**Original Article**

# The Evaluation of the Effect of Coffee Staining and 16% Carbamide Peroxide Bleaching on the Color Change of Chairside CAD/CAM Ceramics

**Gaye Sağlam[1], Seda Cengiz[1]**

[1]Department of Prosthodontics, Faculty of Dentistry, Zonguldak Bülent Ecevit University, Zonguldak

***Received 4February2021 and Accepted 18October 2021***

## Abstract

**Introduction:** The aim of this study was to evaluate the effect of coffee staining and home bleaching agent on the color stability of stained CAD/CAM ceramics.**Methods:** Forty specimens were prepared from feldspathic ceramic (CEREC Blocs) and hybrid nano-ceramic (Cerasmart) CAD/CAM blocks (N=40). The polished specimens were ultrasonically cleaned in distilled water and then, immersed in coffee for seven days. The stained specimens were divided into four subgroups (n=10) according to their type of ceramic and bleaching treatment; CEREC control, CEREC bleaching, Cerasmart control and, Cerasmart bleaching. The home bleaching agent (Opalescence PF 16%) was applied to specimens of bleaching groups for seven days. Control groups did not take any bleaching procedure and were placed in distilled water during this period. Then the specimens were immersed in coffee for seven days again for staining susceptibility. CIELAB parameters were recorded at four times; initial color, 1-week coffee staining, after bleaching, and coffee staining after bleaching with a dental spectrophotometer (VITA Easyshade). Color changes between each step were calculated as ΔE values. The data were statistically analyzed with t-test and Kruskal Wallis test. **Results:** After 1-week coffee staining the highest ΔE values were obtained from Cerasmart ($p<0.001$). The bleached Cerasmart group showed significantly higher color change values compared to Cerasmart control and both CEREC groups ($P<0.05$). No significant differences were found between control and bleached groups in both Cerasmart and CEREC groups after coffee immersion.**Conclusion:** Coffee staining and 16% carbamide peroxide bleaching significantly influenced the color of resin ceramic CAD/CAM materials.

**Keywords:** CAD/CAM, Bleaching, Staining

-------------------------------------------------------

SağlamS, CengizS.The Evaluation of the effect of coffee staining and 16% carbamide peroxide bleaching on the color change of chairside CAD/CAM ceramics. J Dent Mater Tech 2021; 10(4): 198-205.

## Introduction

Computer-aided design and computer-aided manufacturing (CAD/CAM) technology became more popular in dentistry because of their advantages of simplifying the manufacturing process, obtaining more aesthetic and uniform indirect restorations (1). With the development of CAD/CAM technology and the increased aesthetic expectations of patients, various millable restorative material options are launched to the market (2, 3).

Although various materials in different structures are used in the CAD/CAM system, the most frequently used materials in dentistry are ceramics and composites. CEREC block which is composed of feldspathic glass-ceramic, was first launched in 2007, and available in 6 different shades and 3 different color saturation (4). Feldspathic ceramics have high aesthetic properties and these materials are recommended for use in veneer restorations, inlays/onlays and single crowns (5). Cerasmart is a nano-ceramic hybrid material with a matrix containing a homogenous distribution of 71% silica and barium glass, and combines the advantages of both ceramics and composites (6).

Providing an aesthetic appearance can mainly depend on the color, shape, and position of the teeth (7). Especially discoloration is one of the most common reason of aesthetic failure, and poor color match of restoration leads to patient dissatisfaction and additional costs for tooth-colored restorations (8). Restorations in the oral cavity are subjected to various factors, and as a result, the discoloration may occur. Discoloration of restorations, which may be caused by staining beverages, smoking habits, and poor oral hygiene, is the most common reason for replacing a tooth-colored restorations. Toothbrushing, surface polishing, and dental bleaching can be used for removing the stain from restorations (8, 9). Bleaching appears to be a more efficient and conservative method for stain removing compared to other methods (10).

In dental practice external bleaching is mainly done by the following techniques: home bleaching, in-office bleaching, and over-the-counter whitening products (11).The hydrogen peroxide gel with concentrations varying from 30% to 35% is commonly used during in-office procedures. The home bleaching procedures typically use the carbamide peroxide gel with concentrations varying from 10% to 22% (12).

Home bleaching can be applied to remove stains because it is a nondestructive and safe method. The advantages of home bleaching are the use of carbamide peroxides in lower concentrations, ease of application, the ability to bleach the entire arc at the same time, and its low cost (13). Carbamide peroxide with 10% to 16% concentrations can be used during home bleaching with 1-4 week bleaching period and 4-8 hours a day (14).

Currently, there are studies in the literature that evaluate the color stability of CAD/CAM ceramics after immersion in staining solutions (15, 16). However, to the author's knowledge, there are no studies assessing the effect of bleaching on the color change of CAD/CAM ceramics immersed in staining solutions and re-staining after bleaching. The aim of the present study was to evaluate the effect of coffee staining and 16% carbamide peroxide bleaching on the color change and staining susceptibility of feldspathic ceramics and hybrid nano-ceramics. The null hypothesis of the present study was that coffee staining and bleaching would not affect the color stability of CAD/CAM ceramics.

## Materials and Methods

Forty specimens were prepared from two different types of CAD/CAM blocks, a feldspathic ceramic (CEREC Blocks, Sirona Dental Systems, Bensheim, Germany) and a hybrid nano-ceramic (Cerasmart, GC, Tokyo, Japan) (N=20). A2 shade CAD/CAM ceramic blocks were sectioned with a dimensions of 12mm×14mm×1.5mm by using a low-speed precision cutting device (Micracut 201, Metkon, Bursa, Turkey) underwater. The specimens were grounded using 600-800-1200 grit silicon carbide abrasive paper (English Abrasives, London, England) under water. Surface polishing were done by using three-step diamond polisher set (EVE Diapol, Ernst Vetter GmbH, Germany) which contains blue discs for removing and shaping as the first step, pink dics for smoothing as second step, gray discs for polishing as third step, according to the instructions of the manufacturer. The polished specimens were ultrasonically cleaned in distilled water for 5 minutes and then air-dried. The thickness of the specimens was checked using a digital caliper (Alpha Tools, Mannheim, Germany) for standardization.

All specimens were immersed in coffee solution (Nescafe Classic, Nestle, Bursa, Turkey) and was stored in an incubator at 37°C for 7 days during staining. Coffee solutions prepared by pouring 3.6 gr coffee into 300 ml boiling distilled water and were replaced every day to avoid bacteria and yeast contamination. Each sample, once removed from the staining solution and rinsed for 60 seconds with a high-pressure hot-water airbrush and air-dried.

Then, each CEREC and Cerasmart specimens were divided into two subgroups according to the bleaching treatment as follows (n=10);

Group 1: Stained CEREC specimens were stored in distilled water and no bleaching was applied.

Group 2: Stained CEREC specimens were bleached with 16% carbamide peroxide (CP).

Group 3: Stained Cerasmart specimens were stored in distilled water and no bleaching was applied.

Group 4: Stained Cerasmart specimens were bleached with 16% CP.

The home bleaching agent (Opalescence PF 16%, Ultradent Products Inc., South Jordan, Utah) was applied to specimens of bleaching groups. A thin layer of the bleaching agent was applied to the surface of specimens using an applicator at room temperature and then stored at 37°C during the bleaching period. Bleaching agent was left on the specimens for 6 hours per day for 7 daysaccording to the manufacturer's recommendations. Between each bleaching procedure, exposed specimens were washed with water for 60 seconds and stored in distilled water at 37°C until the next application. Control groups (Group 1 and 3) did not take any bleaching procedure, and were placed in distilled water at 37°C during this period. After bleaching treatment, all specimens of four groups were rinsed with high-pressure water and dried with airflow. Then specimens were immersed in coffee solution again for staining after bleaching for seven days, as previously described.

Color measurements were recorded at four-time points; initial, 1-week coffee staining, after bleaching, and coffee staining after bleaching. Color measurements of each sample were performed on a grey background with a dental spectrophotometer (VITA Easyshade Advance 4.0VITA Zahnfabrik, Bad Säckingen, Germany). The probe of the spectrophotometer was settled at the center of the specimens and L*, a*, and b* parameters were recorded. Each sample was measured three times and before each measurement, the spectrophotometer was calibrated according to the manufacturer's instructions.

The color change values (ΔE) between each measurement were obtained using the following formula:

$$\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$$

The ΔE values were obtained for each specimen, $\Delta E_1$ was calculated for color changes between initial and first coffee immersion; $\Delta E_2$ was calculated for color changes between first coffee immersion and bleaching; $\Delta E_3$ was calculated for color changes between bleaching and re-staining after bleaching. ΔE values greater than 2.0 were considered as perceptible color changes (17).

Color changes (ΔE) were evaluated by the National Bureau of Standards (NBS), according to NBS units of color difference (Table I) (18). Following equation was used for calculating NBS units:

$$\text{NBS unit} = \Delta E \times 0.92$$

Surface analysis of the samples was evaluated by obtaining images with a scanning electron microscope (SEM) (Quanta FEG 450, Oxford Instruments, Uedem, Netherlands). SEM images were obtained before and after bleaching under x1000 magnification and evaluated according to the presence or absence of any alteration.

The data were analyzed using statistical software SPSS 19.0 software (IBM SPSS Statistics for Windows, Version 19.0. Armonk, NY: IBM Corp.). The Shapiro Wilk test was used to verify the normal distribution of the data. The data were statistically analyzed with a t-test for comparisons of two groups. Kruskal Wallis test was used for comparisons between four groups. For pairwise comparisons, Bonferonni corrected Mann Whitney U test was performed. In all statistical analyzes $P<0.05$ were considered statistically significant.

**Table I.**National Bureau of Standards (NBS) system of expressing color differences

| Critical remarks of color difference | ΔE NBS units |
|---|---|
| Trace | From 0.0 to < 0.5 |
| Slight | From 0.5 to < 1.5 |
| Noticeable | From 1.5 to < 3.0 |
| Appreciable | From 3.0 to < 6.0 |
| Much | From 6.0 to < 12.0 |
| Very much | ≥12.0 |

## Results

Mean±SD of color changes after coffee staining ($\Delta E_1$), and Median (IQR) of bleaching ($\Delta E_2$), coffee staining after bleaching ($\Delta E_3$) for all materials are shown in Table II. The results of the Shapiro Wilk test showed that normal distribution of data was obtained in $\Delta E_1$. The data of the $\Delta E_2$ and $\Delta E_3$ showed non-normal distribution. According to the $\Delta E_1$ values, the Cerasmart group showed significantly higher values than the CEREC group ($P<0.001$). According to the $\Delta E_2$ values, a significant difference was found in comparison of 4 groups($P=0.026$). The bleached Cerasmart group showed significantly higher color change values than other 3 groups. The lowest color change values were shown in the Cerasmart control group. No significant difference was found between the control groups of Cerasmart and CEREC ($P=0.032$), and between Cerasmart control and CEREC bleached ($P=0.047$). $\Delta E_3$ values showed that no statistically significant differences were found between control and bleached groups in both Cerasmart and CEREC groups after coffee immersion ($P=0.053$). No perceptible color changes were observed in all groups between bleaching and re-staining procedures.

According to the SEM images, similar surfaces were observed in both Cerasmart and CEREC control groups when compared to bleached groups for both materials (Figure 1). The SEM images at 1000x magnification revealed that the 16% CP bleaching agent did not cause additional alterations on the surface of Cerasmart and CEREC bleach groups.

**Table II.** Mean±SD of color changes after coffee staining ($\Delta E_1$), and Median (IQR) of bleaching ($\Delta E_2$), coffee staining after bleaching ($\Delta E_3$) for all materials.

| | $\Delta E_1$ Mean±SD | *P* | Groups | $\Delta E_2$ Median (IQR) | *P* | $\Delta E_3$ Median (IQR) | *P* |
|---|---|---|---|---|---|---|---|
| CEREC | 1,77±0,59 | <0,001 | Group 1 | 1,63 (0,59) | 0,026 | 1,28 (0,23) | 0,053 |
| | | | Group 2 | 1,57 (0,54) | | 1,25 (0,22) | |
| Cerasmart | 2,57±0,58 | | Group 3 | 0,76 (1,78) | | 0,87 (2,44) | |
| | | | Group 4 | 3.46(3.52) | | 1.32 (3.61) | |

Group 1, CEREC specimens, no bleaching was applied;Group 2, CEREC specimens, bleached with 16% CP; Group 3,Cerasmart specimens, no bleaching was applied; Group 4,Cerasmart specimens, bleached with 16% CP.

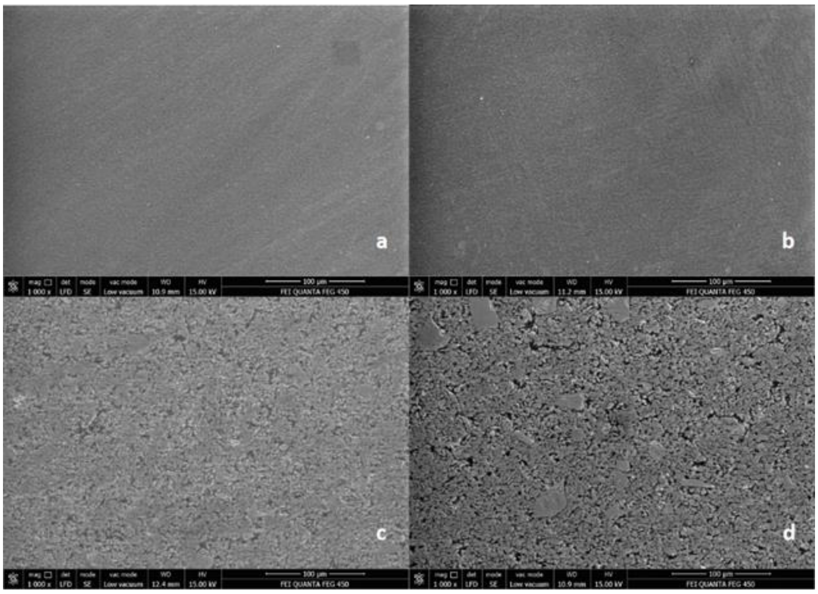

Figure 1. Representative SEM images of control and bleached groups; a. Control Cerasmart; b. Bleached Cerasmart; c. Control CEREC; d. Bleached CEREC

## Discussion

In this study, tested materials were immersed in a coffee solution for staining before and after bleaching. Coffee is one of the most commonly used beverages and includes chromogenic contents such as tannin and chlorogenic acid. Furthermore, its pH is ranging from 4.9 to 5.2 that contributes the discoloration (19). The preparation of beverage and the immersion cycling were performed as described in a previous study (20). One week immersion of samples in coffee solution is equivalent to seven months of coffee drinking (21).

Effects of staining and bleaching on teeth or restorative materials were previously studied (10, 15, 16, 22, 23, 24), and it has been reported that these applications may cause color change on CAD/CAM materials (24). The null hypothesis of the study was rejected, because significant color changes were obtained after staining and bleaching. The results of this study show that higher ΔE values were obtained in Cerasmart compared to CEREC after one-week coffee immersion. Cerasmart presented perceptible color changes (ΔE>2.0) and this finding is in agreement with previous studies. Barutçugil et al., evaluated the color stability of CAD/CAM materials including Cerasmart and they reported perceptible color changes in Cerasmart after immersing in coffee for 24 hours (16). Quek et al., obtained perceptible color changes from hybrid ceramic after one-week coffee immersion (21). The color stability of CEREC was significantly better than Cerasmart after one week coffee immersion. Supporting the results of the present study, Sagsöz et al., compared the staining resistance of feldspathic and resin ceramic CAD/CAM materials in bevareges and reported that CEREC presented greater staining resistance when compared to Cerasmart (15). Karaokutan et al.(25) reported that CEREC showed better color stability than resin nano-creamic blocks after accelerated artificial aging.

Although there have been studies about the effects of bleaching agents on ceramics and composite resins, limited data were available on whether bleaching agents have a definite effect on stained CAD/CAM materials (9, 24). In the present study, while a significant color change was observed only for Cerasmart after bleaching, no significant color change was seen in the CEREC group and the control groups of both two materials. These findings can be attributed to the different composition of Cerasmart and CEREC CAD/CAM materials (26). The significant color changes of Cerasmart after coffee immersion and bleaching process may be related to containing polymers, which uptake water and absorbed pigments due to hydrophilic monomers. Moreover, the surface energy of the resin-based CAD/CAM materials are higher than other restorative materials (27, 28). Resin ceramic materials containing monomers such as BIS-GMA, UDMA, Bis-MEPP or TEGDMA show color changes due to water absorption and therefore, they are affected by both staining and bleaching processes (29). As in the staining process, CEREC exhibits better color stability in the bleaching process because of the hydrophobic ceramic matrix in its structure (30).

Limited data was available about the effect of bleaching on Cerasmart and CEREC CAD/CAM materials in literature. Turker and Biskin reported that 10% to 16% CP causes only slight changes in the optical properties of feldspatic ceramic(31). Öztürk et al.(32) examined the effect of bleaching on Cerasmart and other resin matrix ceramics and reported that home and office bleaching procedures caused color changes in resin matrix ceramics below the clinically acceptable thresholds. In the present study, the perceptible color change was obtained in the Cerasmart group after bleaching.The discrepancy between the two study may due to the application of bleaching gel to the samples stained with coffee in the present study. Because the organic structure of the Cerasmart leads to staining and, bleaching gel act on the pigments and organic structure in the material. On the other hand, Öztürk et al.(9) applied bleaching to the samples that were not stained. Similar to the present study, Alharbi et al., examined the effects of bleaching on stained feldspathic ceramic and resin ceramic materials and less color changes were obtained in feldspathic ceramic group compared to other resin ceramic and resin groups atfer staining and bleaching.

Celik et al. (33) stated that staining of the composite resins did not cause any significant differences between bleached and non-bleached materials. Although different materials were used in the present study, compatible results were obtained in this study. No significant differences were found between bleached and control in both Cerasmart and CEREC groups, this finding could be attributed to similarity in surface roughness of materials created by 16% CP bleaching agent. The highest color change values were seen in the bleached Cerasmart group, which may be related to the UDMA polymer matrix structure of the material.

Demir et al. (34) investigated the effect of 16% carbamide peroxide on the surface of leucite and lithium disilicate CAD/CAM blocks with SEM and demonstrated that surface alterations occurred after bleaching in both two materials. Against the previous study, similar surface images were obtained in the control and the bleached groups in both Cerasmart and CEREC. Despite the use of the same bleaching gel and similar application times, different results may occur depending on the different restorative materials used. In another study, Karakaya et al. (35) reported that 16% carbamide peroxide bleaching did not cause any surface alteration on resin nano-ceramic and polymer-infiltrated ceramic network materials according to the atomic force microscopy evaluation. Also, Polydorou et al. (36)

applied CP (15-38%)to feldspatic porcelain, and they observed no major surface texture changes. Similar to these previous findings, no topographic changes were observed in the present study. Also, supporting these results, no significantly different color change values were observed between control and bleached groups in terms of staining susceptibility.

There are some limitations in the study that, the intraoral environment with factors such as saliva cannot be fully simulated. Furthermore, all surfaces of the specimens were affected during immersion in a staining solution that does not reflect the clinical situation.

## Conclusion

Within the limitaions of the present study, it can be concluded that;

1. Coffee staining significantly affects the Cerasmart blocks compared CEREC blocks.
2. CEREC blocks are significantly less affected by the 16% carbamide peroxide bleaching process compared to Cerasmart.
3. 16% carbamide peroxide bleaching did not affect the staining susceptibility of both Cerasmart and CEREC blocks.
4. Home bleaching process did not cause any additional surface alterations in both two CAD/CAM materials according to SEM micrographs.

## Conflict of interest

Authors declare that they have no financial support or relationships that may represent a conflict of interest.

## Acknowledgment

The authors would like to thank Dr. Mustafa ÇağatayBüyükuysalfor his contribution in statistical analysis of this study.

## References

1. Beuer F, Schweiger J, Edelhoff D. Digital dentistry: an overview of recent developments for CAD/CAM generated restorations. Br Dent J. 2008;204(9):505-511.
2. Raptis NV, Michalakis KX, Hirayama H. Optical behavior of current ceramic systems. Int J Periodontics Restorative Dent. 2006;26(1):31-41.
3. van Noort R. The future of dental devices is digital. Dent Mater. 2012;28(1):3-12.
4. CEREC Blocs-for CEREC/InLab. Operating Instructions. Charlotte, NC: Sirona Dental. Available from: https://assets.dentsplysirona.com/
5. Li RW, Chow TW, Matinlinna JP. Ceramic dental biomaterials and CAD/CAM technology: state of the art. J Prosthodont Res. 2014;58(4):208-216.
6. Awada A, Nathanson D. Mechanical properties of resin-ceramic CAD/CAM restorative materials. J Prosthet Dent. 2015;114(4):587-593.
7. Polydorou O, Mönting JS, Hellwig E, Auschill TM. Effect of in-office tooth bleaching on the microhardness of six dental esthetic restorative materials. Dent Mater. 2007;23(2):153-158.
8. Garoushi S, Lassila L, Hatem M, Shembesh M, Baady L, Salim Z, et al. Influence of staining solutions and whitening procedures on discoloration of hybrid composite resins. Acta Odontol Scand. 2013;71(1):144-150.
9. Alharbi A, Ardu S, Bortolotto T, Krejci I. In-office bleaching efficacy on stain removal from CAD/CAM and direct resin composite materials. J Esthet Restor Dent. 2018;30(1):51-58.
10. Türkün LS, Türkün M. Effect of bleaching and repolishing procedures on coffee and tea stain removal from three anterior composite veneering materials. J Esthet Restor Dent. 2004;16(5):290-301.
11. Kihn P.W. Vital tooth whitening. Dent Clin North Am. 2007;51(2):319-331.
12. Mokhlis GR, Matis BA, Cochran MA, Eckert GJ. A clinical evaluation of carbamide peroxide and hydrogen peroxide whitening agents during daytime use. J Am Dent Assoc. 2000;131(9):1269-1277.
13. Sulieman M. An overview of bleaching techniques: 2. Night guard vital bleaching and

non-vital bleaching. SADJ. 2006;61(8):352-356.

14. Attin T, Hannig C, Wiegand A, Attin R. Effect of bleaching on restorative materials and restorations: a systematic review. Dent Mater. 2004;20(9):852-861.

15. Sagsoz O, Demirci T, Demirci G, Sagsoz NP, Yildiz M. The effects of different polishing techniques on the staining resistance of CAD/CAM resin-ceramics. J Adv Prosthodont. 2016;8(6):417-422.

16. Barutçugil Ç, Bilgili D, Barutcigil K, Dündar A, Büyükkaplan UŞ, Yilmaz B. Discoloration and translucency changes of CAD-CAM materials after exposure to beverages. J Prosthet Dent. 2019;122(3):325-331.

17. Seghi RR, Hewlett ER, Kim J. Visual and instrumental colorimetric assessments of small color differences on translucentdental porcelain. J Dent Res. 1989;68(12):1760-1764.

18. Shotwell JL, Razzoog ME, Koran A. Color stability of long-term soft denture liners. J Prosthet Dent. 1992;68(5):836-838.

19. Alaqeel S. Effect of Grit-blasting on the Color Stability of Zirconia Ceramics Following Exposure to Beverages. Cureus. 2020;12(3).

20. Güler AU, Güler E, Yücel AC, Ertaş E. Effects of polishing procedures on color stability of composite resins. J Appl Oral Sci. 2009;17(2):108-112.

21. Quek SHQ, Yap AUJ, Rosa V, Tan KBC, Teoh KH. Effect of staining beverages on color and translucency of CAD/CAM composites. J Esthet Restor Dent. 2018;30(2):E9-E17.

22. Carlos NR, Pinto A, do Amaral F, França F, Turssi CP, Basting RT. Influence of Staining Solutions on Color Change and Enamel Surface Properties During At-home and In-office Dental Bleaching: An In Situ Study. Oper Dent. 2019;44(6):595-608.

23. Farawati FAL, Hsu SM, O'Neill E, Neal D, Clark A, Esquivel-Upshaw J. Effect of carbamide peroxide bleaching on enamel characteristics and susceptibility to further discoloration. J Prosthet Dent. 2019;121(2):340-346.

24. Gasparik C, Culic B, Varvara MA, Grecu A, Burde A, Dudea D. Effect of accelerated staining and bleaching on chairside CAD/CAM materials with high and low translucency. Dent Mater J. 2019;38(6):987-993.

25. Karaokutan I, Yilmaz Savas T, Aykent F, Ozdere E. Color Stability of CAD/CAM Fabricated Inlays after Accelerated Artificial Aging. J Prosthodont. 2016;25(6):472-477.

26. Kara HB, Aykent F, Ozturk B. The effect of bleaching agents on the color stability of ceromer and porcelain restorative materials in vitro. Oper Dent. 2013;38(1):E1-8.

27. Stawarczyk B, Sener B, Trottmann A, Roos M, Ozcan M, Hämmerle CH. Discoloration of manually fabricated resins and industrially fabricated CAD/CAM blocks versus glass-ceramic: effect of storage media, duration, and subsequent polishing. Dent Mater J. 2012;31(3):377-383.

28. Arocha MA, Basilio J, Llopis J, Di Bella E, Roig M, Ardu S, et al. Colour stainability of indirect CAD-CAM processed composites vs. conventionally laboratory processed composites after immersion in staining solutions. J Dent. 2014;42(7):831-838.

29. Gajewski VE, Pfeifer CS, Fróes-Salgado NR, Boaro LC, Braga RR. Monomers used in resin composites: degree of conversion, mechanical properties and water sorption/solubility. Braz Dent J. 2012;23(5):508-514.

30. Gawriołek M, Sikorska E, Ferreira LF, Costa AI, Khmelinskii I, Krawczyk A, et al. Color and luminescence stability of selected dental materials in vitro. J Prosthodont. 2012;21(2):112-122.

31. Turker SB, Biskin T. Effect of three bleaching agents on the surface properties of three different esthetic restorative materials. J Prosthet Dent. 2003;89(5):466-473.

32. Öztürk C, Çelik E, Özden AN. Influence of bleaching agents on the color change and translucency of resin matrix ceramics. J Esthet Restor Dent. 2020;32(5):530-535.

33. Celik C, Yüzügüllü B, Erkut S, Yazici AR. Effect of bleaching on staining susceptibility of resin composite restorative materials. J Esthet Restor Dent. 2009;21(6):407-414.

34. Demir N, Karci M, Ozcan M. Effects of 16% Carbamide Peroxide Bleaching on the Surface Properties of Glazed Glassy Matrix Ceramics. Biomed Res Int. 2020;2020.

35. Karakaya I, Cengiz-Yanardag E. Changes in Optical Characteristics and Surface Topography of CAD/CAM Materials after Bleaching Applications: An AFM Evaluation. J Prosthodont. 2020;29(3):226-236.

36. Polydorou O, Hellwig E, Auschill TM. The effect of different bleaching agents on the surface texture of restorative materials. Oper Dent. 2006;31(4):473-480.

**Corresponding Author**
Gaye Sağlam
Department of Prosthodontics, Faculty of Dentistry, Zonguldak Bülent Ecevit University, Zonguldak
Tell: (372) 261 36 00
Email: dtgaye@hotmail.com