

## Taking a Custom Shade, Step by Step: A Technician's Viewpoint



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### INTRODUCTION

Have you ever struggled with the selection of a shade for a single anterior tooth in a crown restoration? Were you satisfied with the final result? Was the patient? Does perception of color change from one person to another as to what looks good? In fact, perception of color is different for everyone. From a laboratory technician's/ceramist's point of view, custom shading for a single tooth restoration is one of the most time-consuming and difficult tasks; it is truly an art. This article offers a guideline—a checklist of points to be considered when selecting a shade—as well as a discussion about a case that presented this very issue, and the steps taken to achieve the patient's requests.

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### SHADE SELECTION—CLINICAL PROCEDURE

When mapping a custom shade request, it is important for the laboratory technician/ceramist to understand what the clinician is looking for. Goals and objectives must be discussed, stated, and decided prior to commencing the clinical procedure. The following is the checklist I use for making decisions in the selection of a perfectly matched custom shade for the anterior dentition.

#### CHECKLIST

1. Select surface and texture (Coarse? Shiny? Dull?). If the texture is not interpreted correctly, it will change the restoration's appearance. Viewing the teeth from another angle will change the appearance, if the texture is not the same everywhere.
2. Determine value (High or low? Overlay with enamel? What color?). The value of a color is defined by the amount of reflection and absorption our eyes register when we view the tooth. How bright or dark is the color?



Figure 1: The patient with a fractured maxillary central incisor, tooth #9.



Figure 2: Custom shade—GC Initial tab used to check the color of white calcification.

Dark colors register with a low value (more gray), light colors with a high value (more white.)

3. Determine hue (Intensity? Which portion? Body? Gingival? Incisal?). Hue gives our color definition. What is the color's appearance? The technician will sometimes utilize enamel in order to determine hue.
4. Determine translucency or transparency (Where is the tooth translucent or transparent? Divide the tooth into nine segments to determine the answer):
  - mesial gingival, mesial middle, mesial incisal
  - middle gingival, middle middle, middle incisal
  - distal gingival, distal middle, distal incisal.
5. Check stump (preparation) shade, especially with a complex case, for best material selection. A darker shade of tooth after preparation (stump) will change the appearance of a restoration because of possible bleed-through in the color.
6. Establish (identify) symmetry reflection (Concave or convex? Which areas show reflection?).

The light will reflect in the direction of the curve of the tooth. For one central incisor to match the other, they need to show symmetry/balance.

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7. Understand tooth morphology<sup>1</sup> (What does the adjacent tooth look like?). When deciding shade and opacity, we must consider the appearance and shape of the natural tooth, since a fabricated shade will be affected by the final crown's form and size. The technician creates an illusion of a natural tooth, but in order for it to "work," it must look real.
8. Determine material selection (Metal-free? Non-oxide metal?). Some choices are as follows:
  - Pressed Ceramics have made all-ceramics popular, with Empress (Ivoclar Vivadent; Amherst, NY) probably the best known. The first pressed ceramic was leucite, seen in veneers and crowns, due to its high translucent quality. It

has been enhanced in popularity by lithium disilicate, used in crowns and bridges. It is stronger than leucite but not as translucent.

- Zirconia is the most commonly used material in CAD/CAM. Some examples include Lava (3M ESPE; St. Paul, MN), Zerion® (Etkon; Arlington, TX) (Nobel Biocare; Yorba Linda, CA). They have the same strength as metal and are called *all-ceramic steel*.
  - Alumina was used before zirconia, with Procera, and Vita In-Ceram and Wol-Ceram (Vident; Brea, CA), being the most widely recognized brand names. Zirconia has replaced it, due to its strength.
  - Captek (Altamonte Springs, FL) is a composite gold material that does not oxidize. Pure gold is similar to Captek but requires a different technique.
9. Verify the presence of mamelons (Dark or light? What color? Crack or craze lines?). The incisal edge of a crowned maxillary incisor should duplicate the adjacent incisor precisely.



Figure 3: Laboratory-made custom tabs made to check color (a subtle orange-brown hue with white enamel).



Figure 4: Custom-made shade tab—A1 dentin background with blue, white enamel, clear, and orange-brown. Cervical transparency allows for the reading of the correct matching color.



Figure 5: Appearance of a natural tooth, and various all-ceramic materials and metals with a variety of porcelains.

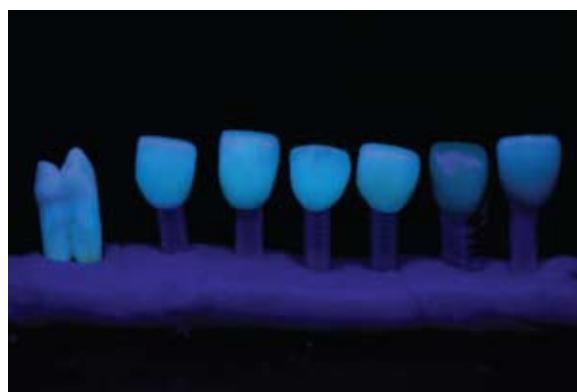


Figure 6: The various fluorescence effects, seen under an ultraviolet (UV) light.

10. Take a photograph (with either a digital or a Polaroid Macro camera (Waltham, MA), set up with 3X shade tab and teeth at 90° perpendicular for best results. There should be no reflection and no angles).
11. Polish and glaze.<sup>2</sup> (Use a well-calibrated porcelain oven, diamond pumice polish, and correction powder). Polishing the porcelain causes it to shine in the patient's mouth.
12. Communicate. To achieve the best level of satisfaction for everyone involved—the patient,

clinician, and technician—there has to be ongoing communication.

### CLINICAL CASE

I considered all of the points above when determining the best restoration for a 16-year-old male patient, who presented with a fractured maxillary central incisor (tooth #9). The damage had occurred to the incisal half of the tooth in a skateboarding accident. The patient's smile was severely compromised and needed restoration (Fig 1). A patient this young normally presents with a dull,

coarse texture surface. This means that the final restoration cannot be shiny or glossy.

X-rays of the tooth after the accident revealed pulpal involvement, requiring endodontic treatment. The tissue involved was within a normal range. The root canal therapy was followed by crown preparation and involved a core buildup with fluorocore, with margins at a 360° shoulder preparation. The impression was taken with Examine Injectiona (GC America; Alsip, IL) (with heavy-body impression material). The temporary crown was then fabricated from Voco



Figure 7: Laboratory fabrication of a single central tooth, photographed in natural light.



Figure 8: Two premolars exhibit different enamel and characteristics.



Figure 9: Preparation design.

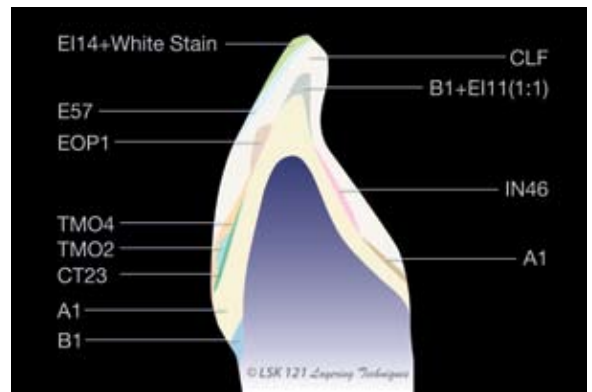


Figure 10: Shade mapping.

bis-acryl temporary material (Cuxhaven, Germany).

#### SHADE MAPPING

The next step in this patient's repair process was custom shade mapping. A slightly unusual enamel characteristic was noted: There were white decalcification spots visibly apparent on all the teeth (Fig 2). This finding had to be taken into account when formulating the custom shade. A point the technician must always remember when taking a shade is that the environment and patient dehydration can play a significant role in the accuracy of the

process.<sup>3</sup> Dehydration will change surface texture (see Checklist, Step #1). The tooth will lose color and luster if it is dehydrated. I believe that the optimal amount of time to allow for a custom shade is approximately five minutes, since keeping a patient in the chair longer than that can lead to dehydration. In addition, if the clinician's eyes become fatigued there is a decreased chance of correct color matching.

I created 0.2-mm shade tabs, thinner in consistency than the commercially developed brand and better able to match the finished restoration.<sup>4</sup> When baked in a porcelain

oven, the results are consistent and predictable, which is not always the case with a manufactured tab. The process was performed in order to correctly read the matching color for this patient's maxillary anterior—a challenging procedure, considering the multi-faceted appearance of the teeth. I decided to use very subtle orange-brown hues with the white enamel (Fig 3). Shade mapping can be accomplished with external or internal staining/color. The three basic factors that must be taken into consideration are: Hue (tone), chroma (color saturation), and value



Figure 11: An Etkon zirconia coping with a frame modifier base shade, applied by using GC Initial ZR porcelain.



Figure 12: Dentin shade and fluorocore dentin are applied to capture the internal colors.



Figure 13: "T" shape for light brown enamel.



Figure 14: Opal color and translucency modifier.

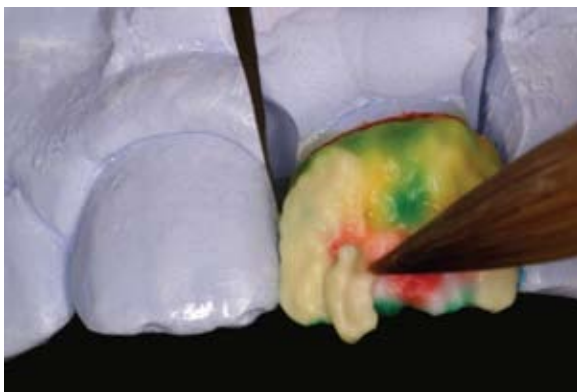


Figure 15: Cover with clear fluorescence.

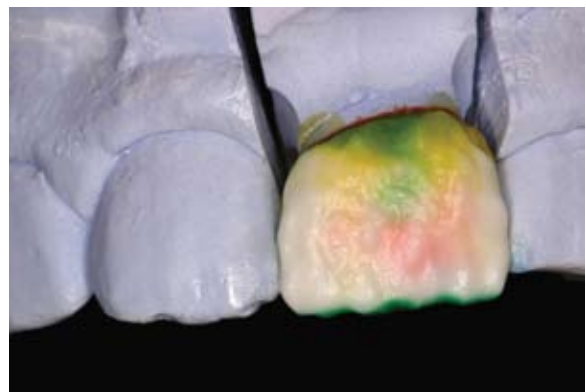


Figure 16: Final enamel effect applied.





Figure 17: First bake surface texture should be the texture of an orange peel or an eggshell in appearance, at 810° Celsius.

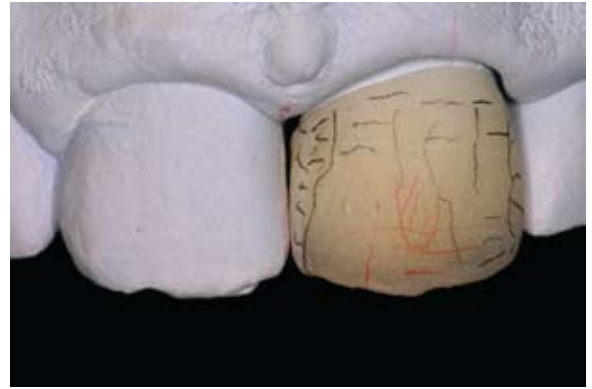


Figure 18: Preparation of a variety of surface textures.

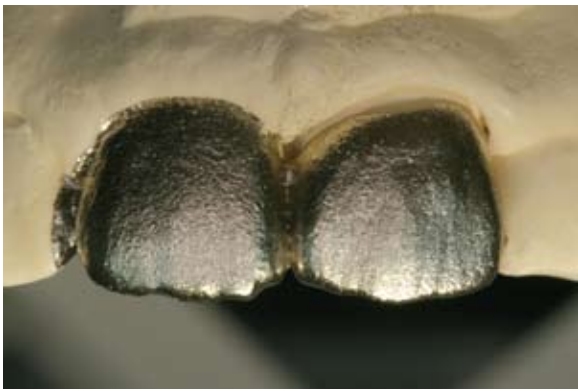


Figure 19: Silver powder for surface texture.



Figure 20: Final restoration—Etkon zirconia crown.

(amount of reflection and amount of absorption).

There are five color tabs shown: A1 dentin, blue, white enamel, clear, and orange-brown (Fig 4). The clear tab will decrease the value or reflection of the color; white will increase it. When layered together on top of one another, they create a different reflection than that which meets the eye singularly.

#### MATERIAL CHOICE

The differences between the appearance of a natural tooth versus several all-ceramic and metal/

porcelain combinations, without (Fig 5) and with (Fig 6) ultraviolet (UV) lighting, were used to determine the best material choice for the patient. It was decided that a porcelain-fused-to-metal (PFM) material was not a suitable match with the teeth in this case. Instead, it was determined that zirconia would create the best esthetic effect. This is often the case with a young patient, as youthful teeth are heavily calcified, whereas an older patient's teeth are of lower value, due to the lack of enamel and more transparency (see Checklist, Step #8). For older

patients, an alumina material is the better alternative.

A single central tooth, which I fabricated and photographed in a natural light, was used as a guide (Fig 7). In contrast, the next photograph demonstrates two Initial (GC America) porcelain fabricated premolars (Fig 8), presenting the different enamel characteristics of the color variances between the natural enamel and the guide. Shade and opacity are affected by the shape of the tooth (i.e., its morphology) (see Checklist, Step #7).



*Figure 21: Intraoral try-in. The stump shade of the color is darker. The zirconia and external colors block out the dark shade and blend in with the adjacent teeth.*



*Figure 22: Ultraviolet light, showing white opaque incisal shade.*



*Figure 23: Postoperative view. An immediate photograph, taken once the restoration is dry, evidences a match to the surface texture.*



*Figure 24: The completed restoration at rest position, after moistened by saliva. Note the harmony of the restoration with the adjacent dentition.*

## PREPARATION

Preparation plays an important role in checking the facial and incisal room for proper material selection, along with the stump shade (Fig 9). For the technician, the ideal space preparation for a tooth is 1.0 mm to 1.5 mm facially, in order to fabricate a properly matched restoration (see Checklist, Step #5).

With the help of a detailed shade-mapping guide, and strict attention to detail by the dentist and I, the shade of the final crown was naturally and ideally suited to the patient (Fig 10). An Etkon zirconia coping

with a frame modifier base shade was applied, using Initial ZR porcelain, and served as the beginning of the hue or tone decision process (Fig 11) (see Checklist, Steps #2 to #4). Next, dentin shade and fluorocore dentin were applied to capture the tooth's internal colors (Fig 12).

Figure 13 demonstrates how the "T" shape exhibited a translucent modifier near the gingival third and a light brown enamel (brown hue) at the incisal edge to pick up the internal colors. Opal color and translucency modifiers are picked up by color (Fig 14). In contrast, clear fluorescence is demonstrated in Fig-

ure 15. The final enamel effect with white stain was applied to obtain proper value (Fig 16). The first bake surface texture should be that of an orange peel or an eggshell in appearance, at 810° Celsius (Fig 17).

## SURFACE TEXTURE

Surface texture plays an important part in the overall illusion the technician creates in fabricating natural restorations. A variety of surface textures are presented here (Fig 18). To check the surface texture and symmetry reflection, a silver powder marker was placed on the surface of the maxillary central incisors. Artic-

ulating powder can be used in this procedure as well. The fixed restoration was then modified to give it the texture of the adjacent anterior dentition (Fig 19) (see Checklist, Step #1).

#### FINAL RESTORATION

The final restoration, a zirconia crown, was tried on the model for fit and occlusion verification (Fig 20). There was no bleed-through of any color or any change evident in material surface during the insertion try-in (Fig 21); in other words, the material was properly and harmoniously blended. The UV lighting showed the matching texture of the white incisal edge on both the crown and the natural tooth (Fig 22) (see Checklist, Step #9). The chipped incisal of tooth #8 would be corrected by the dentist with a direct composite, placed intraorally. An immediate postoperative dry view following the seating of #9 verified mamelons (Fig 23) (see Checklist, Step #6). In a rest position, once the tooth is moistened, note the harmony between the two maxillary central incisors (Fig 24) (see Checklist, Step #10).

#### CONCLUSION

I believe that custom shade matching is so important that spending one or two days with a patient after fabricating several copings is sometimes necessary (although it was not in this particular case). The restoration can then be checked under different light sources—morning, afternoon, late day, natural, indoor, etc., as required—and the technician can also become acquainted with the patient's lifestyle patterns. In the long term, skipping steps or shortening the procedure does not help the development of a technician's craftsmanship. If a restoration is poorly constructed or the color is selected in haste, the restoration will look like a restoration and not a natural tooth.

Numerous excellent new materials and application techniques are available today for the fabrication of dental restorations.<sup>5</sup> This abundance has enhanced the custom shading process because the final effect is more esthetically pleasing. By concentrating on the surface texture (with glaze being the most important factor for this particular patient), I am proud to present a

case that was beautifully constructed and crafted with care. Our team of three—I, the dentist and, most importantly, the patient—all were happy with the final result.

#### References

1. James F, Gerald D. *Concise dental anatomy and morphology*. The University of Iowa Press 9:144-148, 1999.
2. Muterthies K. *Replication of Anterior Teeth in the Four Seasons of Life*. Hanover Park, IL: Quintessence Pub., 1991.
3. Sorenson B, Bonstein T. *The Effect of Hydration State on Tooth Color. Spectrophotometric Evaluation*. Winnipeg, Canada: University of Manitoba Press; 1980.
4. Fradeani M. *Esthetic Rehabilitation in Fixed Prosthodontics*. Hanover Park, IL: Quintessence Pub.; 2004.
5. Ahmad I. *Digital and Conventional Dental Photography: A Practical Clinical Manual*. Hanover Park, IL: Quintessence Pub.; 2004. *AE*

