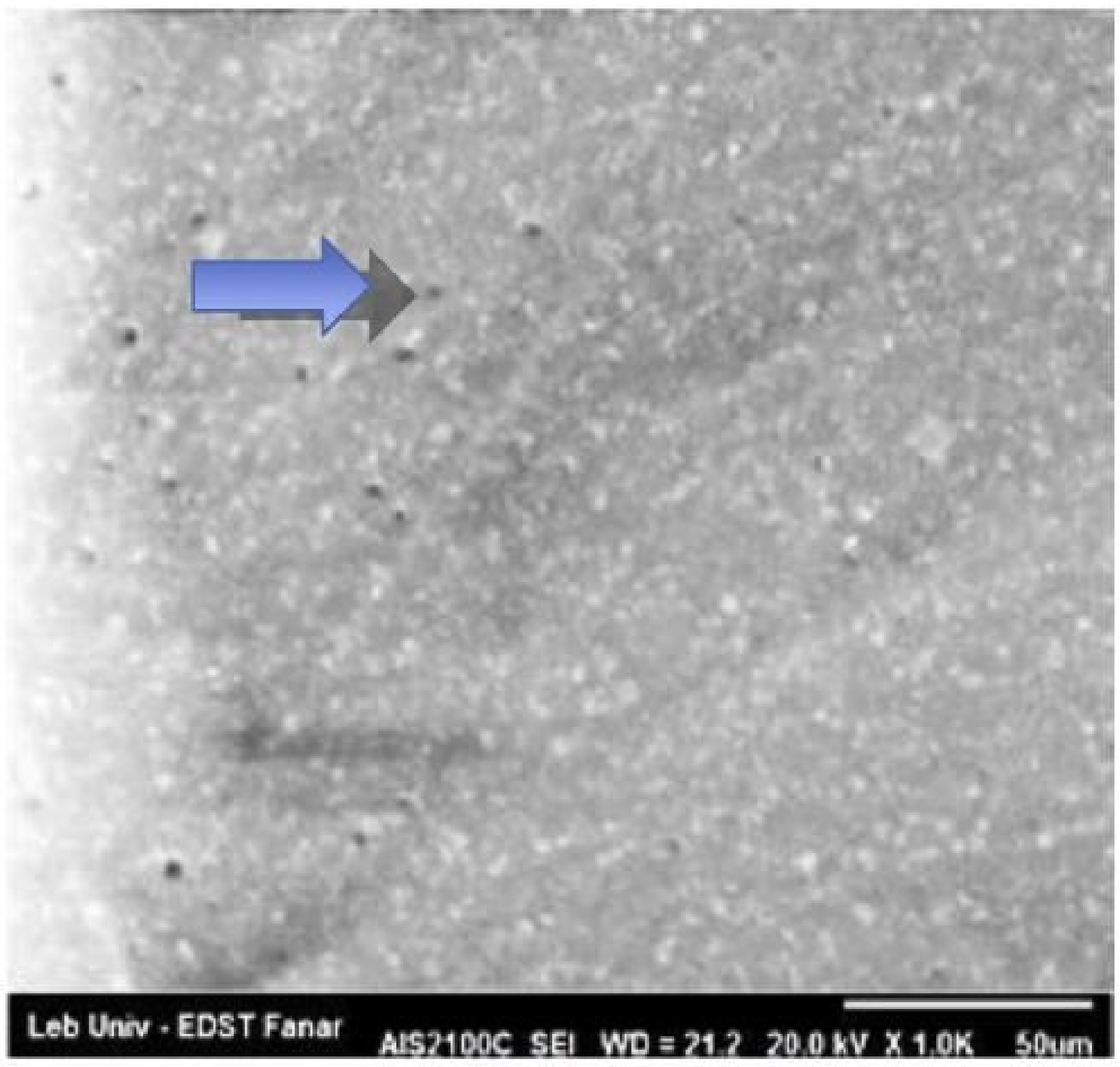

Fig. 3. SEM micrograph of Beautifil II replica one-year after bleaching (1000x magnification).

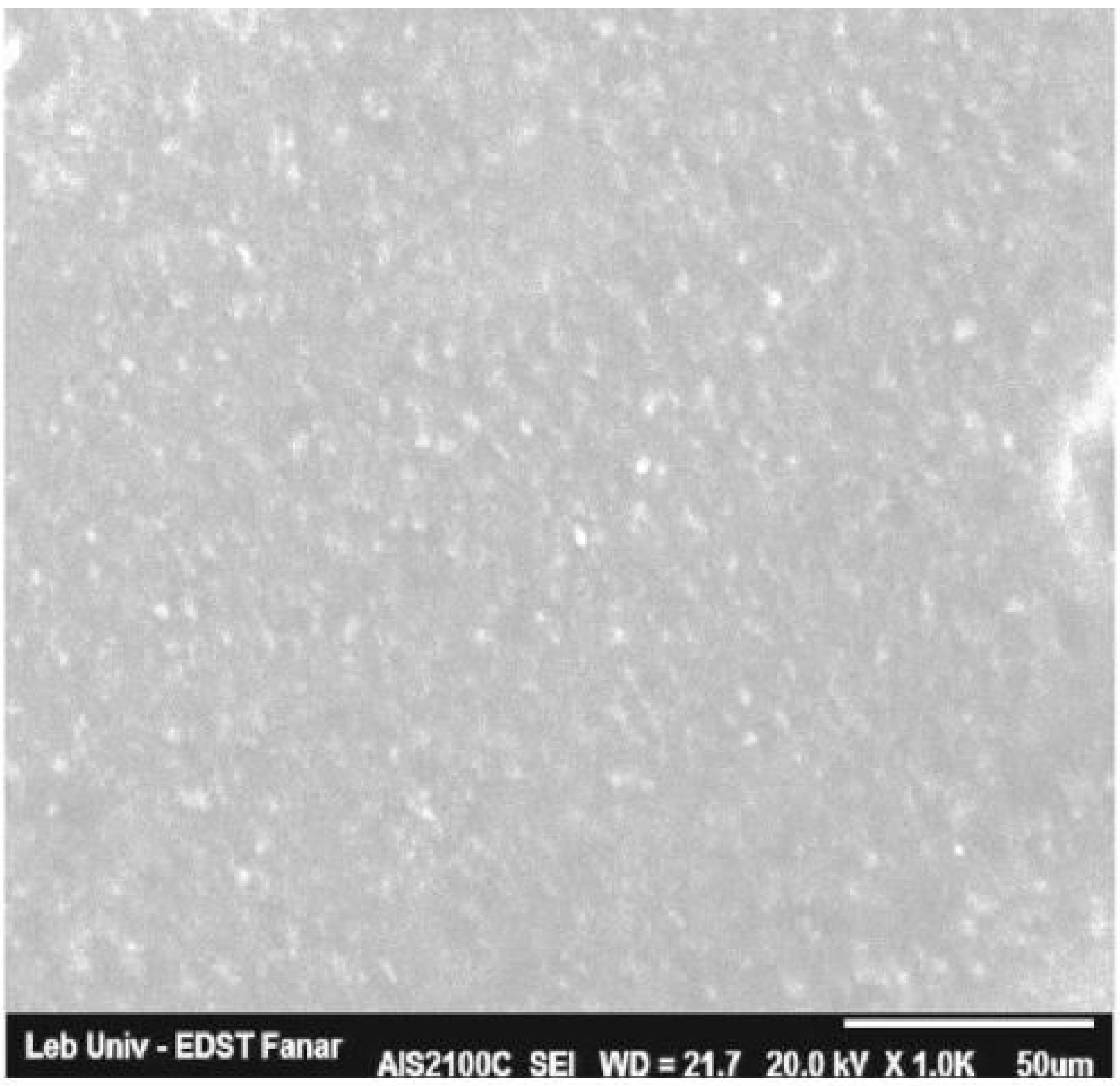

Fig. 4. SEM micrograph of IPS Empress Direct replica before bleaching (1000x magnification).

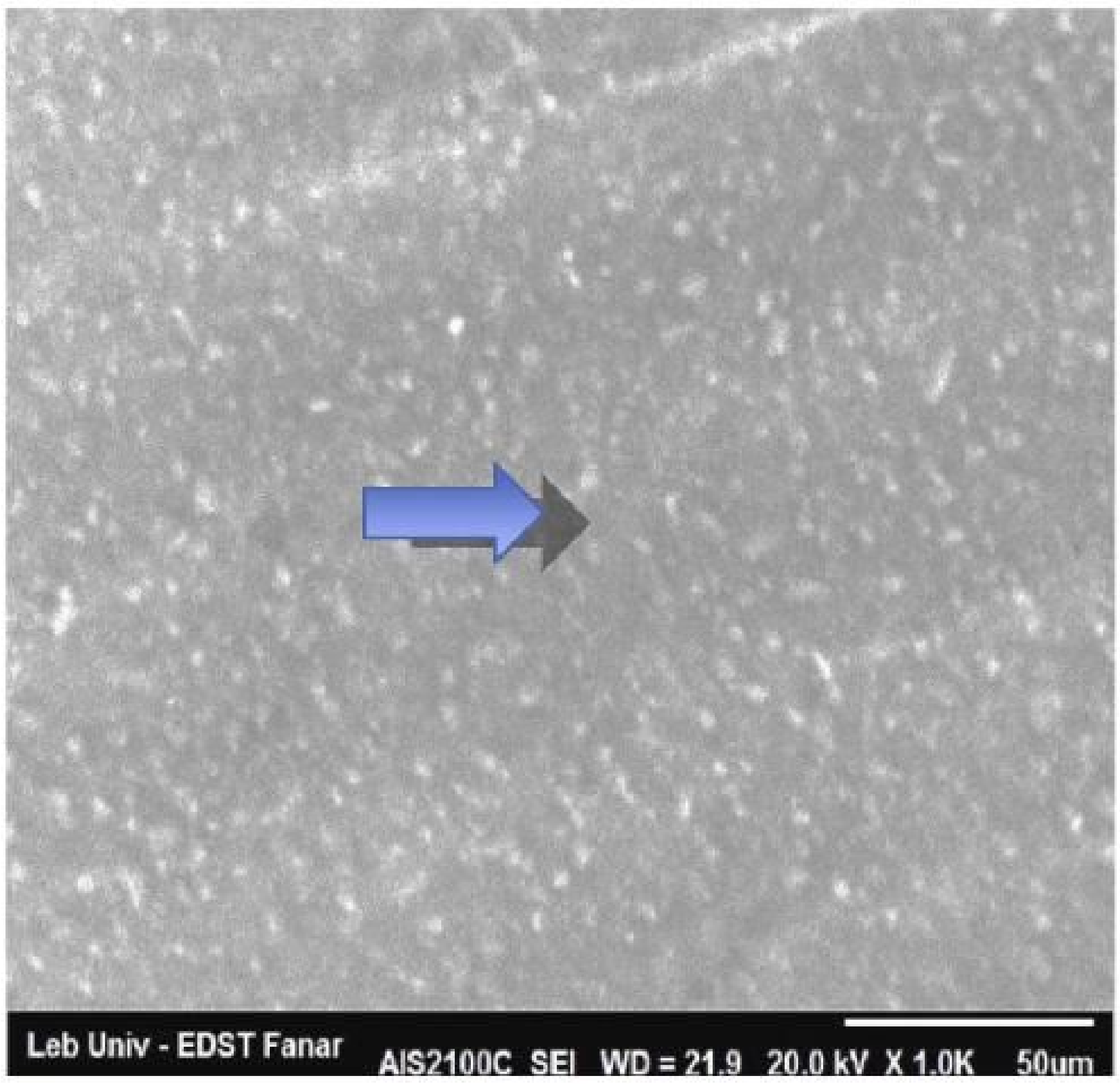

Fig. 5. SEM micrograph of IPS Empress Direct replica two-days after bleaching (1000x magnification).

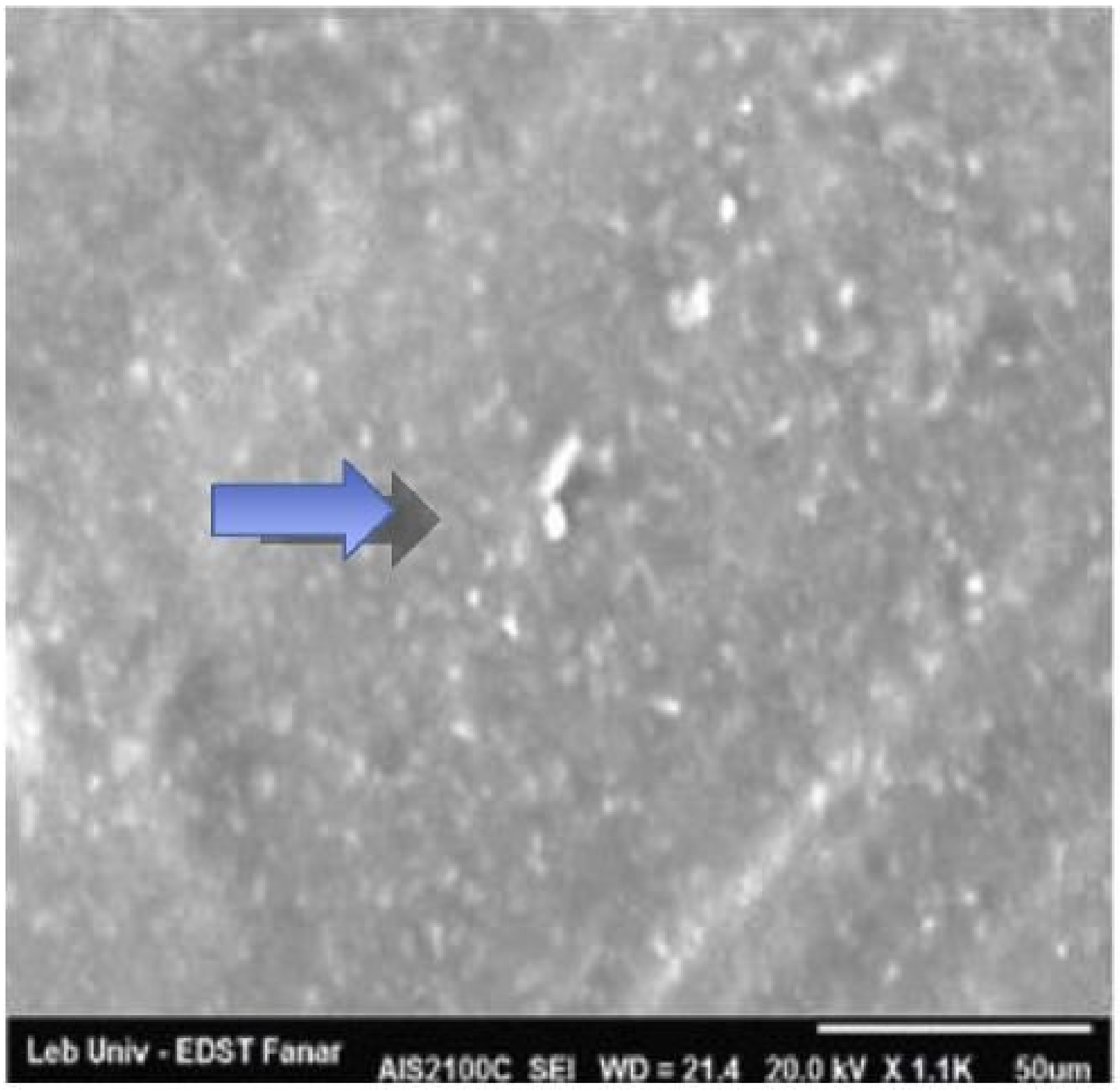

Fig. 6. SEM micrograph of IPS Empress Direct replica one-year after bleaching (1000x magnification).

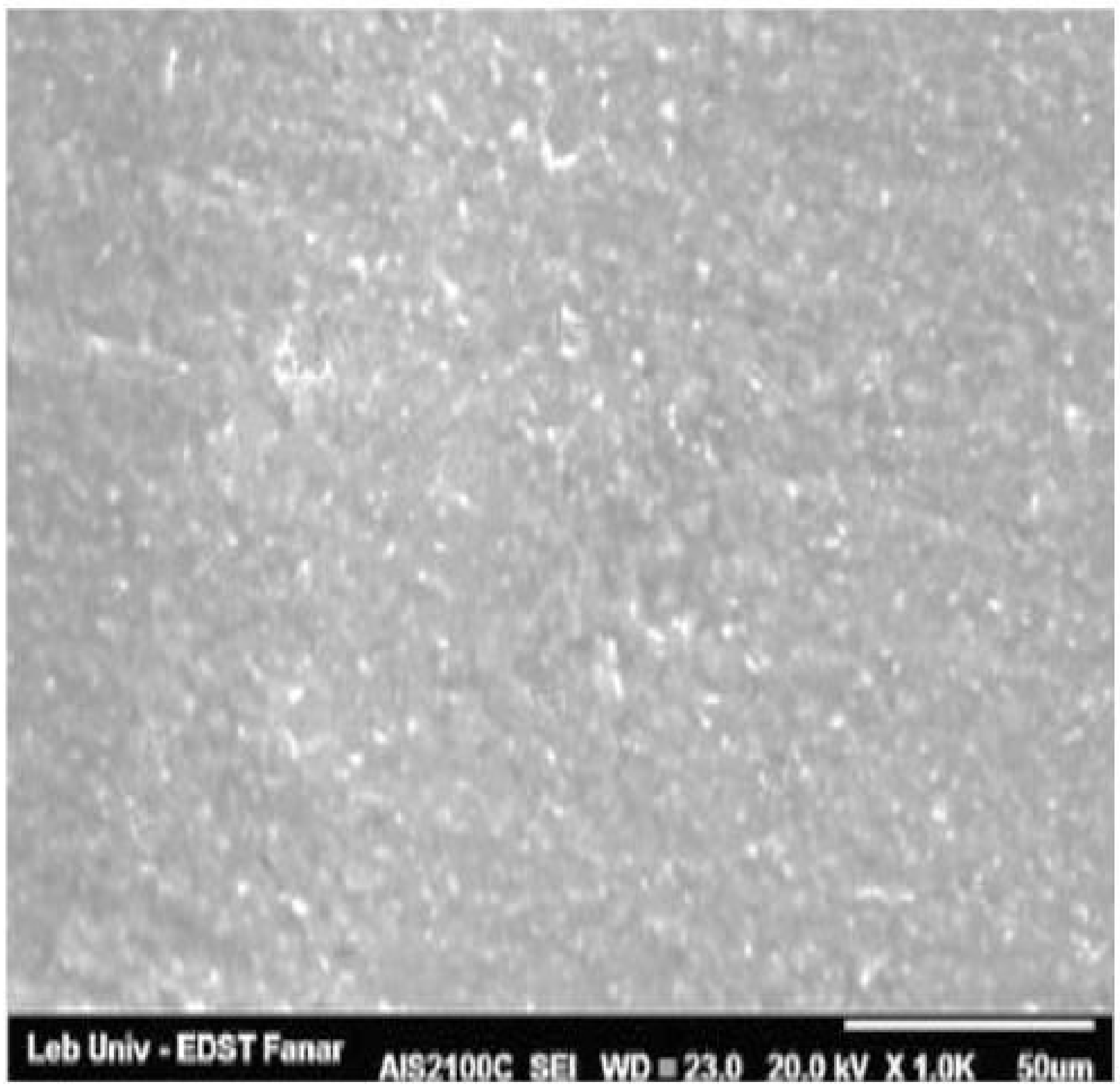

Fig. 7. SEM micrograph of Ceram.x.mono replica before bleaching (1000x magnification).

These changes were in the form of increased notches and surface porosity. Before bleaching, the SEM micrographs of all the composite resins used in this study revealed regular surface morphology with no visible porosity or cracks (Figs. 1, 4 and 7). At two days after bleaching, some porosities were seen in the Beautifil II and IPS Empress Direct replica micrographs (Figs. 2, 5 and 8). No obvious changes were found in the Ceram.x.mono replica micrographs. At one year after bleaching, the three representative SEM micrographs of the composite resin replicas revealed some irregulars and porosities as indicated by the arrows (Figs. 3, 6 and 9).

Fig. 10 represents a comparison between the three composite resin types regarding the percentage of minor changes in surface texture (+) versus no change (−). Minor changes were observed in 30% of the Bea group, 20% of the IPS group, and 10% of the Cer group.

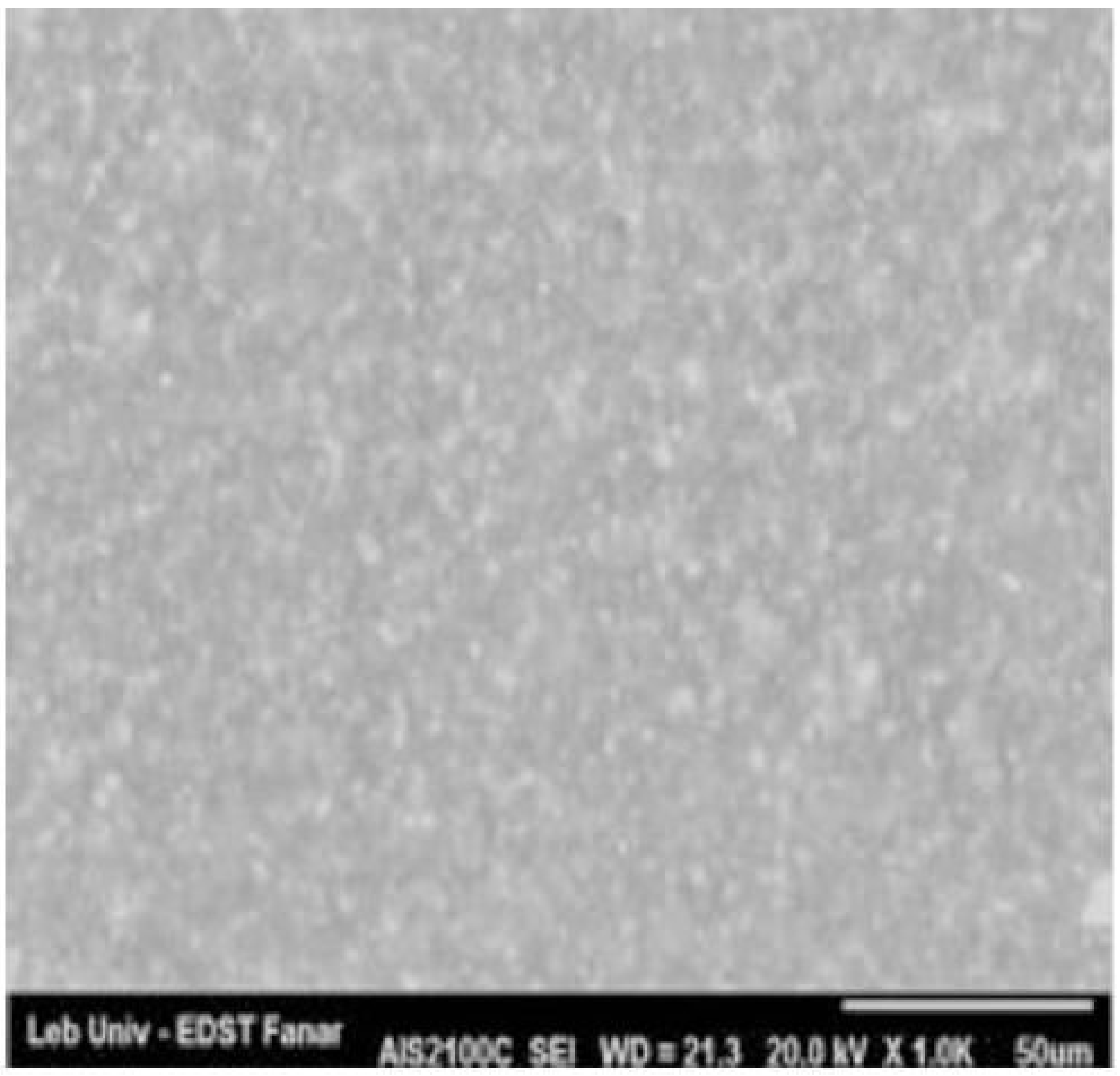

Fig. 8. SEM micrograph of Ceram.x.mono replica two-days after bleaching (1000x magnification).

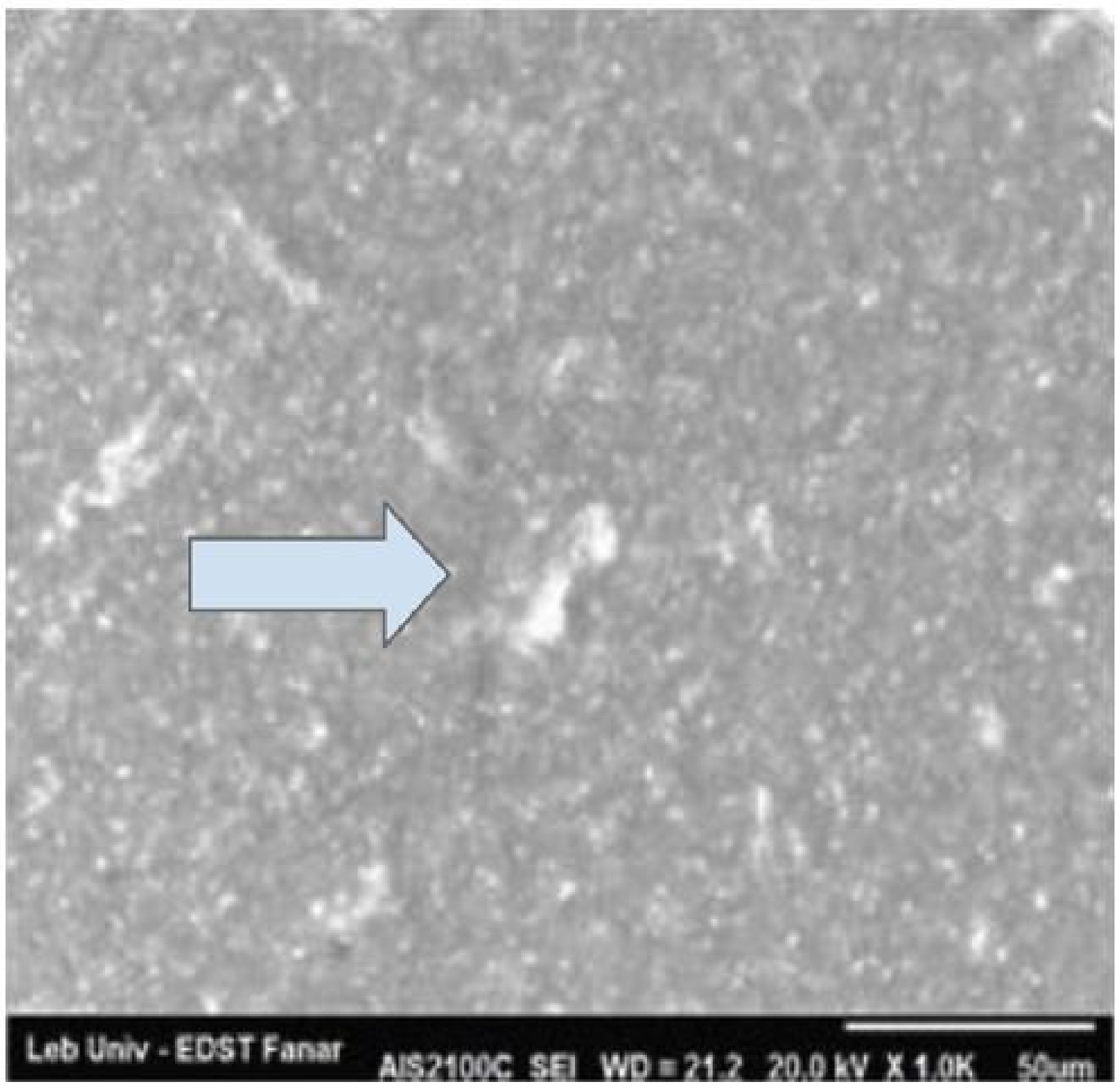

Fig. 9. SEM micrograph Ceram.x.mono replica one-year after bleaching (1000x magnification).

4. Discussion

The purpose of this in vivo study was to evaluate the effects of Zoom gel-bleaching agents on the surfaces of three different aesthetic restorative materials, as well as the effects of different follow-up times on the three different surface treatment situations.

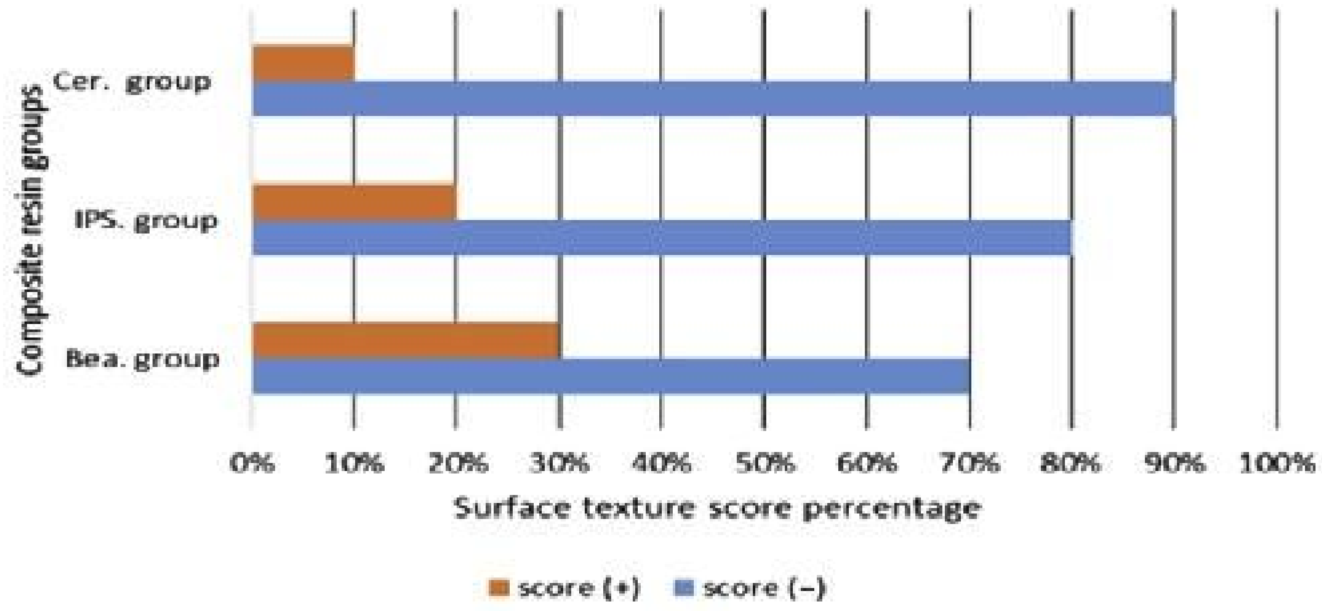

Fig. 10. In vivo surface texture percentage change for the three composite resins.

Light can be reflected from a surface, such as from a mirror, or scattered in all directions. In this case the surface is an ideal reflecting polished surface, while it is not the case in a matt scattering surface. Whether a material has a shiny or a matt surface texture is (more importantly) a function of how smooth the surface is [23].

Few studies have been performed that deal with the effects of bleaching agents on restorative materials. However, it is difficult to compare the results of these studies due to the variety of restorative materials used. For this study, we know of no published studies that are available on the effects of bleaching on some of the restorative materials used in this study. In addition, in the literature, only a few publications were found that addressed the effects of in-office bleaching on the surface texture of restorative materials [14].

According to the SEM micrographs, Zoom gel 25% H_2O_2 was found to have a mild effect on the surface materials. The alterations observed on the surfaces of the restorative materials were primarily found to be slight changes and material-dependent.

The results of this study do not concur with those of previous studies [4,12,23–25].

Schemehorn et al. [24] found no significant effects of 6% hydrogen peroxide on the surface morphology of the hybrid composite being tested. A study by Duschner et al. [25] revealed no significant deleterious effects on the restoration surfaces from 6% hydrogen peroxide. Wattanapayungkul and Yap [14] only found slight differences in surface roughness between the control and bleached groups after in-office bleaching procedures.

They also found differences between the materials, varying somewhat, depending on the treatment procedure. Wattanapayungkul et al. [13] showed that resin-based restoratives may be significantly roughened by the extended use of bleaching agent. Their results, however, were found to be material-dependent, which is in line with the results of this study. The Ceram.-x.mono composites were not significantly affected by bleaching, while the Beautifil II and IPS Empress Direct composites showed changes in roughness, and the SEM images revealed minor changes. Bailey and Swift [4] demonstrated that at-home bleaching agents (10% carbamide peroxide) caused only slight changes (some areas with cracking) to the surface of the micro-filled composite after immersion in fresh bleaching gel for 4 h daily.

In a study by Turker and Biskin [12], the SEM findings showed that the surface roughness of the micro-filled composite was not affected by different carbamide peroxide concentrations (10−16%). In the same study, although there were no significant differences in surface roughness (with respect to the controls) for the micro-filled composite tested, the SEM micrographs showed extensive shallow pitting localized in the center, which was considered worse than after treatment with Nite White and Rembrandt bleaching agents when compared to treatment with Opalescence.

This diminution suggested that the bleaching agents caused erosion on the surface of the composite matrix. Bailey and Swift [4] suggested that the surface changes could be caused by complex interactions within multi-component bleaching products [4]. The roughening was suggested to result from the loss of the matrix, rather than the filler particles [4]. Wattanapayungkul et al. [13] suggested that the differences between the materials could be a result of the difference in the resin matrix components and the filler size [13]. Langsten et al. [26] reported that a higher-concentration carbamide peroxide bleaching agent, used as intended by the manufacturer, posed no significant risk to resin composite restoration surfaces.

Most of the products used in previous studies were home systems and over-the-counter bleaching products. The apparent discrepancies might be explained, in part, by differences in experimental methodologies and the bleaching agents used. While some researchers adopted clinically relevant protocols, others employed continuous exposure of the restorative materials to the bleaching agents over stipulated periods [12,27,28]. The frequent change of bleaching agents may also contribute to the disparity in the results.

In this study, the only material not influenced by the bleaching agent was Ceram.x.mono. This bleaching agent caused minor alterations to the surface of the specimens' replicas to such a degree that the polished restorations by this material should be not replaced after bleaching, as the bleaching was carried out with the Zoom light bleaching agent. The presence of pre-reacted glass ionomer on the surfaces as inorganic fillers of the Beautifil II composite might be the reason that this material is more susceptible to alterations during the bleaching procedure.

In addition to the Beautifil II composite, the SEM micrographs showed that the specimens' replicas from the IPS Empress Direct composite became smoother when they were treated with 25% hydrogen peroxide for 45 min. Additionally, it was found that the specimens' replicas from the Beautifil II and the Empress Direct composites, when treated with 25% hydrogen peroxide, showed minor changes earlier than Ceram.-x.mono. The results pertaining to the Beautifil II composite may be due to the different composition of every composite. The total content of the inorganic fillers of the Beautifil II composite is higher (83%wt) than IPS Empress Direct (79%wt) and Ceram.x.mono (76 %wt).

The differences in effects were more pronounced in the cases of a higher concentrated solution (25% hydrogen peroxide). Bleaching gels contain a variety of aqueous solvents, any of which could contribute alone or in combination with other components to decrease the solubility of the resin matrix. Hydrogen peroxide, in turn, breaks down into free radicals, which eventually combine to form molecular oxygen and water. Some aspect of this chemical process might accelerate the hydrolytic degradation of resin composites, as described by Söderholm [29]. Another aspect may be that hydrogen peroxide and free radicals have an effect on the resin filler interface and cause a filler matrix debonding, thereby leading to changes in the surface roughness [13]. It is important to note that the results are material-dependent, as some tooth-colored materials are more susceptible to alterations, and some bleaching agents are more likely to cause these alterations [30].

The latter may be attributed to the differences in pH between the bleaching agents [31]. This study showed that the composite composition and filler type have an important influence on the effects of bleaching on the surfaces of the materials. The Ceram.x.mono composition and filler type were found to be more stable than the Beautifil II and IPS Empress Direct composites. Alterations to the surfaces of the Beautifil II specimens' replicas were found to be fewer when compared to the alterations observed to the IPS Empress Direct specimens' replicas. This could be explained by the fact that the matrix-finished unpolished surfaces are polymer-rich [32], and that this layer is relatively unstable [33,34]. In contrast, the finished polished surfaces are filler glass-rich and more characteristic of the bulk material [32].

The effects of bleaching gels on the surface roughness of nano-filled composite resins on bovine enamel was evaluated by Wang et al. [35] using three different bleaching agents: 35% hydrogen peroxide Whiteness HP, 35% Whiteness HP MAXX, and 16% carbamide peroxide Whiteness Standard. They found that bleaching gels affected nano-filled and micro-hybrid composite resins. The enamel was the surface least affected. They concluded that surface roughness alterations were material and time dependent.

It is vital to point out that within the limitations of an in vivo experiment, the parameter of the monomer leaching of the composite materials into the oral cavity, the effect of saliva PH, tooth-brushing methods, and the effects of oral cavity thermal changes all had an effect on the restoration surfaces.

The surface of the Beautifil II and IPS Empress Direct specimens' replicas used in this study were altered only slightly after bleaching with 25% hydrogen peroxide. Bleaching did not change the surface of the Ceram.x.mono specimens' replicas. This agrees with the findings of Turker & Biskin [12]. It is a fact that Zoom bleaching gel is a very powerful bleaching agent compared to different concentrations of the others, which may explain the slight changes on the surfaces of the Beautifil II and IPS Empress Direct specimens' replicas because of this bleaching agent. Additionally, the way the Beautifil II and IPS Empress Direct specimens were polished might explain these changes, even though we were polishing with Sof-Lex discs for this kind of restoration.

5. Conclusions

1. The effects of in-office bleaching on the surface morphology of tooth-colored materials was material and time dependent.
2. The composition, filler type, size, and distribution had an important influence on the effects of bleaching on surfaces.
3. Beautifil II and IPS Empress Direct were found to be smoother compared to the Ceram.x.mono specimens in terms of the detrimental effects of bleaching agents.
4. In clinical situations, the restorative materials required no replacement of the restorations after bleaching with Zoom bleaching gel 25%, or changes to their surface morphology, such as staining, the formation of biofilm, and bacterial adhesion.
5. After bleaching with the Beautifil II composite resin the restorations after time may need surface repolishing, while this is not needed after bleaching with IPS Empress Direct and Ceram.x.mono composite resin restorations.
6. Surface roughness is an effective tool to assess the surface changes of materials and the behavior of different types of compositons.
7. The result of surface roughness according to the composition of the materials.
8. The changes in surface roughness are small and considered clinically not significant by the effects of bleaching; however, they are significant by aging.
9. Replicas are more related to qualitative rather than quantitative measurements and they represent the changes in the tooth-restoration surface.
10. Further and longer follow-up studies are recommended at two or three years.
11. These results explain the absence of cracking during surface roughness.
12. Measurements (AFM micrographs) and surface micro-hardness tests.
13. Increasing smoothness representing a healthier field.

Clinical relevance

The in-office Zoom gel agent does not cause changes that would demand a replacement of the restorations when the agents have been applied onto the surfaces of the aesthetic dental restorative materials.

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