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## UNDERSTANDING ZIRCONIA BACKGROUNDS FOR CUSTOM SHADE MATCHING

### INTRODUCTION

Before beginning a case requiring the fabrication of a zirconia restoration, the technician must first understand zirconia background color and the way the porcelain powder shades will appear together.<sup>1</sup> Additionally, in order to assign a final color to the restoration, the patient's modified or base shade must be obvious to the technician in order to best match the custom color. One question that must be answered is, "Is there less dentin or more dentin?" That is the key to shading.

If the technician cuts the dentin porcelain back too much, the value of the restoration will be low. The result will not look natural, and no one will be satisfied. If the technician cuts less, there will be insufficient room for enamel placement and creation of translucency; the color will be wrong and the value will be too high.

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Given the particular clinical situation, the technician must decide where to begin based upon what he or she knows about zirconia copings and porcelain powder, as well as the information received about the patient. This article illustrates my general approach to color matching and fabricating zirconia copings based upon my personal philosophy. A specific case study is used to demonstrate the technique.

### CASE STUDY

The female patient was a public speaker who presented with two 15-year-old porcelain-fused-to-metal (PFM) crowns on teeth #7 and #8 that she no longer liked. In-office radiographs revealed recurrent caries; however, the patient had healthy gingival tissue. She sought "natural-looking crowns with no black lines." Her dentist prepared the teeth, and an impression was taken



*Figure 1: Two 15-year-old PFM crowns that the patient wanted replaced were photographed preoperatively for "before-and-after" viewing.*



*Figure 2: A shade tab check using light blue and white transparent modifier verified the natural teeth's shades, in order to achieve a color match with tooth #9 and the finished restorations.*

(Flex-Time Impression Material, 3M ESPE; St. Paul, MN). Provisional restorations were then fabricated (Pro-temp, 3M ESPE) and stained for better color matching.

A technician can obtain a great deal of information about a patient from a preoperative photograph (Fig 1), such as the opacity of the teeth, gingival color, discoloration of soft tissue, and differences between the natural teeth's color and value compared to existing crown restorations. EOP3 and TM02 shade tabs (GC Initial, GC America; Alsip, IL) were used to verify the patient's recommended amount of translucency and opalescence (Fig 2). A stump color check (Fig 3) was compared with brown-orange, and the gingival color was found to be very dark. The adjacent central incisor was a strong key to the color-matching process. The in-office whitening she completed lent a blue tone to the overall color of her teeth.

#### **EXPERIMENTING WITH ZIRCONIA BACKGROUNDS**

Success with the custom-shading process for zirconia restorations begins with an understanding of the

zirconia coping background, from porcelain to the finished product. While each case is different, I have found that for multilayering porcelain techniques, a general formula can be followed based upon experimentation and case study. After the modifier is applied, the following powders can be placed, in this order:

- first layer—a thin but deep, dark chroma
- second layer—dentin
- third layer—translucency
- fourth layer—mamelon and enamel (the color is chosen according to the individual patient, but will include shade possibilities of orange, brown, yellow, red, etc.).

By applying the layers in this sequence, the custom shade is systematically broken down and the color direction and strategy will unfold naturally. Eight zirconia test copings (CAD/CAM facility copings, GC America) I fabricated are shown in Figure 4. Four copings demonstrate a white background and four demonstrate a color tone.<sup>2</sup> The colors to be applied were D2, A3.5, B4, and

C1, as these are the most common starting points for custom color matching.

First, the color modifiers light tan, orange, yellow, and pink were applied<sup>3</sup> (Fig 5). A category background color check was then performed (Fig 6) by applying D2, A3.5, B4, and C1 to the body of the copings, after which the porcelain buildup was cut back slightly to allow application of translucency enamel and color modifier to the copings. This was an important step, as the amount of porcelain cut back would determine the final color appearance. Cervical color, translucency modifier (Fig 7), and enamel opal was applied for color range; mammelon was then applied and checked. The variations in color ranged from translucent, to brown, to orange-toned, to chalky white.

The final shades were achieved through the layering technique. In fact, the amount of porcelain powder applied versus the manner in which it was layered was very different. Before the technician can decide what he or she wants the outcome to be, they must first

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Figure 3: A stump shade check revealed that the overall color had a brown-orange tone and that the gingival shade was fairly dark.



Figure 4: Eight zirconia copings were fabricated and displayed for shade-testing purposes.



Figure 5: Four body colors (D2, A3.5, B4, and C1) were tested with color modifiers (left to right: light tan, orange, yellow, and pink) to achieve the proper internal color.



Figure 6: The body colors were tested and the dentin porcelain was cut back for color matching.



Figure 7: To give a better transparency viewing, the copings were first fired at a temperature 10° higher than normal. Note the variation achieved through porcelain layering techniques.



Figure 8: On each crown there is a thin layer of enamel, covered by one-half of a porcelain buildup. This aids the technician in deciding the final enamel color and texture application for the best possible match.



Figure 9: A final modifier color is applied to the zirconia copings. Each coping is given a specific recipe and texture.



Figure 10: The contours of the zirconia coping were checked, after which frame modifier color was applied.



Figures 11 and 12: Enamel, translucency modifier, and enamel opal were applied.



Figure 13: The final restorations were verified on the master cast.



Figure 14: The final restorations, dramatically displayed on a black background, exhibit beautiful and natural-looking color variations.

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*Figure 15: Upon insertion of the restoration for tooth #7, I performed a width check. The restorations had to be flat in order to avoid the “black triangle” effect.*



*Figure 16: The internal difference in shades between the coping and the layered porcelain color can be seen from this view.*

understand the powder and how it can be used to their advantage. There are distinct differences in appearance during the stages of the porcelain layering process and the final texture application.

The difference between the segmented teeth can be observed in Figure 8. Half of each crown was covered in porcelain buildup, while the other half received a thin layer of enamel. The left-hand side illustrates the final color with enamel; the right-hand side shows the dentin and modifier color without enamel. This demonstrates the basic-to-final build-up process that I apply to my experimental restorations, in the following order:

- inside modifiers
- color (D2, A3.5, B4, or C1)
- enamel opal or clear fluorescence (depending upon color)
- white stain (D2 only)
- translucency modifier
- cervical translucency.

These various coping colors can be categorized by the general age groups of the patients, as follows:

- The D2 zone will usually fit into a very young person’s category—white modification; less translucency; high value; and rough, frosty texture.
- The A3.5 coping appears shiny, clear, and transparent—the way a slightly older person’s teeth appear.
- The B4 coping is usually associated with a middle-aged person’s color, with more dentin, transparency, and translucency, less enamel, and more enamel opal color.
- The transparent grayish tone of C1 is brought out after the pink undertone is applied. This represents the approximate shade of an elderly person’s tooth color that results from the enamel wearing away over time. This color is very hard to mimic and requires Vita 3M1, 3R1.5, and 5M1 (Vident; Brea, CA), an essential range of colors that brings out the pink undertone. In order to achieve a Vita 3D Master Shade color, the pink tone from classic Vita color is crucial.<sup>4</sup>

The outcome of this experiment with zirconia backgrounds is that the first coping appears to be rough, similar to the tooth surface of a very young person. The second, third, and fourth copings have more translucency, or what can be categorized as a “shiny” appearance. This almost always applies to older patients. Color differences can also be noted. With this information, technicians can begin their work by using each illustrated zone, for a large range of possible colors. The experiments will recall for them each of their patient’s individual cases and their own unique coloring (Fig 9).

## REVISITING THE CASE

The patient’s base range of color was 030 after in-office bleaching (BriteSmile, Discus Dental; Culver City, CA), with a B1 base shade and translucency. Tooth whitening caused a blue-gray enamel color and translucency, indicating that this patient’s color belonged within the third experimental coping color range. Her crowns therefore required more dentin, transparency and translucency, and more enamel opal color.



*Figure 17: An emergence profile view illustrates a perfect match with the patient's adjacent teeth.*



*Figure 18: An alignment check of teeth ##7-10 shows an incisal halo match and perfect contouring, texture, and translucency opal.*

This was the starting point for the patient's case. I would have to utilize a manufacturer's porcelain containing more enamel and translucency in order to match her color. Her case would require only a slight change of color from the test coping experiment (B4 versus B1 base shading). The value of the time spent studying zirconia copings was evident because the patient's case plan was "blueprinted" before it had ever been received from the dentist and reviewed by the laboratory.

Cervical porcelain and regular dentin (GC Initial) were applied (Fig 10). The next step in the process was to create enamel and apply translucency modifier and enamel opal (Figs 11 & 12). The final restorations were then viewed on a master cast (Fig 13). The final restorations were revealed on a black background in order to accentuate their multiple color variations (Fig 14). One or two porcelain colors will not match with natural teeth; in my opinion, there must be at least five or more shades for true harmony. This color differentiation will normally show well in the mouth because natural teeth are multicolored, not one-dimensional.<sup>5</sup>

Immediately after the insertion of the restoration for tooth #7, the restoration for tooth #8 could be checked for size and width from the gingival to the incisal level (Fig 15). The interproximal contact for tooth #8 had to be flat in order to avoid the "black triangle" effect and still provide proper fit.

Even though the patient's stump shade was dark, it could be masked with a zirconia crown (Fig 16).<sup>6</sup> By fabricating a zirconia crown, slicing it in half, and placing it over the patient's remaining tooth #8, it could be seen that the stump shade was well masked. Does it blend with stump color? How well can the dark color can be masked with the coping? Material selection plays a role in verifying the final appearance because the patient sought a "no metal, no black line" look after her experience with the two previous PFM crowns. From a technical viewpoint, by presenting this experiment with the crown, I ensured that the clinician and patient would be satisfied with the final restoration because the color would match better. The image (Fig 16) was taken to serve as verification of the testing.

A side emergence profile view illustrates two perfectly matched restorations (Fig 17). The flawless alignment among teeth ##7-10, with matching incisal halo, contouring, texture, and translucency opal (Fig 18), is also apparent. After cementation, the patient was relaxed and at ease about her appearance (Fig 19).

## CONCLUSION

This patient was seen twice for custom shade matching in the laboratory. The first time was unsuccessful because her appointment was scheduled at 4:00 p.m. My visual acuity is not at its best in the afternoon; I endeavored to match her color but was not pleased with the outcome. I asked her to return for a morning appointment when my eyes would not be fatigued and my perception would be clearer. During this second visit, the shade was matched successfully.

This example is a reminder to recognize the potential for fatigue when scheduling a patient for custom color-matching. In the interest of saving time for everyone, if the technician has a preference for time

of day, it is certainly acceptable to inform the clinician and patient of this before getting started.

As mentioned earlier, in my experience, it is important to determine where to start and how to proceed with each individual patient's case. This coping experiment and case study benefited everyone involved: The patient, clinician, and technician. The patient has been very pleased with her final restorations. She no longer hides her smile and is much more comfortable in front of large audiences during her speaking engagements.

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*Figure 19: Final postoperative view of the patient in a rest position, no longer hiding her smile.*

