

RESTORATIVE DENTISTRY

A Clinical Shade Matching Case Report

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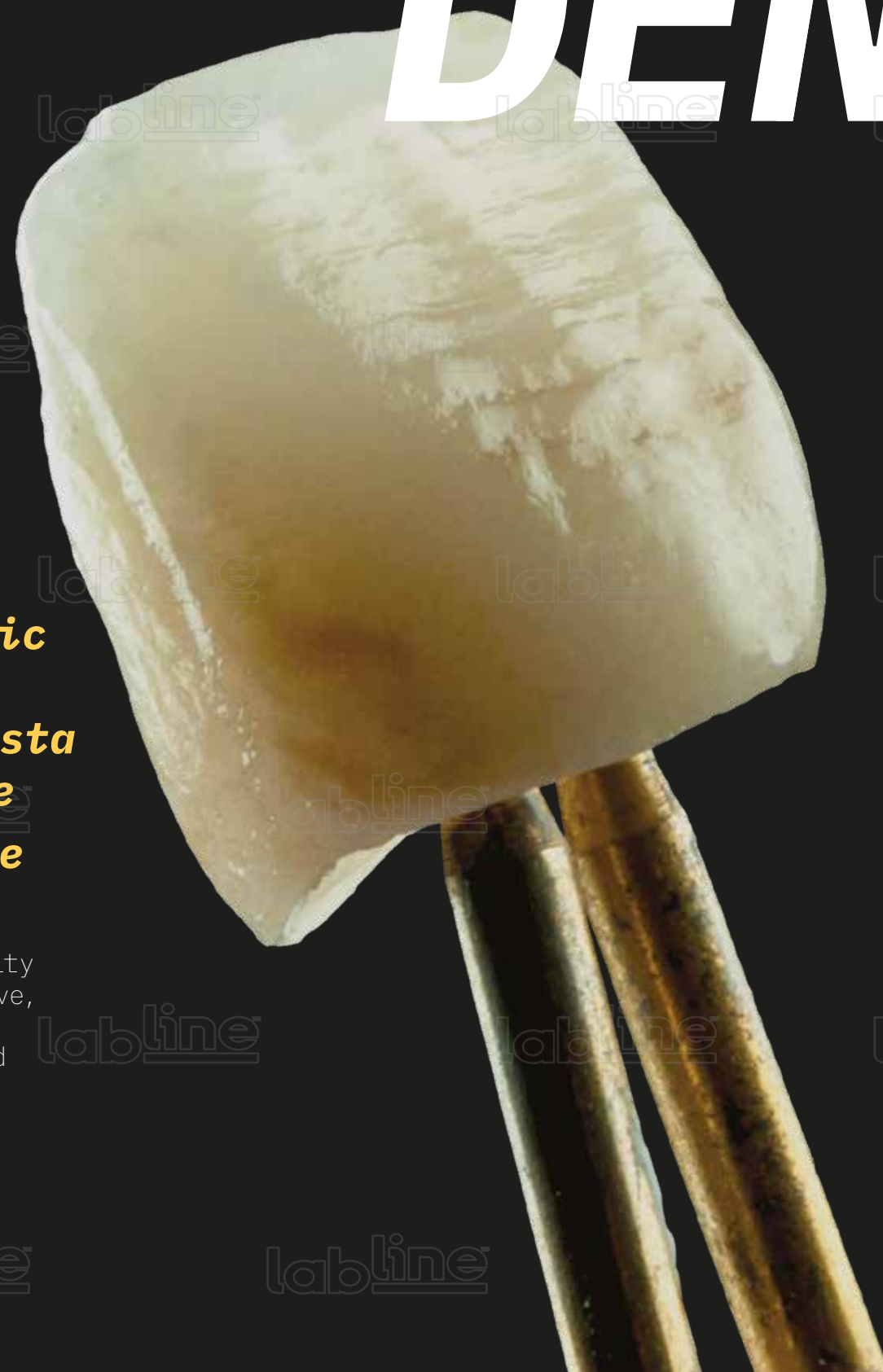
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introduction_

A correct shade match is an essential aspect of restorative and esthetic dentistry. Over the past years, CAD/CAM technology has developed significantly including 3D printing, digital impressions, models, restorations, appliances, and virtual smile designs. Despite many advancements in digital technologies, shade matching remains one of the most perplexing and challenging tasks for dental laboratory technicians and clinicians in the fabrication process of indirect restorations. Restorations harmoniously matching to the rest of the dentition is a combination of science, art, and experience.^{1,2} In addition, proper material and shade selection, photography, and communication are key factors in achieving more predictability.³ A systematic and appropriate approach is required for matching restorations to natural teeth.⁴ This article describes how the authors approach and perform a shade match case with all-ceramic materials by utilizing various tools and techniques practically and methodically.

Clinical phase



A 38-year-old white female presented for consultation with a failing anterior existing fixed partial denture on teeth #'s 9x11. The patient's chief concern was: "I want to have either a new bridge that is more esthetic or implants placed and crowns or a combination." The advantages and disadvantages of both treatment options were explained to the patient.



[Fig. 1.1] Preoperative frontal intraoral image



[Fig. 1.2] Preoperative occlusal intraoral image

The intraoral clinical examination revealed the following findings:

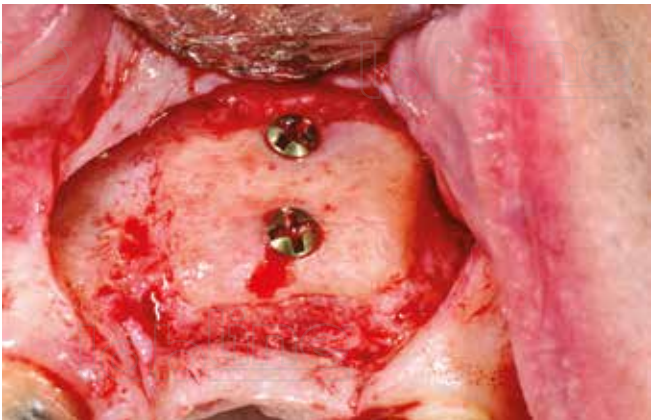
[Figs. 1.1 and 1.2]

- Vertical bone defect site # 11
- Generalized plaque and calculus
- Generalized gingival inflammation
- Severe gingival inflammation # 9 & 11
- Uneven gingival levels
- Non-esthetic fixed partial denture # 9 -11
- Decay associated with # 9,10,12
- Deficient labial bone and tissue concavity #10
- 3mm incisal display at rest
- Canted anterior plane of occlusion from right side to left side
- Width-to-height ratio discrepancy associated with teeth #6, 7, 8, 9, 10, 11
- Gingival black triangles teeth #8 & 9 and 10 & 11
- Bilateral buccal corridor constriction
- 3mm overjet, and 3mm overbite
- Flat lower lip
- Midline deviation to the left side: 1mm
- Slightly gummy smile

The interdisciplinary plan consisted of the following:

[Figs. 2 to 4]

- Removal of the existing fixed partial denture # 9-11
- Removal of all existing decay
- Endodontic therapy tooth #9
- Post and core tooth #9
- Bone graft harvested from the mandible ramus on site #11
- Placement of an endosseous implant at site #11
- Gingivectomy tooth # 9
- Guided bone regeneration & connective tissue graft sites #10 and 11
- Single porcelain crowns tooth # 9 & 12
- Implant supported screw-retained fixed partial denture #11x10



[Fig. 2] Bone Graft



[Fig. 3] Implant Placement



[Fig. 4] Soft Tissue Graft

The clinical phase was accomplished after all previously planned procedures were made to enhance the restorative sites including soft and hard tissues contour as well as ideal contour shape, shade and esthetics of the provisional restorations.⁵ The casts of the existing provisionals and the gingival contour information of implant site were mounted in CR and sent to the laboratory along with digital pictures in order to start the laboratory phase using all the attached information for reference.

Laboratory phase

shade & material selection

The final shade selection was carried out at the beginning of the appointment to avoid dehydration of the natural dentition. 6 3R 1.5 shade was selected as a reference tab for value, hue, and chroma using the VITA 3D Linear Shade Guide [Fig. 5]. A fixed partial denture (FPD) using high strength zirconia with a facial reduction was selected based on stump shade, minimum connector size, preparation design and occlusal scheme.



[Fig. 5] 3R1.5 shade was selected as a reference tab for value, hue, and chroma.

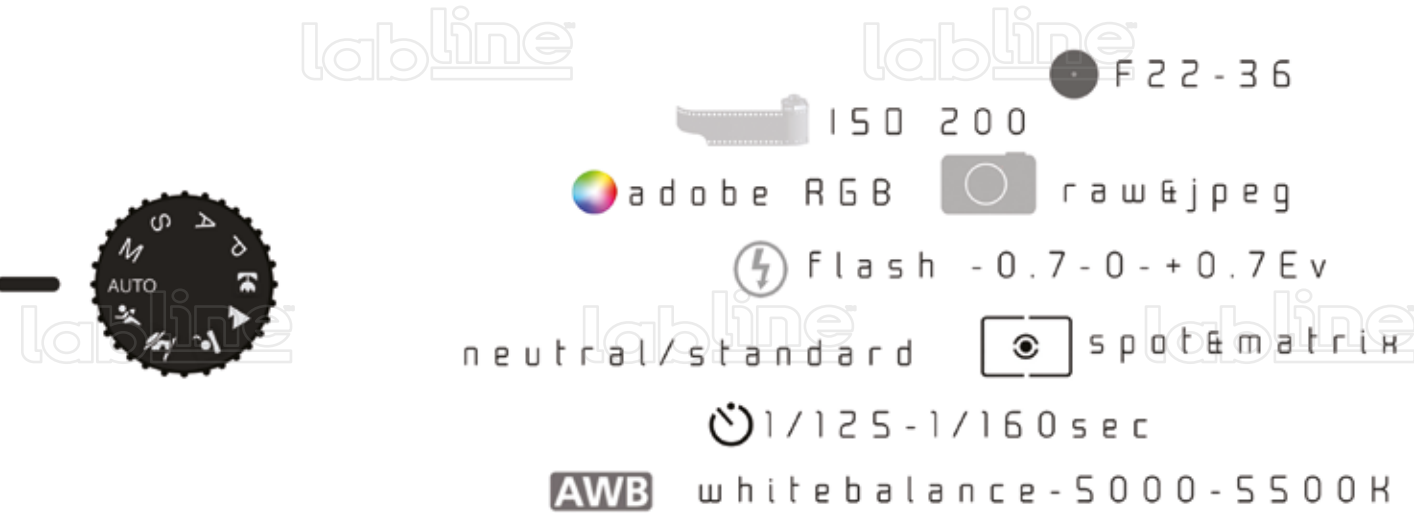
digital photography_



[Fig. 6] Digital camera & equipment

Digital photography is fundamental to achieve more predictable and high-quality results in shade matching cases.⁷ It can help the ceramist to analyze colors, outline form, texture, luster, and allow the ceramist to replicate their observations in the final restorations. Digital photography is also a very useful tool to facilitate shade communication

between the clinician and ceramist. The use of polarized photographs has been suggested to observe internal structure details such as mamelons, crack lines, translucency as well as value, by eliminating surface reflections.^{8,9} For all these reasons, digital photography is an essential tool in shade matching cases [Figs. 6 and 7].



[Fig. 7] Intraoral photography camera settings

full contour wax-up & reduction_

The wax-up design for the final restorations was carefully fabricated using the opposite half of the arch as a reference [Figs. 8 and 9]. A reduction was performed in the wax stage using a silicone matrix to create sufficient space for the layered porcelain [Fig. 10]. Precise attention was given to the design in order to meet the functional and esthetical goals.¹⁰



[Fig. 8] Full contour wax-up



[Fig. 9] Full contour wax-up

[Fig. 10] Cut-back in the wax stage



ceramic build-up sequence_

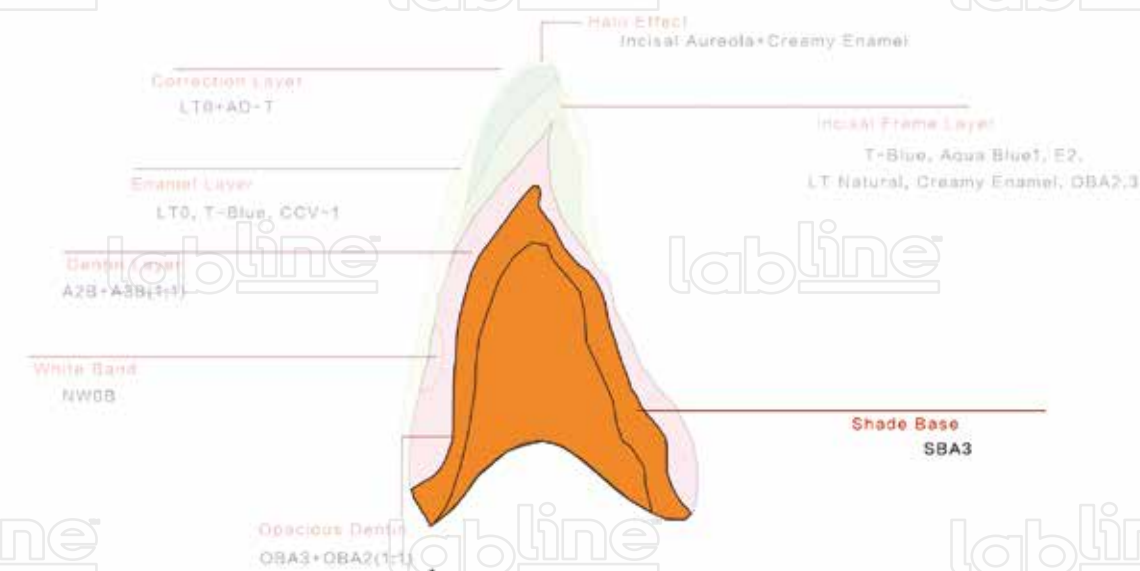
shade base_

The definitive restorations were fabricated using Noritake CZR (Noritake/Kuraray USA).

A shade base bake was carried out using SBA3 on the zirconia copings to establish the base shade [Figs. 11 to 13].



[Fig. 12] Firing Parameters for Shade Base



[Fig. 11] Color Map for Shade Base

Drying			3:00
Closing			3:00
Preheating	580°C		2:00
High Temperature	950°C	45°C/min	1:00
Vac(off/level/hold)	950°C	100%	--:--

[Fig. 13] Firing Parameters for Shade Base

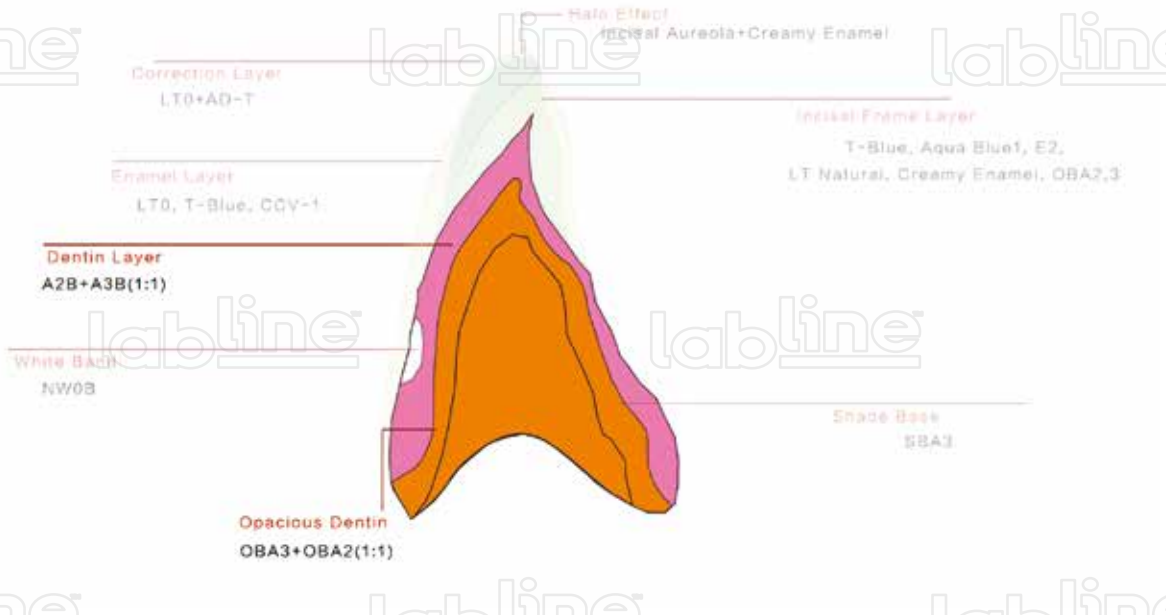


opacious dentin & dentin_

After the first bake, OBA2 (50%)+OBA3 (50%) were applied on the cervical 1/3 and A2B (50%) +A3B (50%) were applied on the middle 1/3 and incisal 1/3 areas to establish the desired value, sufficient chromatic base, and opacity [Figs. 14 to 16].



[Fig. 15] Color Map for Opacious Dentin & Dentin



[Fig. 14] Color Map for Opacious Dentin & Dentin

Drying			3:00
Closing			3:00
Preheating	580°C		2:00
High Temperature	940°C	45°C/min	1:30
Vac(off/level/hold)	940°C	100%	--:--

[Fig. 16] Firing Parameters for Opacious Dentin & Dentin

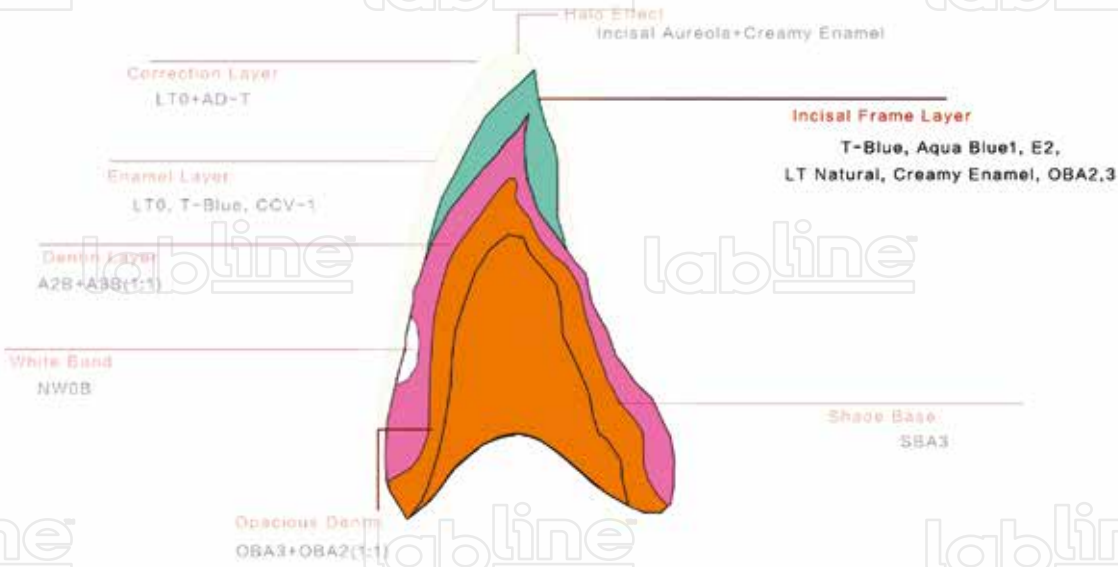


incisal frame_

For the construction of the natural translucent appearance often found in nature, the following powders were used segmentally in the incisal 1/3 area, mamelon: E2, T-Blue, Aqua Blue1, Incisal Aureola, Creamy Enamel, and OBA2, OBA3. The second layer firing (Opacious Dentin, Dentin, and Incisal Frame) was baked at 940°C under vacuum for 90 seconds [Figs. 17 to 19].



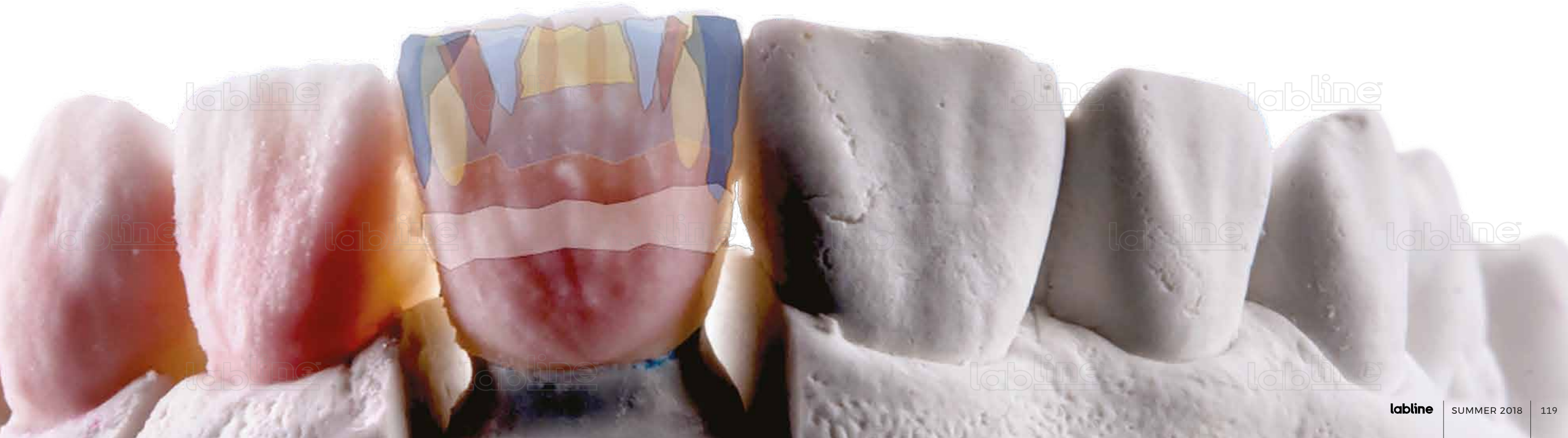
[Fig. 19] Color Map for Incisal Frame

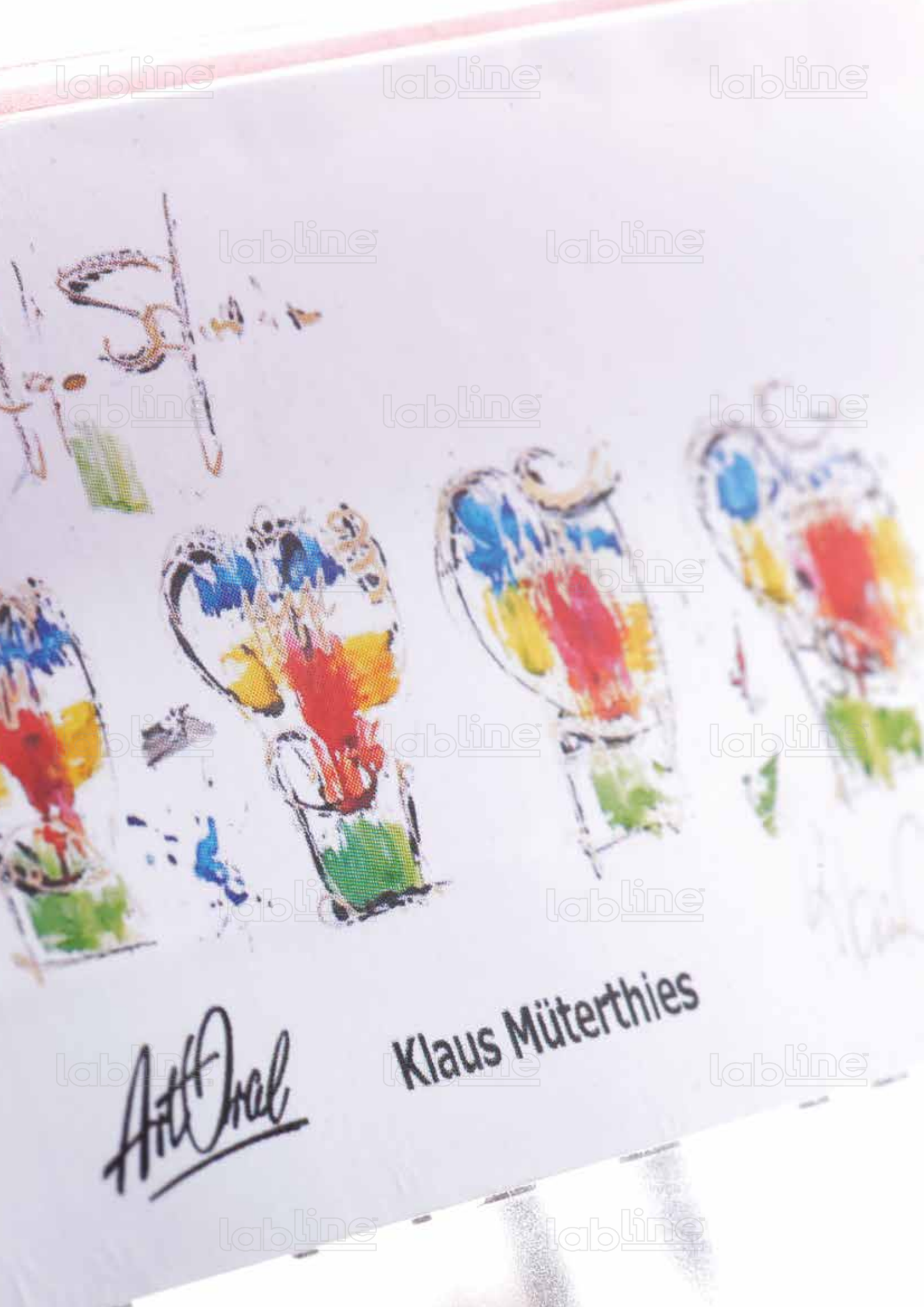


[Fig. 17] Color Map for Incisal Frame

Drying			3:00
Closing			3:00
Preheating	580°C		2:00
High Temperature	940°C	45°C/min	1:30
Vac(off/level/hold)	940°C	100%	--:--

[Fig. 18] Firing Parameters for Incisal Frame





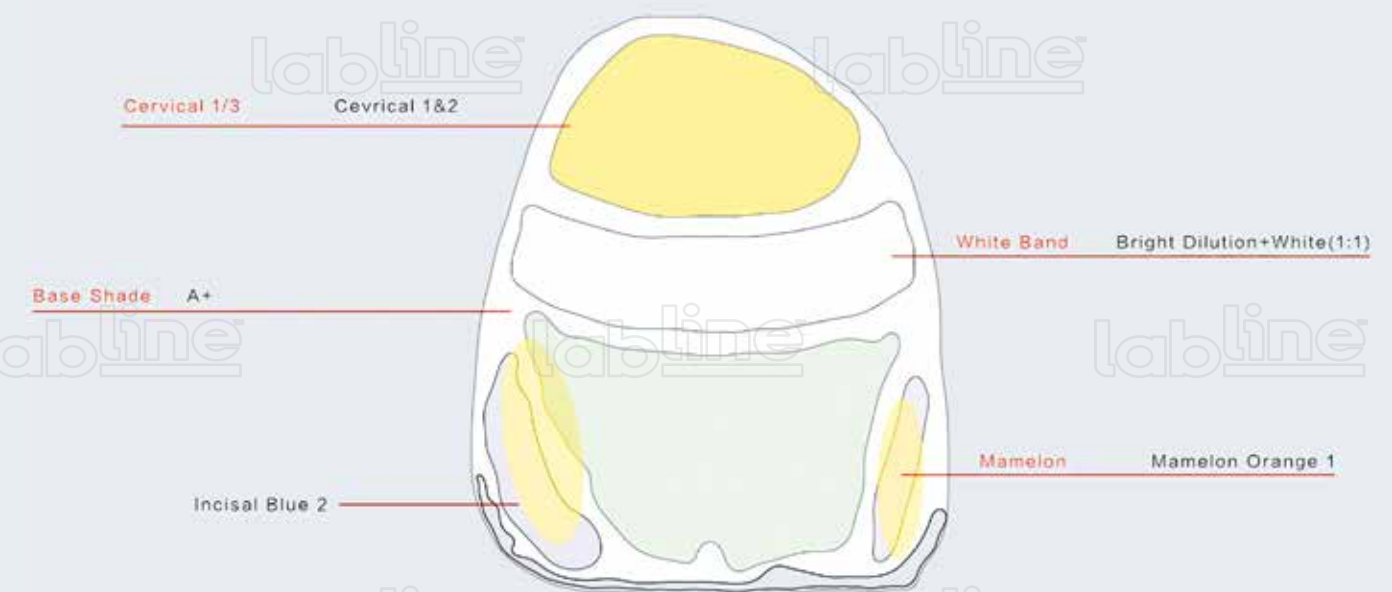
internal stain_

After the first Dentin/Frame bake, the surface was prepared for the internal live stain using a fine diamond and gently removing the skin layer. Using internal stain and dilution ceramic, the internal stain stage was then conducted two times horizontally and vertically to reproduce internal characterization such as mamelons, crack lines, white bands and halo. The stain bake was carried out without vacuum 80°C lower than the second bake to hold stains on the surface

[Figs. 20 and 21].

Drying			3:00
Closing			3:00
Preheating	580°C		2:00
High Temperature	860°C	65°C/min	0:00
Vac(off/level/hold)			

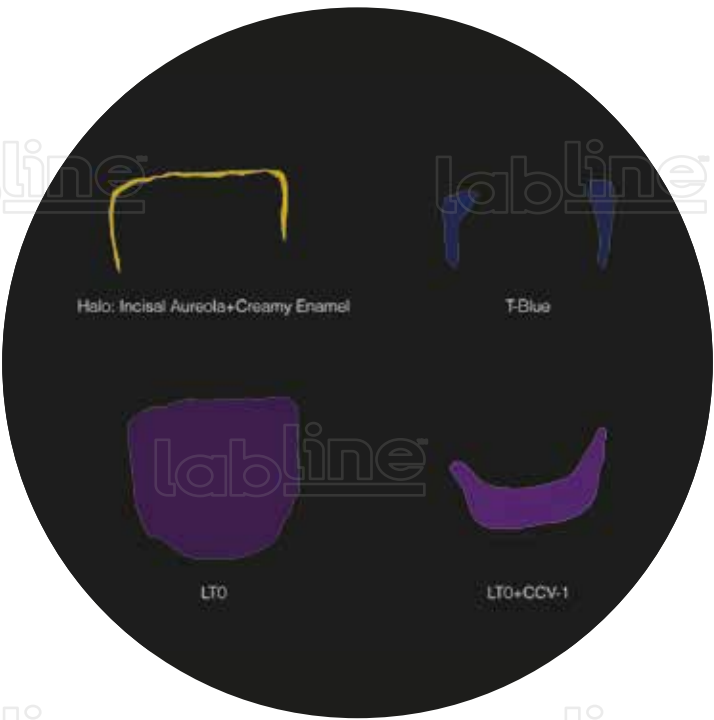
[Fig. 20] Firing Parameters for Internal Stain



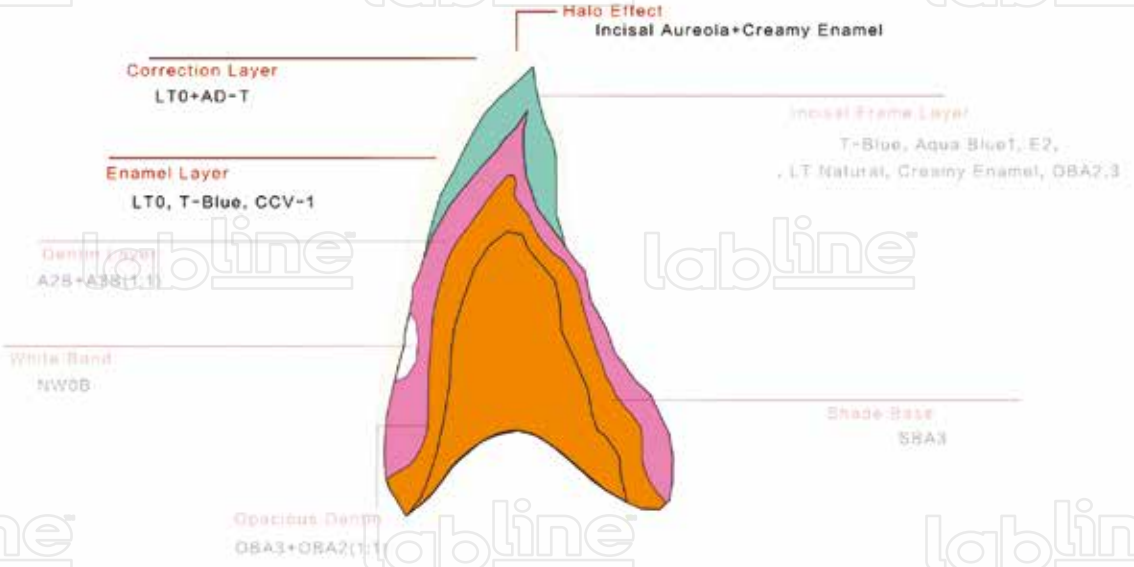
[Fig. 21] Color Map for Internal Stain

skin & correction layer_

In the next bake, three different skin mixtures (LT0, T-Blue, CCV-1) were applied as a gradient to create subtle contrasts over the entire surface. The size of the build-up was intentionally overbuilt approximately 15% to compensate for firing shrinkage [Figs. 22 to 24]. After the first skin bake, adjustments were made to enhance the tooth shape, contacts, and occlusion. The correction mixture (LT0+AD-T) was next applied to perform morphological corrections.



[Fig. 24] Color Map for Skin Layer



[Fig. 22] Color Map for Skin Layer

Drying			3:00
Closing			3:00
Preheating	580°C		2:00
High Temperature	940°C	45°C/min	1:30
Vac(off/level/hold)	940°C	100%	---

[Fig. 23] Firing Parameters for Skin Layer



contour & finish_

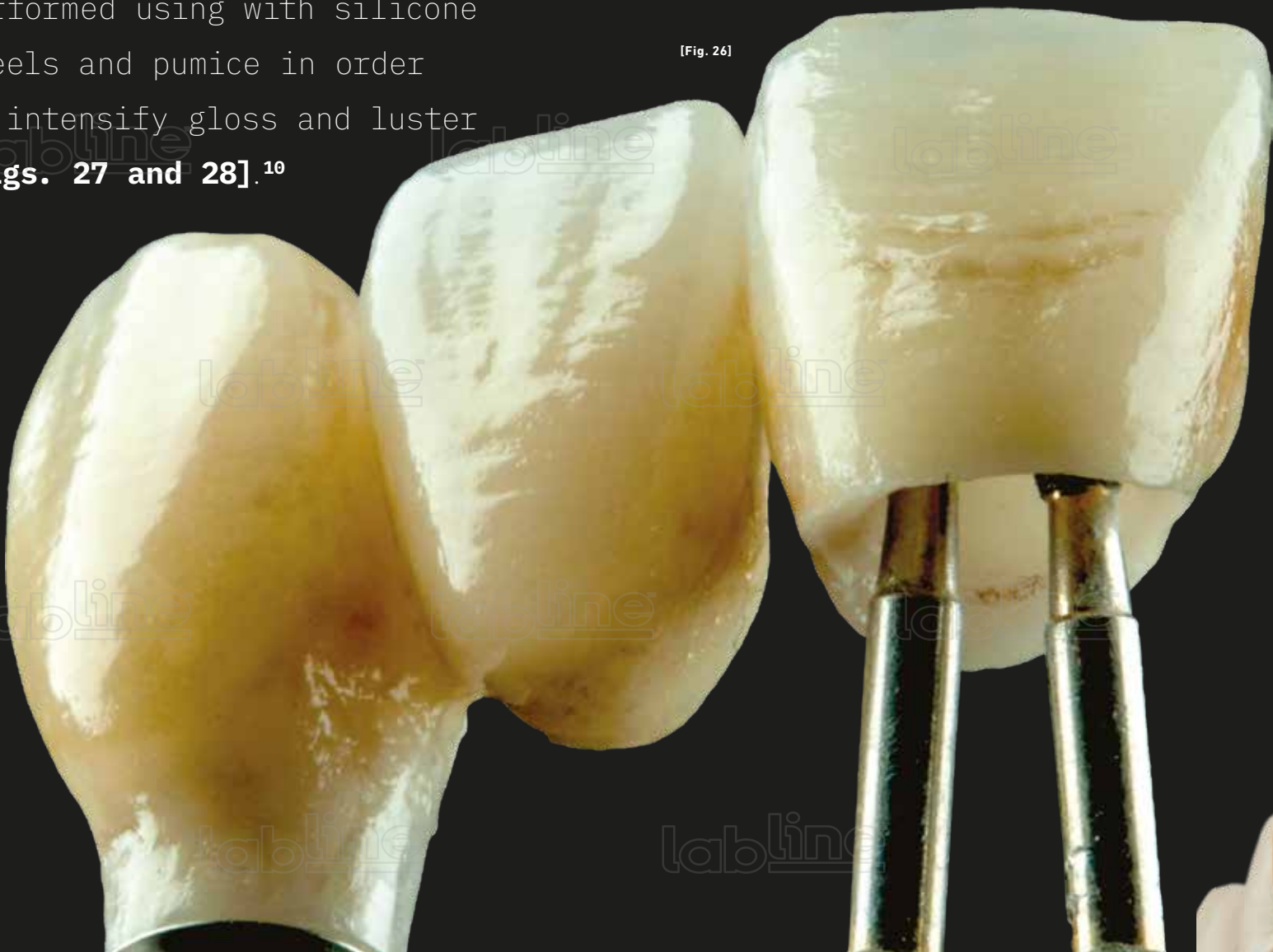
The surface texture was finalized using diamond burs, discs, and silicone wheels [Figs. 25 and 26]. During the try-in appointment, the color was finetuned at chairside using external stains to achieve an optimal shade match with the natural dentition. After glazing, mechanical hand-polishing was performed using with silicone wheels and pumice in order to intensify gloss and luster [Figs. 27 and 28].¹⁰



[Fig. 25] The definitive restorations seated on the master cast.



[Fig. 26-27] The anatomical details including shape, grooves, line angles, and crack lines from the adjacent tooth were replicated using the Klaus Muterthies contouring kit.



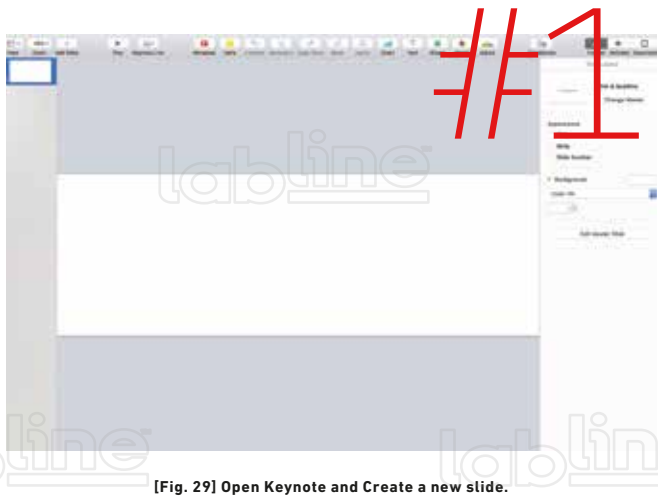
[Fig. 26]



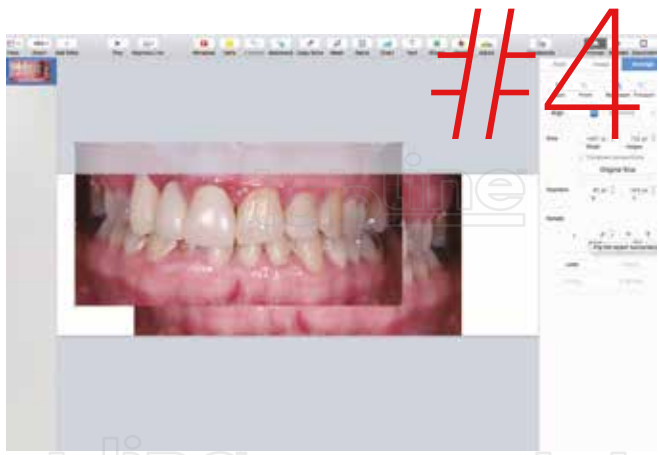
[Fig. 28] The definitive restorations seated on the master cast.

mirrored image technique_

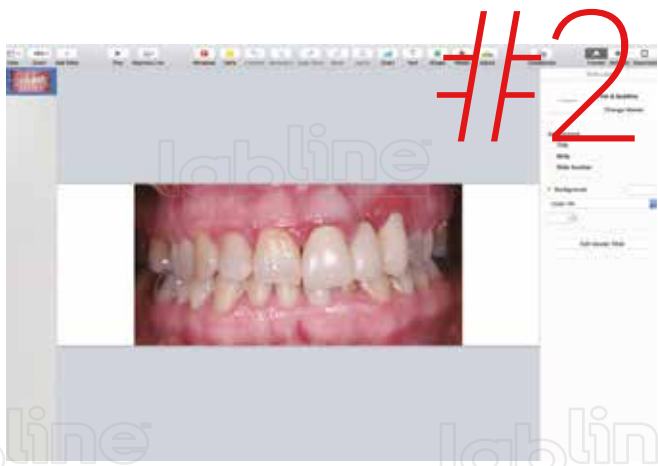
One of the critical challenges of a single shade match lies in the ability to replicate all the details of the adjacent teeth. The ceramist may face the challenge to reproduce a natural tooth by visualizing the reference tooth and only use imagination to produce specific colors, effects, details, and textures into the definitive restoration. The technique described below allows for precise visualization of the internal and external characteristics by using computer software to create a precise mirror image of the reference tooth. It provides a very suitable starting point and enables the ceramist to replicate details with increased consistency and predictability.¹¹



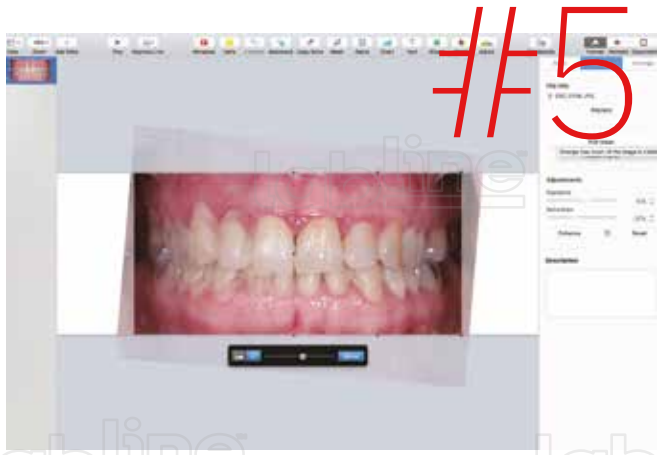
[Fig. 29] Open Keynote and Create a new slide.



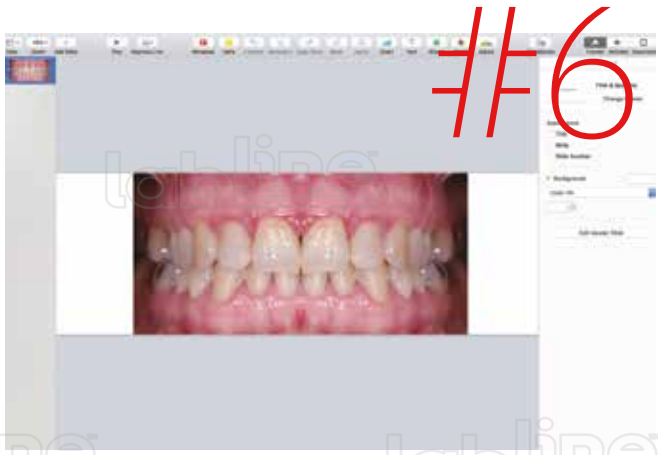
[Fig. 32] Click the Arrange tab at the top of the sidebar on the right. Then click Flip to get the mirrored picture.



[Fig. 30] Import a shade picture.



[Fig. 33] Press "Edit Mask". Crop the pictures until they are aligned with each other.



[Fig. 34] Finally, merge the original picture and the cropped picture together.



[Fig. 31] Select the image and Option+D to duplicate the same image.



[Fig. 35] Final mirrored image.



[Fig. 36] After three months follow-up.

summary_

Shade matching is an indispensable aspect of restorative and esthetic dentistry. Although many color-measuring and digital shade-taking devices have been introduced in recent years, shade matching still remains a most challenging task since color assessment is associated with a high level of subjectivity.¹² Following strict protocols for material choice, methodical shade selection, digital photography, and effective communication between the clinician and laboratory technician are all key factors enhancing predictability and successful results in reproducing the final restorations **[Fig. 36].¹³**

acknowledgment_

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