

# Effect of bleaching systems on properties related to different ceramic surface textures

## Abstract:

Dental bleaching is a conservative alternative to restore the esthetics of either stained or darkened teeth. With careful diagnosis, appropriate treatment planning, and attention to technique, bleaching may represent a more conservative and safe means to lighten discolored teeth. Currently, a broad range of bleaching agents containing varying concentrations of carbamide peroxide (CP) and/or hydrogen peroxide (HP) is available. (CP) agent was introduced as an alternative to traditional hydrogen peroxide agent, and its use has become widespread, this increase in use has also increased the risks of the bleaching agents side effects specially on dental ceramic restorations. The surface texture of the ceramic restoration is very important to be smooth to avoid any roughness accumulating microorganisms, plaque and changing the ceramic shade. This rough surface also make abrasion to the opposing natural teeth. Many studies have proven that there is a little effect of bleaching agents on the properties related to ceramic surface texture properties, but, the higher concentration of carbamide peroxide gel increases the surface roughness of the ceramic restoration.

**Keywords:** Bleaching, ceramic, surface texture, carbamide peroxide, roughness.

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## Introduction:

Tooth bleaching is a cosmetic dentistry procedure that lightens teeth and helps to remove stains and discoloration. It is the most popular treatment by both men and women alike and the treatments available range from one-hour one-time dental visits to take-home do-it-yourself kits. Tooth bleaching is popular because it can significantly improve the appearance of your teeth at much less cost and inconvenience than other techniques [Nixon, P.J., Gahan, M., Robinson, S., Chan, M.F., 2007.](#)

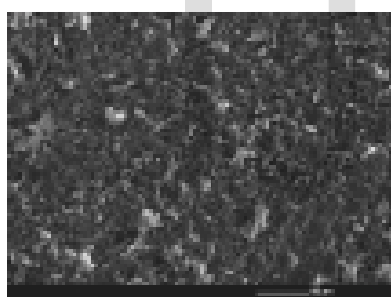
Yellow or stained teeth are a common problems we suffer by age. Our teeth contain enamel, a porcelain-like surface that started out sparkling white. Tooth enamel is

designed to protect the teeth from the effects of chewing, gnashing, trauma and acid attacks caused by sugar.

Over time, our enamel starts to hold stains within its pores and becomes more transparent and permits the yellow color of dentin, the tooth's core material, to show through. As more stains and debris accumulate because of normal wear and tear and eating habits, the teeth develop a dull, lackluster appearance. Tooth whitening exists to remove the stains and debris associated with diet and aging [Matis, BA., Cochran, MA., Franco, M., Al-Ammar, W., Eckert, GJ., Stropes, M.,2007](#) .

By increasing the use of bleaching systems, the fear of side effects of the bleaching agents has increased that it may affect the properties of different cosmetic restoration specially dental ceramic restoration.

A laboratory finished ceramic restoration ideally should retain the surface glaze after it has been fitted to the abutment teeth in the oral cavity ([Boaventura, JM., Nishida, R., Elossais, AA., Lima, DM., Reis, JM., Campos, EA,2013](#)). However, this is not always the case, and there are scenarios where adjustments are required on them. These adjustments and modifications are necessary to correct occlusal interferences and for improvements in aesthetics. A rough surface will abrade the opposing dentition or restoration, and it is highly recommended that the adjusted surface is finished and polished appropriately.



[Figure 1](#): Scanning electron microscopy image of a rough ceramic surface roughened using a diamond instrument

([Martínez-Gomis, J., Bizar, J., Anglada, JM., Samsó, J., Peraire, M.2003](#)) used four different polishing techniques on a ceramic surface. Sof-lex discs white silicon, shofu polishing kit and diamond burs were used, and Sof-lex discs provided the smoothest surface finish. ([Odatsu, T., Jimbo, R., Wennerberg, A., Watanabe, I., Sawase, T.2013.](#)) used carborundum points, silicone points and diamond polishing paste on zirconia and traditional feldspathic porcelain. Feldspathic porcelain showed highest surface roughness values after finishing and polishing procedures.

The use of diamond polishing pastes for porcelain polishing in the dental office is a common practice in dentistry. These pastes provide efficient polishing, and their use can be recommended with an appropriate vehicle. Polishing brushes, rubber cups, polishing brushes combined with abrasive pastes on tooth are the most commonly used procedures clinically.

Loss of surface glaze is the usual result of the clinical intra-oral adjustment process, a situation that must be corrected by re-glazing or polishing to obtain clinical success. Surface treatments affect surface roughness and color stability, and adjusted/polished restorations could also be susceptible to staining ( [Kursoglu, P., Karagoz Motro, PF., Kazazoglu, E.2014](#)) Stainability is another important factor in the long-term clinical success of ceramic restorations. Contour adjustments on restoration surfaces cause differences in ceramic texture that may be affected differently by the staining agent. The use of appropriate polishing materials with a compatible porcelain may reduce stainability.

In this paper we will discuss the different bleaching systems mainly used today, and the bleaching agents used with their different concentrations. This paper presents a review of a number of studies that have examined the visual and microscopic appearance and roughness of autoglazed, unglazed and polished porcelain surfaces after using different bleaching systems using techniques such as, scanning electron microscopy and surface profilometry.

**Types and concentrations of Bleaching agents used:**

Modern bleaching agents used for tooth discolorations contain hydrogen peroxide or carbamide peroxide as active ingredients ([Robinson, FG., Haywood, VB., Myers, M.,1997](#)). These peroxides penetrate the dental hard tissues and oxygenate both the dye substances (chromophores) adsorbed to the enamel surface and those in the enamel and the dentine tissues. In the process of bleaching, the peroxide attacks unsaturated double bonds of the chromophores, which results in colorless oxygenated molecules and particles.

The chromophores lose their coloring capacity, and the natural white tooth color is restored ([Bailey, SJ. and Swift, EJ Jr.,1992](#)). Vital bleaching using carbamide peroxide has been suggested as a safe alternative to vital bleaching with hydrogen peroxide.<sup>5-7</sup> Many of the systems available today use 10%, 15%, 20% or 35% carbamide peroxide as the active ingredient.

Carbamide peroxide solutions are very unstable and immediately dissociate into their constituents after clinical application on contact with tissue or saliva.<sup>5</sup> The 10% to 16% carbamide solution breaks down into 3.5% hydrogen peroxide and 7% to 10% urea. The hydrogen peroxide further degrades into oxygen and water, whereas the urea degrades into ammonia and carbon dioxide.<sup>5,8</sup> Treatment times for night-guard vital bleaching vary extensively and depend on how much time per day the patient spends applying the suggested technique ([Haywood, VB.,1992](#)).

Peroxides	Concentration	Brand(s)	Use
1- Hydrogen Peroxide	10%	1	At home
	35%	1, 2, 3, 4, 7	In Office

Peroxides	Concentration	Brand(s)	Use
		40%	1
2- Carbamide peroxide	10%	1, 2, 3, 4, 6	At Home
	15%	1, 5	At Home
	16%	2, 4	At Home
	20%	1	At Home
	22%	2, 4	At Home
Brand Guide: 1.Ultradent, USA 2.FGM, Brazil 3. DASH, USA	4. DMC, Brazil 5. Fluorescence, USA	6. Nite White, USA 7.Phillips/ ZOOM, USA	

Table 1: Concentrations, use and brands of hydrogen and carbamide peroxides

### Systems of bleaching mainly used:

#### 1- In-office bleaching:

Higher concentrations of Hydrogen Peroxide (25-40%) are used in the clinics to achieve quicker tooth lightening ([Joiner, A. and Thakker, G.,2004](#)). In-office bleach, with its immediate positive outcome, can kick-start a home bleaching regimen. It overcomes the problems of patient compliance, manual dexterity, ([Sulieman .M.,2005](#))and is ideal for those patients with high gag reflex. It prevents patients from the distaste of the bleaching gel.

The treatment in office mandatorily needs isolation and protection, owing to the caustic nature of the high concentration of Hydrogen Peroxide . In-office bleaching results in dehydration; as a result, the shade lightens far more in comparison to baseline shade. On rehydration, the results may be misinterpreted owing to an increased rebound. The clinician can halt the treatment as and when required as he or she is in complete control throughout the procedure.

Hydrogen Peroxide is potent in the first 30 min of mixing, after which the free radicals are depleted ([Sulieman.M.,2004](#)). Depending on the manufacturers' instructions, products are applied in 2-3 mm thickness on the labial surfaces of teeth for a period ranging from 3 to 20 min. The contact of the bleach with the teeth is usually for three periods of 10 min, each termed as "passes." Using gels is advantageous as it contains 10-20% water, which prevents dehydration while bleaching unlike liquid and liquid powder products.

The consistency of the material permits it to remain in intimate contact with the tooth, ([Tam, L.,1992](#)) thus minimizing harm to soft tissues. A thick band of light-cured resin barrier is painted in-between teeth and around the tooth, onto the gingiva for its protection. The isolation of the oral structures depends on the type of power bleaching or the dentists' preference.

Fresh gel is replenished on the surface after suctioning and wiping the tooth clean. The inadvertent leakage of bleach may cause blanching and burning of tissues. Immediately, the area of concern should be washed with copious amount of water followed by the application of neutralizing agent such as Vitamin E supplied with the kit.

Treatment can resume after careful placement of the barrier for recommended bleaching passes. Postbleaching, teeth are polished with diamond-polishing pastes to increase luster and coated with an application of neutral fluoride gel, especially in patients who experience sensitivity. Postbleach shade and photographs with tabs are taken to aid documentation. To stabilize the shade, home bleaching is recommended after in-office bleach.

The oxidation potential of Hydrogen peroxide can be intensified by exposure to heat, LASERS, or intense blue light with a spectrum of wavelength between 480 nm and 520 nm, either to activate the bleaching agent or decrease the time required for bleaching. Various types of curing lights used in bleaching.

## **2-Nightguard vital bleaching:**

Tray-based tooth whiteners are available both professionally and OTC. OTC trays are stock trays that are not comfortable, as they do not adapt to every mouth. Professional trays are fitted trays, in which Carbamide peroxide or Hydrogen peroxide is dispensed at home by the patient, while the concentration and the results are monitored by the dentist ([Carey, CM.,2014](#)).

This dentist-monitored bleaching technique or NGVB is most opted for as it is safe, cost-effective, easy, and has a high success rate, qualifying it as a gold standard against which other techniques are judged. Lower concentration of the bleaching agent is recommended to be used for longer time durations for more number of sessions. Higher concentrations of viscous bleaching agents to whiten the teeth pronto are linked with an increased risk of thermal sensitivity. Depending on the patient's lifestyle, availability of time, and sensitivity, dentist can recommend bleaching during the day or night ([Sulieman ,M.,2005](#)).

Occlusal pressure and increased salivary flow may dilute gels when used during the day. As home bleaching demands compliant patients, it witnesses a high dropout rate. Overzealous patients with a strong urge for whiter teeth replenish the gel frequently or use the trays for a longer period of time leading to thermal sensitivity. For selected cases with different chromas within the same arch, lower and higher concentrations of the bleaching agents can be used simultaneously for lighter and darker teeth, respectively.

An alginate impression is recorded to deliver bleaching trays. Standard trays are made of poly (vinyl acetate) polyethylene sheets with a thickness of 0.9 mm. Reservoirs are placed to hold greater thickness of material to contact teeth. Trays with reservoirs are preferred for viscous materials, bulbous teeth, and darker teeth. However, trays with or without reservoir show no difference in the rate of bleaching ([Haywood .VB.,1997](#)).

The trays could be scalloped following the tooth/gingiva interface, minimizing soft tissue contact and gingival irritation. Unfortunately, this design washes the gel with the ingress of saliva and may also irritate the lip or tongue. Trays that are cut 2 mm over the incisors in a straight line or nonscalloped have a better seal. Trays are modified as per the individual cases, in those with gingival recession or sensitivity, borders are cut back. In cases with crowns or teeth that do not require to be bleached, windows are cut in trays. The trays for bruxers are made from sheets of 1.5 mm thickness, and for those prone to gagging, thinner sheets of 0.5 mm are used.

A stepwise demonstration of the placement of bleach within the tray as per manufacturer's instructions is given to the patients. Brushing and flossing teeth prior to loading the tray is emphasized. Excess material extruded from the tray is removed with cotton wool rolls, toothbrush, cotton bud, or finger. Patients should be instructed to merely clean the tray and store it in a dry place till its use again. Patients should be instructed to discontinue treatment temporarily if irritation within the gingiva or sensitivity sets in.

Sensitivity set can be treated by incorporating desensitizing protocols. Desensitizing toothpaste containing potassium nitrate can be rubbed or brushed against the affected teeth. Neutral fluoride gels, potassium nitrate gels, or desensitizing toothpaste can be worn overnight in the bleaching tray. Preloaded trays of potassium nitrate and neutral fluoride can be used prior to bleach as recommended by manufacturers, relief is almost immediate. The protocol of bleach could be altered by using the same bleach on alternate days or decreased time periods. A lower concentration bleach could be prescribed which may prolong the duration of treatment but will ensure comfort for the patients([Sulieman ,M.,2005](#)).

Patients could anticipate banding of teeth in the initial phase of bleaching, especially with higher concentration of bleach and in lower incisors ([Strassler ,HE., Symer, SE., Hendrix, J.,1997.](#)) The color evens out as the treatment progresses. Bleaching an arch at a time creates an obvious contrast motivating bleaching of lower arch too. The shade of teeth should be reassessed and compared to baseline and noted with patients' consent.

### **3-Over-the-counter whitening strips and gels:**

The strips and gels are two groups of novel tooth whitening system. Strips are thin layers of 5.3% Hydrogen peroxide gel on polyethylene strips, shaped to cover the anterior teeth from canine to canine. They were introduced in 1980 and have reported effective whitening in comparison to home bleaching with 10% Carbamide Peroxide in trays([Matis ,BA., Gaião, U., Blackman, D., Schultz, FA., Eckert, GJ.,1999](#)).

The concentration of Hydrogen peroxide is on the rise with 6.5% Hydrogen peroxide-coated strips available. They are advocated to be used for 14 days. The 5.3% strips are applied twice daily for 30 min and 6.5% Hydrogen peroxide for 30 min in a day. It is difficult to place the strips on malaligned teeth; in addition, they are irritating to the gingiva ([Auschill, TM., Hellwig, E., Schmidale, S., Sculean, A., Arweiler, NB., 2005](#))

#### **4-Whitening rinses:**

The rinse comprises Hydrogen peroxide, which reacts with the stains, lightening the tooth by 1-2 shades ([Carey, CM., 2014](#)). Manufacturers recommend rinsing for 3 months twice daily for 60 s each.

#### **Classification of ceramics according to surface glazed texture:**

1-Autoglazed

2-Reglazed

3-over glazed

4-Chair side polished surface

Surface modifications are essential for correcting occlusal interferences and faulty contours, finishing the margins of ceramic restorations, and improving the esthetic appearance and surface smoothness of porcelain restorations. It is a common clinical practice to adjust the glazed surface of porcelain restorations before cementation by grinding. These Adjustment procedures break the glaze layer which creates a rougher surface which promotes plaque formation and maturation, thus producing gingival inflammation and adverse soft tissue reactions ([Kawai, K., Urano, M., Ebisu, S., 2000](#)). It may also increase the wear of the opposing dentition or restorative material. Therefore, glazing or polishing after the adjustment procedures is necessary to improve the flexural strength and appearance of the restoration ([Chlissel, ER., Newitter, DA., Renner, RR., 1980](#)).

Literature reports of various techniques for finishing and polishing a porcelain restoration to achieve optimum smoothness of the glazed porcelain. Reglazing has been documented to adversely change the porcelain structure (for example devitrification) and is time consuming ([Al-Hiyasat, AS., Saunders, WP., Sharkey, SW., Smith, G., Gilmour, WH., 1997](#)). Polished ceramic restorations, when compared to the glazed restorations, may also have the advantage of reducing the wear of the opposing dentition. Several studies reported different polishing techniques of ceramic restorations and supported the use of polishing as an alternative to glazing.

However, data evaluating different ceramic materials and surface finishing techniques, e.g. self-glazing, overglazing and polishing to achieve the smoothest and strongest porcelain restorations after chair side clinical adjustments is limited. The results had shown that there is no statistically significant difference both



quantitatively and qualitatively, between the surface roughness of reglazed and chair-side polished surface. In addition, both reglazed and chair-side polished surfaces are better than the autoglazed surface.

Company	Group	Mean	N	Standard Deviation
Ivoclar	Autoglazed	.1470	10	.00483
	Reglazed	.1190	10	.00876
	Chair-side polished	.1220	10	.00422
	Total	.1293	30	.01413
Vita	Autoglazed	.1440	10	.00516
	Reglazed	.1140	10	.00966
	Chair-side polished	.1180	10	.00632
	Total	.1253	30	.01525
Total	Autoglazed	.1455	20	.00510
	Reglazed	.1165	20	.00933
	Chair-side polished	.1200	20	.00562
	Total	.1273	60	.01471

Table 2: Shows the means of surface roughness values of three different groups with their respective standard deviations.

**The effect of surface glaze:**

Glazing of ceramic restorations is a routine laboratory procedure which involves the provision of aesthetic and hygienic glass coated surfaces to the finished restorations (Haralur, SB.2012). It is said that glazing is done to strengthen the restoration, but this is uncertain. Binns stated that the process of glazing is a way of strengthening glass. However, he also has questioned the efficacy of this procedure as the surface of a dental porcelain appliance is often ground subsequent to glazing in the dental office and still provides reasonable clinical service.

The procedure of self-glazing is appropriate for the clinical use as this will provide the restoration with a smooth, hygienic surface with specimens showing better color stability. Glazing as the means for strengthening brittle glass can be considered as the production of a surface layer of a thermal expansion which is lower. This will serve two functions that are, it will place the surface into a compressive state, and it will also reduce the depth and width of surface flaws and will strengthen the material theoretically. However, it may be that the strength of dental porcelain is controlled by



intrinsic factors rather than the surface flaws ([Corbitt, G., Morena, R., Fairhurst, C.1985](#)).

Manipulation of porcelain requires adequate skills of laboratory technicians and fabricating porcelain crowns and bridges is highly technique sensitive. Minor laboratory faults may result in clinically unacceptable surface layers. One of the major faults as described by ([Rashid, H. 2012](#)) is the formation of porosities. These porosities may in turn affect the surface roughness, texture and shade. Common reasons for the formation of porosities in dental porcelain are faults during condensation, in-appropriate powder/liquid mixing ratio and due to variations in firing time and temperature.

### **Effect of bleaching agents on different ceramic surface textures:**

Numerous studies have shown bleaching to be effective in whitening certain types of discolored teeth, but its effect on enamel and restorative materials is not clearly understood ([Cabrika, RM., Myers, M., Downey, MC.,1999](#)). Conflicting data exist regarding the effects of bleaching on enamel. Some authors report no alterations after exposure to 10% to 16% carbamide peroxide, while others observed some modifications in enamel especially at lower pH ([Shannon, H., Spencer, P., Gross, K.,1993](#)).

The changes recorded in bleached enamel include pitting and erosion for lower pH solutions, increase in enamel wear rate of bleached teeth, decrease in fracture toughness, and decrease in hardness in the outer enamel. According to ([McGuckin, RS., Babin, JF., Meyer, BJ.,1992](#)), bleached enamel appeared to resemble acid-etched enamel.

[Moraes et al. \(2006\)](#) reported that there was a significant increase in surface roughness of feldspathic porcelain surface after 21 day immersion in carbamid peroxide.

([Matis, BA., Moussa, HN., Cochran, MA.,2000](#)) and ([Leonard, RH., Sharma, A., Haywood, VB.,1998](#)) concluded that lower concentrations of bleach procedures produced similar color changes as higher concentrations if used for longer periods. Regarding bleaching effects on restorative materials, several studies show contradicting results. ([Hunsaker et al](#)) studied the effect of seven brands of bleaching gels on dentine, enamel, and restorative materials and concluded that no major changes were observed with scanning electron microscope examination.

([Turker, SB. and Biskin, T.,2000](#)) investigated the effects of three home bleaching agents on the microhardness of various dental esthetic restorative materials. All the bleaching agents decreased the microhardness of the porcelain and increased that of the light-cured modified glass ionomer cement.

([Turker, SB. and Biskin, T.,2003](#)) also recorded the surface roughness of three restorative materials (Duceram, Ducera Dental GmbH, Rosbah, Germany; Fuji II LC,

GC Corp, Tokyo, Japan; 3M Silux Plus, #M dental products, St. Paul, MN) after using three brands of bleaching agent products (Nite White, Discus Dental Inc, Beverly Dental Inc, Beverly Hills, CA; Opalescence, Ultradent Products Inc, South Jordan, UT; Rembrandt Lightning Gel, Den-Mat Corp, Santa Maria, CA). Surface roughness values increased significantly during the first two weeks for all bleaching groups of each restorative material, with no significant changes observed in the following periods.

([Butler, C., Masri, R., Driscoll, C.,2004](#)) compared the surface roughness of three porcelains (feldspathic, low-fusing, and aluminous porcelains) when exposed to two fluoride solutions, 10% carbamide peroxide, and distilled water. They concluded that for low-fusing ceramic, the autoglazed surface had a significantly high mean of 1.23% fluoride. The other two ceramics were affected after immersion in the three solutions; however, the roughness of the three glazed ceramics was unaffected.

([Kamala, K., Annapurni, H.,2006](#)) tested the effect of three acidic solutions (1.23% APF Gel, 16% carbamide peroxide, Coca-cola) and distilled water (control) on the roughness (Ra) of two ceramics: a low-fusing ceramic (Ivoclar classic) and an all-ceramic (Ivoclar IPS Empress 2). They concluded that acid solutions etched ceramic surfaces of both ceramics.

## Summary:

Dental bleaching is a procedure that has become increasingly popular in dentistry because it appears to be efficient and non-invasive. The treatment can be performed in the dental office by the dentist, or at home by the patient himself. Among the agents available, there are carbamide peroxide (CP) gels at concentrations between 10-40%. Bleaching times vary according to the gel concentration and technique used. Carbamide peroxide is an oxidizing agent; consisting of hydrogen peroxide compounded with urea, that when it comes into contact with the oral tissues and saliva, its constituent parts separate. The 10% to 16% (CP) solution dissociates into 3% to 5% hydrogen peroxide and 7% to 10% urea. Although dental bleaching does not cause macroscopically visible alterations, microscopic alterations may cause undesirable effects. Many studies have assessed the influence of bleaching agents on oral tissues, enamel and dentin. Some studies have assessed the effects of bleaching agents on composites. However, there are hardly any reports on the effects of dental bleaching on dental ceramics, which have been an excellent alternative to substitute metal restorations, due to their characteristics of safety and efficiency when adequate indications and techniques are used. Studies on the effect of (CP) gels on the surface roughness of ceramic dental materials after different exposure times have reported some conflicting results.

## Ethical statement:

This review article does not require ethical approval.

### Conflict of interest:

The author of this manuscript has no conflict of interest to declare.

### Acknowledgment:

No one .

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