

# Using Technology to Improve Shade Matching



**Lonie Berland, DDS**  
Private Practice  
Dallas, Texas  
Phone: 214.350.7110  
Fax: 214.350.7114  
Email: lonie@lonie.com  
www.lonie.com



**Amelia Williams, DDS**  
Private Practice  
Dallas, Texas  
Phone: 214.350.8118  
Fax: 214.350.7114  
Email: amelia@lonie.com  
www.lonie.com

One of the most commonly traumatized teeth is also the most difficult to re-create as a natural appearing tooth—the central incisor. This is one of the ultimate challenges facing esthetic dentists. Restoring the health, function, and appearance of this anterior tooth to that of natural dentition is a skill that should be among every dentist's repertoire. A dentist must select from the various preparation techniques, restorative options, and bonding materials to provide treatment and a natural-looking restoration that will have an excellent prognosis. The success or failure of an anterior maxillary restoration depends not only on the esthetics and function of the restoration, but on the health of the surrounding tissues as well. While re-creating the shade, translucency, and contours of the natural tooth is important, it is also imperative to design a bio-compatible restoration with an optimal marginal fit that is free-able to the soft tissues.<sup>1</sup>

The tooth had been restored with a porcelain-fused-to-metal crown. Although the color was excellent, the gingiva exhibited a telltale visible black margin at an unhealthy and receding gum line (Figure 1). The adverse reaction some gum tissue has to the nonorganic metal margins of porcelain-fused-

restoration. The highly biocompatible polished Captek™ margins reduce plaque accumulation, thereby preserving gingival health.<sup>2</sup> In addition, Captek™ crowns can be placed subgingivally without the inherent biological problems associated with conventional alloys.<sup>3</sup> Furthermore, the natural light-transmitting characteristics of Captek™ contribute to restorations that appear vital, natural, and healthy.<sup>4</sup>

The success or failure of an anterior maxillary restoration depends not only on the esthetics and function of the restoration, but on the health of the surrounding tissues as well.

to-metal crowns was discussed with the patient. After considering porcelain materials such as IPS Empress® (Ivoclar Vivadent®, Inc.), In-Ceram® (Vita Zahnfabrik, distributed by Vident™), and Procera® (Nobel Biocare™ USA, Inc.), this author recommended a Captek™ (Precious Chemicals Company, Inc.) porcelain crown for the health of her soft tissues and for the color characteristics that allow for a much more esthetic and healthy

help prevent future trauma from shearing the crown off at the gum line. The author has found metal posts and amalgam build-ups to be unsatisfactory, and recommends using post systems that both bond and transmit light. The treatment recommended for this patient included removing the old crown and restoring the tooth with a bonded post and core before placing the new porcelain crown.



Figure 1—Preoperative view of tooth No. 9.



Figure 2—The ShadeEye-NCC™ chromameter measures the exact shade.

## Case Study

### The Tooth

A common indication for the anterior single-unit restoration is replacement of a preexisting defective crown. The patient, a 23-year-old woman, was experiencing gingival sensitivity associated with the endodontically treated tooth No. 9. Eight years earlier,

## Matching the Shade

These are critical considerations for assessing shade match and distinct tooth characteristics duplication in a successful anterior restoration case. The ShadeEye-NCC™ chromameter (Shofu® Dental Corporation) is a highly accurate electronic shade-taking device designed to precisely and consistently identify the base shade of the tooth to be duplicated (Figure 2).<sup>5</sup> Even to the most astute dentist, color is subjective and open to individual variation in interpretation. The effect that outside variables such as light sources and background differences have on shade taking is eliminated using the ShadeEye-NCC™ chromameter. Electronic shade taking devices allow for objective and predictable shade determination. Other popular systems aside from ShadeEye-NCC™ include the X-Rite® Inc.'s ShadeVision™ System, and the Vita® ShadeGuide (Vita Zahnfabrik, distributed by Vident™). Different kinds of room lighting, which vary from natural sunlight to fluorescent lighting, give teeth different coloring. The human element of color interpretation contributes to further mistakes in shade taking, with variation in age, gender, and even nationalities. The influence the immediate surrounding environment has on color matching, such as the gingiva and the dark oral cavity, should also be considered. These all have effects on hue, value, and color contrast, and give different appearances because of a perceived color change.

The ShadeEye-NCC™ chromameter measures the exact shade of the tooth to be duplicated according to instructions. The poured-up stone model was used for fabrication of a single-unit temporary.

Using the ShadeEye-NCC™ for Custom Colorization First Observation

Look at the tooth to be measured to observe the color and characteristics. This should be performed as a first observation. Place a clean contact tip on the ShadeEye-NCC™ unit on, and observe according to instructions.

## Case Study continued

base shade of the tooth and documents it in an exact numerical formula. It provides precise color measurement of the foundation shade of the tooth, and can be used with all porcelain systems including Vintage® Halo (Shofu® Dental Corporation), IPS d-SIGN® (Ivoclar Vivadent®, Inc.), Finesse® All-Ceramic (Dentsply Ceramco), and HeraCeram™ (Heraeus Kulzer, Inc). When used with the Vintage® Halo porcelain system, very accurate and natural restorations can be created. Many shade guides and porcelain systems have inherent color deficiencies that make creating exact color-matched restorations difficult. The ShadeEye-NCC™ is keyed to a porcelain system matched to natural tooth color.<sup>6</sup> The Vintage® Halo porcelain expanded shade range is more closely matched to the naturally redder and brighter tooth color than other porcelain systems. It has the necessary red-enhanced coloration to compensate for the gingiva and oral cavity effect on color matching. It also provides the opalescence of natural dentition, with a refractive index similar to natural enamel and microfine particle technology to control light transmission and translucency. This provides a porcelain system that

helps create the most natural and lifelike restorations.<sup>7</sup> The ShadeEye-NCC™ simplifies matching the single centrals. It gives the exact opaque/body/incisal combination that matches the hue and value of the natural tooth on either side.<sup>8</sup> With the aid of digital photography, dentists can re-create the artifacts found in the natural teeth, such as cracks, incisal translucency, and diastem coloration, and the resulting crowns can be very life-like. In this case, the patient had very distinct white mineralization marks on her maxillary anterior teeth that needed to be duplicated to create the most natural appearance.

The ShadeEye-NCC™ gave a recorded shade of A1/Bue R2 along with an exact "recipe" for color matching in Vintage® Halo porcelain. The appropriate shade tabs were placed in the shade tab holder to neutralize the effect the patient's gingiva has on shade sensation. This was placed next to the adjacent teeth and a digital photograph was taken and printed on photo quality paper to forward to the laboratory (Figure 3). This should be done before preparation and before the teeth are dehydrated, which affects color. An alginate impression was also taken of the upper arch and Shade Measurement.

With the contact tip in the proper position, press the measurement switch button. The ShadeEye-NCC™ will flash. Wait for the green ready light to illuminate and repeat. Usually only three flashes are necessary and the ShadeEye-NCC™ LED will display "333" and begin printing. Depress the "display" button on the handheld unit and the ShadeEye-NCC™ will print the recipe.

## Second Observation and Verification

To verify agreement of the shade measurement and a second observation of characteristics of the tooth, select the recommended Vintage® Halo shade tabs noted as the printed recipe, place them in the shade tab holder that matches the patient's gingival color, and observe them next to the measured tooth (and the tooth to be reproduced if different than the measured tooth).



Figure 4—A coarse round and tapered diamond No. 0837-1 used to remove the old porcelain-fused-to-metal crown with the Kavo ELECTRO-torque high speed.

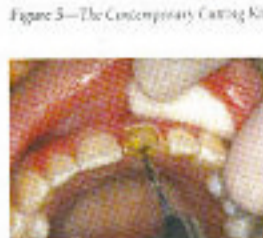


Figure 5—The Contemporary Cutting Kit (Shofu® Dental Corporation) used for crown preparation.

Take a digital picture for a more accurate duplication.

## Recording and Communication of Shade Information

On the laboratory prescription, note the following information:

- The tooth from which the shade measurement was taken.
- The location on the tooth the shade measurement was taken.
- Incisal characteristics and qualities.
- Drawings and/or photos are helpful in communicating existing characteristics such as incisal translucency and hypo-calcification spots or desired characteristics.

## Preparation

Using a coarse diamond 0837-1 (Shofu® Dental Corporation) (Figure 4) from the Contemporary Cutting Kit (Shofu® Dental Corporation) (Figure 5), the existing crown

was easily sectioned with the ELECTRO-torque high speed (Kavo America Corporation), and then torqued loose using a crown separator hand instrument. A caries detector was used to identify underlying tooth structure, which was then removed in the preparation. The tooth was gently refined and prepared for a porcelain shoulder margin using the coarse round-end tapered diamond 0835-1.

A reamer in Kavo's ELECTRO-torque low speed was used to remove guttae percha in the canal to a depth of 6 mm to 7 mm (Figure 6). A Glass Fiber Core Post (Den-Mat® Corporation) was verified to fit snugly into the canal post space without binding. In preparation for the post's cementation, the canal was etched using 34% phosphoric acid and thoroughly rinsed and dried. Tenure® A&B (Den-Mat® Corporation) was brushed into the canal and around the preparation using a microbrush until glossy and gently dispersed with air.

Because the tooth had been treated endodontically twice and this would be the second crown placed, the author chose Geristore™ (Den-Mat® Corporation) to cement the post. The biocompatibility of Geristore™ in reconstructive endodontics is well documented.<sup>9</sup> The post was carefully sealed with firm pressure using dual-cured high-radopacity Geristore™.

The supragingival portion was then built up with Core Paste White Shade (Den-Mat® Corporation). The author used the most opaque white build-up because at this point it was not yet determined if an all-porcelain crown or Captek™ would be used. However, the two-tone core contained the author to use Captek™ rather than an all-porcelain crown and risk show-through. The post/build-up was light-cured using the Rembrandt® Sapphire™ Xenon Power Arc curing light (Den-Mat® Corporation) and was further prepared using the No. 0872 football diamond (Shofu® Dental Corporation). The entire preparation was then refined using the superfine round-end tapered diamond No. 0836V-1 (Shofu® Dental Corporation) to remove undercuts and create a slightly

## Case Study continued



Figure 7—The tooth preparation with a 1-mm chamfer (Figure 7).<sup>10</sup>



Figure 8—The Zekon® Gingival Protector (Zentek™ ADMG Functional Dental) at the gingival margin, slightly retracted margins were



Figure 9—The triple subgingival margin was sealed with a capy for cement and increased surface area for increased bond strength.



Figure 10—The temporary crown in place.

By using the Zekon® Gingival Protector (Zentek™ ADMG Functional Dental) at the gingival margin, slightly retracted margins were

created without needing to place a retraction cord that may further damage the already compromised tissues (Figure 8). This clearly exposes a natural lined rest on the facial of the tooth. A standard porcelain-fused-to-metal crown, with metal and preparations, may not be able to salvage this morphologic irregularity and may result in the inflammation and recession evident in the previous crown. The patient was then instructed to close down to check for adequate occlusal clearance.

## Taking the Final Impression

In anticipation of impression taking, Expa-syl™ (Kerr Corporation) was carefully applied to the dry gingival margin to provide gingival retraction and to control gingival hemorrhaging, and the Expa-syl™ was then thoroughly rinsed (Figure 9). A Premier® Anterior Triple Tray® (Premier® Dental Products Co.) was used to capture the preparation, opposing arch, and bite registration in one impression. Impregnum™ Penta™ Soft (3M ESPE) was dispensed by a thin nozzle syringe onto the preparation and dispersed using an air syringe. The patient then closed down on the Impregnum™ Penta™ Soft loaded Triple Tray® for 6 minutes. By using this hydrophilic polyether impression material, a highly accurate and stable impression was taken.<sup>11</sup>

## Temporization

The Crown Bridge Veneer A-1 temporary crown (Den-Mat® Corporation) was sealed to check for accurate tooth contour, marginal fit, and shade match. The build-up was lightly lubricated to prevent bonding to the acrylic, and the acrylic-filled provisional was sealed and held with finger pressure until fully set. After trimming and polishing the margins of the provisional, it was temporarily cemented using Tempbond™ Clear (Kerr Corporation) (Figure 10).

## Laboratory Work

Because of previous gingival irritation and color-matching difficulty, Captek™ was chosen for its color and biocompatibility. A Captek™ coping was adapted to the die for Vintage® Halo porcelain. Although an all-

ceramic crown was considered, the Captek™ crown was used to block out the two-tone color of the underlying abutment. The beauty of the Captek™ crown is a result of the rich gold color in the coping material.<sup>12</sup> Captek™ is an acronym for Capillary Casting Technology and is not a regular alloy. The process creates 22-karat gold copings with exceptional strength. The end result is a warm, gold-colored coping consisting of 88% gold and 9% platinum.<sup>13</sup> This yellow-gold color allows for thinner amounts of opacifying agents. In fact, some feel that the underlying gold color provides a degree of warmth found in the pulp and identical tissues of natural teeth. These factors allow the restorative dentist to create all-ceramic beauty with a contemporary metal ceramic material.<sup>14</sup> The combination of the ShadeEye-NCC™ recipe in chroma, hue, and value accompanied by the digital picture of the shade tabs next to the teeth to capture the pattern of hypo-calcification spots and incisal translucency was indispensable.

The porcelain was baked and contoured. Special attention was paid to match the mesial and distal contour arms and the labio-incisal embrasure forms of the adjacent central. The surface of the crown was highly polished with a diamond polish and a cotton buff. The crown was evaluated on a solid model for interproximal contacts and tissue adaptation.<sup>15</sup> The Captek™ intaglio illustrates the color advantages of Captek™ over traditional metal alloys (Figure 11).<sup>16</sup>

This yellow-gold color allows for thinner amounts of opacifying agents.

## Cementation

At the seating appointment, the provisional was removed. Residual temporary cement was removed from the preparation using air abrasion with BONDOLUX® (Kavo America Corporation) (Figure 12). The tooth surface was etched using 34% phosphoric acid and rinsed and dried but not desiccated. Tenure® A&B was mixed in a well, and applied liberally to the preparation surface and air-dried to a glossy shine.

## Finishing

Ultra II Porcelain Polishing Paste (Shofu® Dental Corporation) provided the final polish.

## Final Full Face View

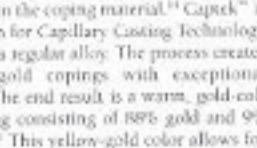


Figure 11—Final full face view.



Figure 12—The finished subgingival margin was sealed with a capy for cement and increased surface area for increased bond strength.



Figure 13—The prepared capy for cement and increased surface area for increased bond strength.



Figure 14—The prepared capy for cement and increased surface area for increased bond strength.



Figure 15—The prepared capy for cement and increased surface area for increased bond strength.



Figure 16—The prepared capy for cement and increased surface area for increased bond strength.

## Case Study continued

Infinity® (Den-Mat® Corporation) resin cement was syringed into the crown and sealed on the abutment. The contacts were finished and excess resin removed with a scribe brush. A microbrush dipped in Tenure® S Quik (Den-Mat® Corporation) was used to remove excess cement and seal the margins. When polymerization was complete, the gingival marginal flash was removed and polished.

A more natural appearance was further accomplished by slightly rounding the distal corners.

A more natural appearance was further accomplished by slightly rounding the distal corners using the SuperSeal® disks (Shofu® Dental Corporation) (Figure 13). The benefits of using a Captek™ restoration to replace a previous porcelain-fused-to-metal crown are color biocompatibility and predictability. In other words, this author can cement them and forget them.

## CONCLUSION

Devices that record and duplicate color along with glass-fiber posts, and porcelain/metal technology can provide restorations that are in harmony with the adjacent natural dentition and surrounding soft tissues (Figures 14 and 15).

## DISCLOSURE

Dr. Berland receives financial/material support from Shofu® Dental Corporation, Den-Mat® Corporation, and Captek™—A Division of Precious Chemicals Inc.

## ACKNOWLEDGMENT

The laboratory work for this case study was completed by Westbrook and Associates of Garland, Texas.

## REFERENCES

1. Wheeler DC, Anderson HA. The esthetic challenge of single tooth restorations: a comparison of finished alternatives. *Proc Prosthodont Acad Soc* 1992;7:27-35.
2. Birkhoff A. Gingival cutting: occlusal changes by the orthognathic course. *Proc Prosthodont Acad Soc* 1980;31:304.
3. Gussone JM, Shuler SG, et al. Natural form plastic restorations to correct gingival margins. *J Prosthet Dent* 2001;105:250-258.
4. Williams M. Development of the integrated complete case construction. *Contemporary* 1992;1:20.
5. Weicki KG, et al. An in vivo study of a color matching system. *J Esthet Restor Dent* 2001;13(2):78-80.
6. Captek™. The color advantage system. *Contemporary* 1992;1:12.
7. Captek™. Color advantage system. *Contemporary* 1992;1:12.
8. Captek™. Color advantage system. *Contemporary* 1992;1:12.
9. Captek™. Color advantage system. *Contemporary* 1992;1:12.
10. Captek™. Color advantage system. *Contemporary* 1992;1:12.
11. Captek™. Color advantage system. *Contemporary* 1992;1:12.
12. Captek™. Color advantage system. *Contemporary* 1992;1:12.
13. Captek™. Color advantage system. *Contemporary* 1992;1:12.
14. Captek™. Color advantage system. *Contemporary* 1992;1:12.
15. Captek™. Color advantage system. *Contemporary* 1992;1:12.
16. Captek™. Color advantage system. *Contemporary* 1992;1:12.

Product References	
<b>Product:</b> Captek™ <b>Manufacturer:</b> Precious Chemicals Company, Inc. <b>Address:</b> 150 Alvarado, Corona Boulevard, Alhambra, CA 91803 <b>Phone:</b> 626-448-8800	<b>Product:</b> Ultra II Porcelain Polishing Paste <b>Manufacturer:</b> Shofu® Dental Corporation <b>Address:</b> 2707 Sylvia Drive, Santa Fe, CA 95070 <b>Phone:</b> 925-352-3300
<b>Product:</b> ShadeEye-NCC™ chromameter, Vintage® Halo porcelain system, contemporary Cutting Kit, No. 0872 football diamond, Ultra II Porcelain Polishing Paste, Contemporary Cutting Kit, SuperSeal® disks <b>Manufacturer:</b> Shofu® Dental Corporation <b>Address:</b> 2707 Sylvia Drive, Santa Fe, CA 95070 <b>Phone:</b> 925-352-3300	<b>Product:</b> Impregnum™ Penta™ Soft <b>Manufacturer:</b> 3M ESPE <b>Address:</b> 17170 Zanker Road, Irvine, CA 92614 <b>Phone:</b> 949-251-1300
<b>Product:</b> Zekon® Gingival Protector <b>Manufacturer:</b> Zentek™ ADMG Functional Dental <b>Address:</b> 241 South Main Street, Eugene, OR 97401 <b>Phone:</b> 541-344-0113	<b>Product:</b> Geristore™ <b>Manufacturer:</b> Den-Mat® Corporation <b>Address:</b> 301 West Collins Avenue, Suite 200, Denver, CO 80202 <b>Phone:</b> 303-437-2400
<b>Product:</b> Expa-syl™ <b>Manufacturer:</b> Kerr Corporation <b>Address:</b> 3717 West Collins Avenue, Suite 200, Denver, CO 80202 <b>Phone:</b> 303-437-2400	<b>Product:</b> Tenure® A&B <b>Manufacturer:</b> Den-Mat® Corporation <b>Address:</b> 301 West Collins Avenue, Suite 200, Denver, CO 80202 <b>Phone:</b> 303-437-2400
<b>Product:</b> Tempbond™ Clear <b>Manufacturer:</b> Kerr Corporation <b>Address:</b> 3717 West Collins Avenue, Suite 200, Denver, CO 80202 <b>Phone:</b> 303-437-2400	<b>Product:</b> BONDOLUX® <b>Manufacturer:</b> Kavo America Corporation <b>Address:</b> 340 West 10th Street, Lincoln, NE 68502 <b>Phone:</b> 402-466-0000
<b>Product:</b> Vita® ShadeGuide <b>Manufacturer:</b> Vita Zahnfabrik <b>Address:</b> 35612 Leisner Road, Schwanau, Germany <b>Phone:</b> 49-91-9300-0	<b>Product:</b> Vita® Zahnfabrik <b>Manufacturer:</b> Vita Zahnfabrik <b>Address:</b> 35612 Leisner Road, Schwanau, Germany <b>Phone:</b> 49-91-9300-0
<b>Product:</b> IPS d-SIGN® <b>Manufacturer:</b> Ivoclar Vivadent® <b>Address:</b> 2650 Riverchase Lane, Hoover, AL 36030 <b>Phone:</b> 205-968-2000	<b>Product:</b> IPS d-SIGN® <b>Manufacturer:</b> Ivoclar Vivadent® <b>Address:</b> 2650 Riverchase Lane, Hoover, AL 36030 <b>Phone:</b> 205-968-2000
<b>Product:</b> HeraCeram™ <b>Manufacturer:</b> Heraeus Kulzer, Inc. <b>Address:</b> 10000 Westpark Drive, Charlotte, NC 28217 <b>Phone:</b> 704-546-2000	<b>Product:</b> HeraCeram™ <b>Manufacturer:</b> Heraeus Kulzer, Inc. <b>Address:</b> 10000 Westpark Drive, Charlotte, NC 28217 <b>Phone:</b> 704-546-2000
<b>Product:</b> Den-Mat® Corporation <b>Manufacturer:</b> Den-Mat® Corporation <b>Address:</b> 301 West Collins Avenue, Suite 200, Denver, CO 80202 <b>Phone:</b> 303-437-2400	<b>Product:</b> Den-Mat® Corporation <b>Manufacturer:</b> Den-Mat® Corporation <b>Address:</b> 301 West Collins Avenue, Suite 200, Denver, CO 80202 <b>Phone:</b> 303-437-2400