Correcting esthetics with zirconium oxide restorations

Experiences from the Laboratory

Peter Hammer

The high-performance ceramic, zirconia, has recently established itself solidly in the line-up of dental materials. The chemical and physical properties are exceptionally suitable for framework fabrication in the fixed-denture field. The most challenging aspect is working with the material because we must leave our old ways behind and are faced with an automated manufacturing process. We need to possess creativity and persistence at this interface between handiwork and automated processes. The following report will launch a discussion on whether these demands can be incorporated into the laboratory routine.

WHY ALL-CERAMIC?

Many people still see metal-free restorations as a fall-back solution whenever specific conditions affecting either the patient or clinician create a problem for using metal. The use of all-ceramic crowns or bridges still remains a niche interest and is currently not rated very highly. But if both techniques, i.e., metal-containing and metal-free, were instead presented as equivalent alternatives, then I believe most patients would prefer the metal-free solution. The comparison requires, of course, that some general criteria are equally well met, such as:

- Stability
- Fit
- Function
- Esthetics
- Price

Stability: In our profession, technical development, proof of performance and broad application in free enterprise often go together. But we have now had more than 10 years experience with the material zirconia. When I say zirconia, I mean industrially sintered, hot isostatic pressed (HIP), yttrium oxide-reinforced zirconium dioxide. This material demonstrates the best qualities.

Fit: The description states that the crown margin fit has a 50 μm margin gap and is biologically compatible. Studies show that DC-Zirconia for example has a margin fit of less than 50 μm. In addition, the dental technician has the option of shaping the margin fit in the same way as for a ceramic shoulder.

Function: Functional factors are not affected by the framework material.

Esthetics: Since zirconia technology captured such a small market share and since the CTE required a dedicated veneer ceramic, the dental technician had to make do for several years with makeshift solutions, such as using the veneer material for titanium. But with the number of CAD/CAM system users on the rise, the dental industry finally took note and today we have options – extensive product lines that can fulfill almost any wish.

Price: All beginnings are tough – and often a little more costly. Today, however, because we already have to invest so much in CAD/CAM technology, the final price of a
challenging crown is determined more by the expense of veneering than by the choice of framework material.

**Basics of Veneering Technique**

The ceramic framework material zirconia first of all requires rethinking of the veneering procedure. These frameworks are usually white and slightly translucent. We immediately think: "Great! This couldn’t be better!" – but it must not be forgotten that frameworks are dealing with an area of the tooth structure where white and low translucence are not desirable. Just as with metal, the framework must be blended in. But one thing is easier – in comparison with metal – we will be starting from a better baseline:

- No dark oxide;
- Light transmission closer to a natural tooth (Fig. 1).

The first task is to control crown brightness. Chroma is no problem; we can insert enough body shade into the veneer layer. Intensive materials and even transparent materials with strong tones are available. Brightness should be controlled as far as possible from the inside. The zirconia framework is too white, which means it displays excessive brightness. Gray components will have to be used to reduce this reflective brightness. This is where I use a liner that is fired to the framework like an opaquer. The material itself possesses a low brightness value. You have to combine it with the framework to get the ideal brightness level (Figs. 2a-2b).

This material meets other needs as well: We prevent loss of brightness in the crowns under varying light conditions by elevating the white fluorescence (Fig. 3). In addition, it is possible to anticipate the crown shade structure since the liner is already available in intensive tones and can be modified with stains (Fig. 4). The firing temperature is very high, at 980°C, and the sinter temperature is also high. The result is a high-luster surface. This allows the
framework to be optimally moistened, thereby increasing bond strength. Abrading the surface lightly will enable correct build-up of the veneer ceramic layers (Figs. 5-6).

**A LABORATORY CASE REPORT**

The following case report tracks the fabrication procedure for a fixed bridge using zirconia as the framework material. I will add examples from other jobs to flesh out the example.

The initial situation was a metal-ceramic anterior bridge more than 20 years old. The bridge was fractured at tooth 8 and repaired with composite. The entire optical impression was no longer acceptable to the patient. The bridge therefore needed to be replaced (Fig. 7).

First, we developed a long-term provisional to establish a guide. The tissue situation for the bridge unit at tooth 10 was poor, due to bone degeneration, but the patient wished to leave it as is. Once the temporary bridge was ready (Fig. 8), I fabricated acrylic facets by taking an impression and creating a matrix. These were mounted on the master cast with the aid of a silicone key. This small effort would later provide me with an exact pattern for designing the bridge framework on the screen.

**FRAMEWORK FABRICATION**

Using the master cast as the pattern, the scanner created a data record for a three-dimensional representation of the model (Figs. 9-11). The next step involved scanning the jaw with the acrylic facets already mounted (Fig. 12). The software then created a bridge framework with defined preparation margins, prefabricated pontics and attachment units (Fig. 13). The wax-up can be superimposed to optimize positioning of the bridge units and to extend the crown framework if necessary (Fig. 14). The data are transmitted to the milling unit and converted to the physical framework in ZrO2 (Figs. 15-17).
Fig. 7. Initial situation: The bridge will need to be replaced.

Fig. 8. Temporary bridge.

Figs. 9-10. Positioning the model in the scanner.

Fig. 11. Displaying the model on the screen.
Figs. 12a-12b. Wax-up on the model and on the monitor screen.

Fig. 13. Framework design.

Fig. 14. Superimposed wax-up.

Figs. 15-17. Milling the material in the milling unit.
Fig. 18. Crown fit directly after milling.

Figs. 19-20. Pinpoint detailing of the fit.

Fig. 21. Framework fit after corrections.
The first thing the dental technician will ask is: How well does the framework fit? (Fig. 18). The fit was surprisingly good when one considers that the framework was milled out of a solid block with a milling burr. I finessed the fit manually; one of the requirements referred to above and that the technician has to be comfortable with.

Spot adjustments ensure that the framework seats completely on the abutment. I always work hard to get a stress-free fit, without any friction or clamping that might otherwise cause tension forces to develop in the crown later (Fig. 21).

*Tip:* Steam-clean the stone die carefully by alternating short bursts of steam with cold water spray to prevent damage (Figs. 22-23).

Surface development then follows. It is important not to leave any edges remaining (Fig. 24).

*Tip:* Protect the finger with an adhesive bandage since heat develops rapidly and it also enables a better grip on the slender copings (Fig. 25).

During the in-mouth framework try-in, check the framework fit as well as the base surfaces and the occlusal relation (Figs. 26-27).

*Tip:* A quick, reliable way to check the framework's ability to cover dark abutments is to mark the insides with a black waterproof pen and evaluate the gray influence on the surface (Figs. 28-29).

After the try-in (Fig. 30), I reduced the marginal areas and applied a fired ceramic shoulder. Even smaller ceramic shoulders than we traditionally use in metal-ceramics are successful. I eliminated any macroscopically visible defects in the marginal area of the framework using correction material. The special ceramic DC Cor fires very hot (980°C), preventing changes from occurring during subsequent firings. As a thermoplastic material, the powder is held together with a binder that improves handling even with very small quantities (Fig. 31-36).
Figs. 26-27. Double-checking is the way to go!

Figs. 28-29. A quick reliable way to check framework thickness is to mark the insides with a black waterproof pen and evaluate the gray influence on the surface.

Fig. 30. Reduction to allow for the ceramic shoulder.

Fig. 31. The special ceramic DC Cor offers optimization.
Fig. 32. Applying the liner.

Fig. 33. Framework after liner firing.

Fig. 34. Layering the shoulder materials.

Fig. 35. Result after firing the shoulder materials.

Fig. 36. Situation prior to the additional build-up.

Fig. 37. Layering...
CERAMIC MATERIALS BUILD-UP

As indicated previously, I used a veneer ceramic specially developed for zirconia. Initial Zr Ceramic ensures an optimal match of materials between the framework and veneer. The layering technique I developed is applicable to all other framework materials since their manufacturers are allowing for this in their systems. This benefited me not only with complex restorations (e.g. single crowns on an alumina oxide framework alongside a bridge with a zirconia framework), but also in educating and training laboratory personnel.

The product line includes a wide range of materials. I think the following material characteristics should be particularly desirable when making a choice: strongly fluorescent dentin materials to stabilize brightness, compact dentins for a tooth-like character, shade-intensive primary dentins and no time-consuming mixing.

Figure 37 shows the main layer and Figure 38 the result after firing. You can perfect the ceramic shoulder at the correction firing and the glaze firing. For this, I used wax-bound ceramic mixes (Fig. 39).

The first try-in after the main firing gives you an opportunity for selected touch-ups (Figs. 40-42).

Tip: The addition of 50 percent correction material Zr Cor glazes the base surfaces very nicely, making it very homogeneous and easily polished. (Figs. 43-44).

Patient satisfaction and peace of mind during work are my minimum requirements. And then, if I can answer the question: Is the zirconia restoration also esthetic? With a Yes, I am fully satisfied. And we keep on trying ...

REFERENCES


Fig. 42. The finished restoration.

Fig. 43. View of the pontic on the model.

Fig. 44. The addition of 50 percent correction material Zr Cor glazes the base surface very nicely, making it very homogeneous and easily polished.

Fig. 45. Initial situation.

Figs. 46-48. Views of the six-member zirconia bridge in situ at teeth 6-11.
Introducing GC Initial™ Ceramic System for all Substructure Matching Needs

**One System. One Build-Up. One Choice.**

*initial*

The ceramic system for every indication.

GC Initial, the full-range ceramic system used for all indications, lets you fabricate high quality, natural looking restorations, with total esthetic, color and shading consistency regardless of the substructure material. It doesn’t matter if the case is full ceramic or metal-based or everything side by side, you’ll achieve outstanding, true-to-life restorations every time.

With the same shading system and the same build-up technique regardless of the substructure or framework, GC Initial requires a short learning curve and can be easily adapted by high volume labs or tooth design boutiques. Developed for maximum technique tolerance, GC Initial is very forgiving and has extremely low shrinkage.

Call your dental lab supplier today.

GC America Inc.
Advancing Art and Science of Dentistry
© 2005 GC America Inc., Alsip, IL 60803

http://www.gcamerica.com

GC Initial PC crown #8
Fabricated by Luke S. Kahng, CDT
LSK 121 division of Capital Dental Technology Laboratory, Naperville, IL
Case courtesy of Rick Alwan, DDS
Fig. 49. Close-up of area 7-9 (tooth 8 with bridge unit).

PRODUCT LIST

<table>
<thead>
<tr>
<th>Indication</th>
<th>Name</th>
<th>Manufacturer/Distributor</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAD/CAM system</td>
<td>President</td>
<td>DCS</td>
</tr>
<tr>
<td>Framework correction material</td>
<td>DC Cor</td>
<td>DCS</td>
</tr>
<tr>
<td>Plaster hardener</td>
<td>Plaster hardener</td>
<td>Yeti</td>
</tr>
<tr>
<td>Contact paste</td>
<td>Pasta Rossa</td>
<td>Anaxdent</td>
</tr>
<tr>
<td>Liner</td>
<td>DC Liner</td>
<td>DCS</td>
</tr>
<tr>
<td>Veneer ceramic</td>
<td>GC Initial Zr</td>
<td>GC America</td>
</tr>
</tbody>
</table>

Bio
Peter Hammer completed his dental technology education in 1980 and then went to work in a commercial laboratory and a dental office laboratory. From 1984 to 1987, he worked for a leading dental ceramics manufacturer, specializing in the development of all-ceramic systems. In 1987, he opened his own dental laboratory, which he operates still along with a partner, Christian Berg. The laboratory specialized in the fabrication of metal-free restorations. Since 1997, he has been developing crowns and bridges from zirconia. Since 2003, Hammer has been running the company G-design, a center for developing crowns and bridges with CAD-CAM technology. He also conducts courses and gives presentations nationally and overseas.

Contact Information
Dental Art AG Christian Berg • Peter Hammer
Tel.: (41) 62 8 71 58 02
dentalart@tiscalinet.ch