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# Color stability of advanced lithium silicate ceramics after coffee thermocycling

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**Abstract:**

Objective: To compare the color stability of different advanced lithium disilicates (ALDS) before and after coffee thermocycling. Materials and methods: Twenty-one rectangular-shaped disk specimens were prepared from three different lithium silicate-based materials (CEREC Tessera, Initial Lisi, Amber Mill) (n=7) for each group. All specimens were finished and polished. Color coordinates were measured with a spectrophotometer. All specimens were then aged with 5000 cycles of coffee thermocycling, and the measurements were repeated. The color difference (ΔE00) was calculated. Statistical analysis was performed using mixed model two-way ANOVA followed by the Tukey post hoc test ($\alpha$=0.05). Results: CEREC Tessera had the least ΔE00=1.8 followed by Initial Lisi=2.24 and Amber mill=3.1.

Conclusion: Cerec Tessera was found to be a promising material regarding color stability.

**Keywords:** CAD CAM ,Pros thodontics, Coffee, Color stability.

**Introduction**

Esthetics has an important role in dentistry due to the increasing demand from patients. As a result, dental ceramics with superior optical and mechanical properties are widely used in recent dentistry. [1]

Advanced lithium disilicate (ALDS) glass ceramics are one of the newest technologies of glass-matrix ceramics found for example in (CEREC Tessera Dentsply Sirona), and in Initial LiSi Block, (GC, Tokyo, Japan) also, Amber Mill (HASS, Kangneung, Korea) that controls the level of translucency, such as high, medium, or low, within the single block depending on the temperature selected during the sintering process. [2,3]

The esthetic result of a ceramic restoration depends on its optical properties. [4,5] Also, color stability plays an important role for the success of the restoration.

Thermocycling has been used widely to simulate the physiological aging of restorative materials by exposing them to repeated exposures of different temperatures. Coffee contains acidic components such as tannin and chlorogenic acid that can accelerate discoloration [6]

This study aimed to evaluate the effect of coffee thermocycling on the color stability of three different CAD-CAM materials (CEREC Tessera – Dentsply Sirona, Initial LiSi – GC, Amber Mill – HASS). The null hypothesis was that coffee thermocycling and material type would not affect the color stability of recent lithium disilicate materials.

**Material and Methods**

Table I. list of CADCAM lithium silicate ceramics used in the study:

| Material | Manufacturer | Classification | Shade | Batch number |
|---|---|---|---|---|
| Cerec Tessera block | Dentsply sirona Milford, DE, USA | Advanced Lithium Disilicate ceramic | HT A2/C14 | 16012251 |
| Initial Lisi block | GC Tokyo, Japan | Advanced Lithium Disilicate ceramic | HT A2/C14 | 2112221 |
| Amber Mill block | Hassbio America | Nanocrystalline Lithium disilicate ceramic | HT A2/C14 | EBE05OF2401 |

Study design: A power analysis was performed with a software program (G*Power 3.1.9.7) to determine the required number of specimens in each group. The effect size (f) was 0.738, the alpha level was 0.05, and the beta was 0.2. The anticipated sample size (n) was 21, with 7 specimens in each group. A total number of 21 ceramics were divided according to material type into three groups:

- ❖ Group T: CEREC Tessera – Dentsply Sirona (n=7)
- ❖ Group L: Initial LiSi Block – GC (n=7)
- ❖ Group A: Amber Mill – HASS (n=7)

Specimen preparation: Disks were machined from all materials of the same A2 shade and the same HT translucency using a low-speed diamond saw ISOMET 4000 (Isomet 4000, BUEHLER, Germany) at a speed of 2500 rpm with an integrated coolant delivery system to cut specimens into a rectangular shape of 10 x 12-mm dimensions and thickness of 1 mm. Digital calipers (Total Digital Caliper, China) were used to verify the desired thickness and flat surface of each specimen.

The Amber Mill specimens were crystallized according to manufacturer instructions to achieve a fully sintered form using a furnace (Ivoclar AG Programat EP3010, Germany) with the setting of 815 ºC, vacuum 1= 550 ºC, vacuum 2 = 815 ºC and with a total time of 15 minutes to obtain specimens in HT translucency as recommended by the manufacturer.

The specimens were polished using a low-speed handpiece and an electric motor with a speed of (5000- 7000 rpm) without coolant and with a light touch using a diamond polishing system for processing lithium disilicate from EVE in the following sequence: red-coated for pre-polishing and yellow-coated for final polishing. All specimens were polished for 40 s on one side by the same operator, with the same touch, and under the same conditions for standardization.

Color measurements: After polishing all specimens, the color measurements were made using a reflection spectrophotometer (Cary 5000 spectrophotometer, Agilent, USA) against a black background, the spectrophotometer had been calibrated before each measurement according to the manufacturer's instructions. All specimens were measured three times, and the average measurement was used to calculate different color variables such as L, a, b, C, and H. ( L: refers to the lightness. A: redness to greenness. B: yellowness to blueness. C: refers to chroma. H: refers to hue)

Coffee thermocycling: All specimens were aged by using 5000 cycles of thermocycling in a coffee solution to simulate 6 months of physiological aging. To make the coffee solution, 177 mL of boiled tap water was combined with 1 tablespoon of coffee. After preparing the solution, it was left for 5 minutes before being used to fill the plastic containers. Subsequently, all specimens were subjected to 5000 cycles of thermocycling in a thermocycler using the coffee solution. The thermocycling involved alternating temperatures between 5 °C and 55 °C with a dwell time of 30 seconds and a bath transfer time of 10 seconds.The coffee solution was replaced by a freshly prepared coffee solution every 24 hours in the hot and cold baths.

Coffee residue was removed from the specimen surface after coffee thermocycling by rinsing under running water followed by cleaning with a toothbrush and toothpaste (Sensodyne, rapid action) 10 times in a circumferential motion under running water and to mimic intraoral brushing. Finally, the specimens were dried with sterile gauze, and the measurements were repeated

Final evaluation: Color parameters were measured again for all specimens after coffee thermocycling by using the same spectrophotometer. Color change (AE2000) was calculated to determine the color stability of different materials using the following equation:

$$\Delta E_{00}^{*} = \sqrt{\left(\frac{\Delta L'}{k_L S_L}\right)^2 + \left(\frac{\Delta C'}{k_C S_C}\right)^2 + \left(\frac{\Delta H'}{k_H S_H}\right)^2 + R_T \frac{\Delta C'}{k_C S_C}\frac{\Delta H'}{k_H S_H}}$$

Numerical data were presented as mean and standard deviation (SD) values. The Tukey post hoc test was performed after the mixed model two-way ANOVA was used to examine the data (α=0.05).

**Results:**

Summary statistics and comparisons of the main effects of color change are presented in (Table II) and (Figure 1). Results showed that Amber Mill had the highest color change followed by Initial LiSi, while CEREC Tessera had the lowest change with all post hoc pairwise comparisons being statistically significant ($p<0.001$).

Table II. Summary statistics and main effects comparisons for color change.

| *Parameter* | | *Color change (ΔE) (Mean±SD)* | *f value* | *p value* |
|---|---|---|---|---|
| *Material* | *CEREC Tessera* | $1.80±0.10^{C}$ | 230.23 | <0.001* |
| | *Initial LiSi* | $2.24±0.12^{B}$ | | |
| | *Amber mill* | $3.10±0.13^{A}$ | | |

Values with different superscripts within the same vertical column are significantly different

*Significant ($p<0.05$).

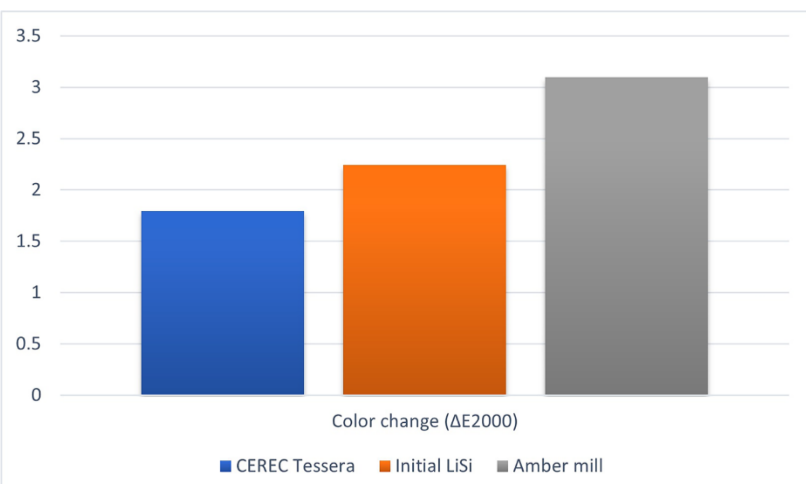


Figure 1- Bar chart showing average color change (ΔE2000) after thermocycling of different materials.

**Discussion**

Aesthetic restorations have become a popular demand among patients who seeking for attractive smile by long-lasting restorations. As a result of the innovation in both ceramic restoration materials and fabrication techniques, there are variable ceramic products and systems on the market that can be used in dentistry. [7] Among all-ceramic systems, Lithium Disilicate is considered to be the gold standard for aesthetic restorations. [8]

Color stability is considered one of the most important factors same as the mechanical properties of the restoration. The quality and lifespan of dental restorations depend partially on the color stability of a restorative material over time so, restorative material should have good color stability to be able to resist any stains from solutions. [9]

A2 shade was selected as it is stated as the most common shade used in dental restorations. [10] 1mm disc thickness was standardized for all samples to mimic 1 mm full crown restoration. Discs were preferred for sample design especially when evaluating the optical properties of a material because they ensure standardized surface quality and size. [11]

Color assessment is a complex process, which is subjected to variable factors. Due to the differences in a person's ability to select identical shades in addition to the subjective nature of color perception, Colorimetric instruments have been used for evaluation of the color differences. Measurement of the color in this study was calculated by $\Delta E2000$ because it is more relevant to dental research. [12–14] Spectrophotometer was used for color measurement because they have been reported to be the preferred instrument to measure color as they are accurate and can evaluate metamerism in opposite to colorimeters that cannot do so and this offered less errors and used in many studies. [3,15]

The null hypothesis was rejected for the effect of coffee thermocycling on the color stability of advanced lithium disilicate.

In this study, color differences were calculated by ΔE2000, The threshold for perceptibility (ΔE00=0.8) and acceptability (ΔE00=1.8) are required to clinically explain the color differences. [16] **Sulaiman et al.** [14] recorded that a CIEDE2000 color difference over 1.8 is considered unacceptable.

There was a significant difference between all materials in CIEDE2000 before and after coffee thermocycling. Cerec Tessera had the best results because it had the least ΔE00 (1,8) and was the only material with a clinically acceptable range, and this may be due to the unique dual crystal structure of lithium disilicate and virgilite in Cerec Tessera The innovation of virgilite crystals enhance both esthetics and mechanical properties, but initial lisi (2.24) and amber mill (3.1) had unacceptable color change perceptible.

## Conclusion

1. Coffee thermocycling has a significant effect on color stability of advanced lithium silicate ceramics
2. Cerec Tessera has the highest color stability within the accepted clinical range.

**References**

1. Awad D, Stawarczyk B, Liebermann A, Ilie N. Translucency of esthetic dental restorative CAD/CAM materials and composite resins with respect to thickness and surface roughness. *J Prosthet Dent*. 2015;113(6):534-540.

2. Lubauer J, Belli R, Peterlik H, Hurle K, Lohbauer U. Grasping the Lithium hype: Insights into modern dental Lithium Silicate glass-ceramics. *Dent Mater*. 2022;38(2):318-332.

3. Jurado CA, El-Gendy T, Hyer J, Tsujimoto A. Color stability of fully- and pre-crystalized chair-side CAD-CAM lithium disilicate restorations after required and additional sintering processes. *J Adv Prosthodont*. 2022;14(1):56-62.

4. Alp G, Subasi MG, Johnston WM, Yilmaz B. Effect of surface treatments and coffee thermocycling on the color and translucency of CAD-CAM monolithic glass-ceramic. *J Prosthet Dent*. 2018;120(2):263-268.

5. Stamenković DD, Tango RN, Todorović A, Karasan D, Sailer I, Paravina RD. Staining and aging-dependent changes in color of CAD-CAM materials. *J Prosthet Dent*. 2021;126(5):672-678.

6. Çakmak G, Weber FA, Donmez MB, Kahveci Ç, Schimmel M, Yilmaz B. Effect of coffee thermocycling on the surface roughness and stainability of denture base materials with different chemical compositions manufactured with additive and subtractive technologies.

*J Esthet Restor Dent*. 2023;(August):1-7. doi:10.1111/jerd.13136

7. Warreth A, Elkareimi Y. All-ceramic restorations: A review of the literature. *Saudi Dent J*. 2020;32(8):365-372. doi:10.1016/j.sdentj.2020.05.004

8. Skyllouriotis AL, Yamamoto HL, Nathanson D. Masking properties of ceramics for veneer restorations. *J Prosthet Dent*. 2017;118(4):517-523. doi:10.1016/j.prosdent.2016.12.003

9. Mezied MS. The effect of thermocycling on the color stability of high translucency monolithic lithium disilicate and cubic zirconia materials. *Saudi J Oral Sci*. 2022;9(3). https://journals.lww.com/sjed/fulltext/2022/09030/the_effect_of_thermocycling_on_the_color_stability.5.aspx

10. Alrifai M, Alharby H, Zubrzycka-Wróbel J, Chałas R. A comparison of anterior teeth color among Polish, Saudi and Taiwanese students of dentistry. *Polish J Public Heal*. 2016;126(3):134-137. doi:10.1515/pjph-2016-0028

11. Turgut S, Bağiş B, Korkmaz FM, Tamam E. Do surface treatments affect the optical properties of ceramic veneers? *J Prosthet Dent*. 2014;112(3):618-624. doi:10.1016/j.prosdent.2014.04.001

12. Paravina RD, Pérez MM, Ghinea R. Acceptability and perceptibility thresholds in dentistry: A comprehensive review of clinical and research applications. *J Esthet Restor Dent Off Publ Am Acad Esthet Dent . [et al]*. 2019;31(2):103-112. doi:10.1111/jerd.12465

13. Sasany R, Donmez MB, de Paula MS, et al. Stainability and translucency of potassium

aluminum sulfate applied computer-aided design and computer-aided manufacturing materials after coffee thermocycling. *J Esthet Restor Dent Off Publ Am Acad Esthet Dent . [et al]*. Published online October 2023. doi:10.1111/jerd.13154

14. Sulaiman TA, Suliman AA, Mohamed EA, Rodgers B, Altak A, Johnston WM. Optical properties of bisacryl-, composite-, ceramic- resin restorative materials: An aging simulation study. *J Esthet Restor Dent*. 2021;33(6):913-918. doi:10.1111/jerd.12653

15. Vasiliu RD, Porojan SD, Bîrdeanu MI, Porojan L. Effect of Thermocycling, Surface Treatments and Microstructure on the Optical Properties and Roughness of CAD-CAM and Heat-Pressed Glass Ceramics. *Mater (Basel, Switzerland)*. 2020;13(2). doi:10.3390/ma13020381

16. Tabatabaian F, Vali S, Namdari M. Effect of surface treatment and surface region on the color stainability of a cemented high-translucency monolithic zirconia ceramic after coffee thermocycling. *J Prosthet Dent*. 2022;127(5):767.e1-767.e7. doi:10.1016/j.prosdent.2022.01.032