Fit Factors of Milled Zirconia Restorations

By Arlo King, CDT

Every dental journal you open today is filled with zirconia advertisements. There are so many claims and options that it is hard to know what to believe.

Image 1.
Point Cloud

Image 2.
Wrong Die Stone Color

Zirconia and CAD/CAM manufacturers talk about the strength and precision of their materials and how well their copings fit the die. Early zirconia clinical studies dating back 10 years had restorations with a marginal integrity of about 100 microns. Since that time, there have been many improvements, both in materials and how those materials are processed, however there are many factors that affect the fit of the coping. Some factors we can control and others rely on the materials selected and the CAD/CAM machines.

There are many types of scanners on the market including laser, contact, optical and cone beam. They operate differently, but are basically collecting data from the surface they are scanning. In the case of a laser, a beam of light goes across the surface of the object and optical cameras collect the data. In the case of the Cercon Eye (DENTSPLY), data points are collected every 10 microns and a point cloud is created (**Image 1**). From there, a 3D image is generated. This data collection process is critical in the fit factor and there are many things we can do to affect this process.

Before you pour the impression, you need to consider the color of your die stone, especially if your scanner utilizes a laser. Lasers appear red to the naked eye, but are actually a concentrated mix of yellow, green and blue light, with green being the center and most important. Some die stones,

such as white, gray or dark colors, do not contrast well with the laser beam colors and should not be used (**Image 2**). In this case, the laser is scattered and has a wider beam that results in an inaccurate reading (**Image 3**). The best way to know if your die stone is the right color is to examine the point cloud. The point cloud is one of the first screens after the scan has been completed. Enlarge the point cloud image on your screen and closely examine the surface. If you are using a die stone with the wrong color, the surface will appear rough. This is sometimes referred to as noise on the surface of the point cloud (**Image 4**). The resulting 3D image will appear rough and result in a poor fitting restoration (**Image 5**). Die stones that are a buff or light yellow to an orange color are generally the best (**Image 6**). A die stone with the correct color will have a tighter and more distinct laser line (**Image 7**) and a smooth surface on the point cloud (**Image 8**). The resulting 3D image will also be smooth and free of defects (**Image 9**).

Be sure not to use any die stones with small reflective particles. Some die stones have added ingredients to increase the strength, but these particles are also reflective. When a laser hits a shiny surface, it is reflected and it cannot collect any data. It will appear on your screen either as a hole in the die or even small sharp spikes on the surface of the die.

The next fit factor is simple: It is your models and dies. Just like every other dental appliance, it starts with a model that is accurate and free of

Image 3. *Laser on a White Die Stone*

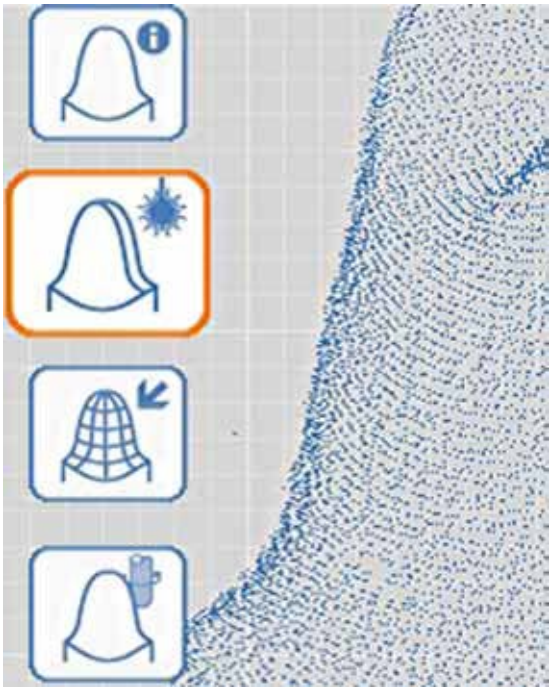


Image 4. *Point Cloud With Noise on the Surface*

Image 5. *(below left) Poor Scan Results*

Image 6. *(below right) Prefered Die Stone Color*

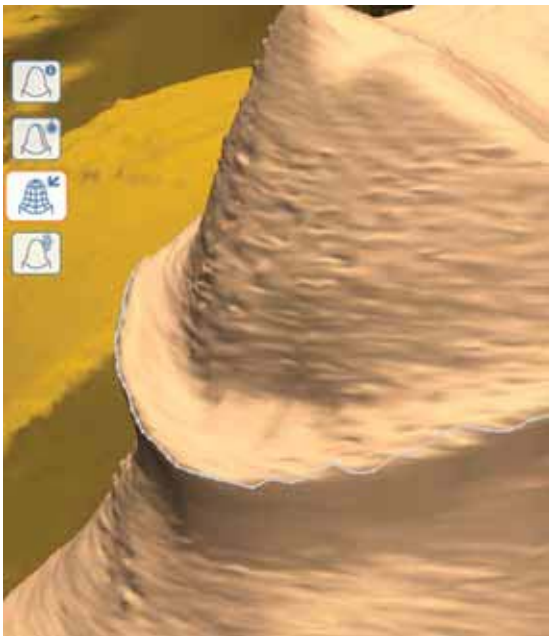


Image 7. *Laser on a Prefered Color Die Stone*

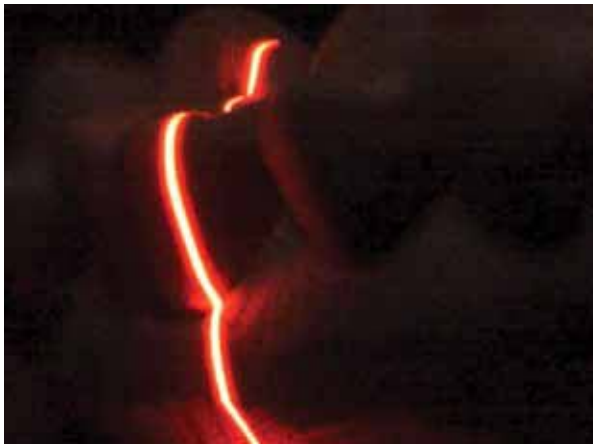


Image 8. *(below left) Point Cloud With no Noise on the Surface*

Image 9. *(below right) Good Scan Results*

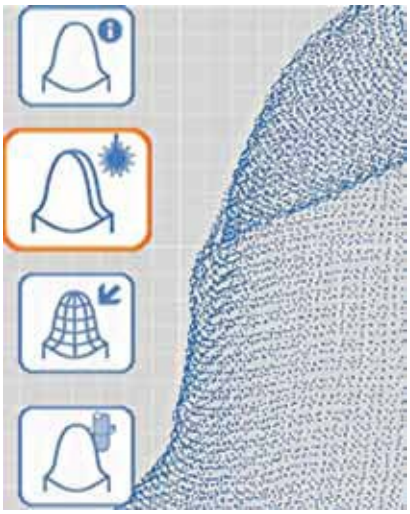


Image 10. *(left) Trimming the Die*

Image 11. *(below left) Automatic Margin Detection*

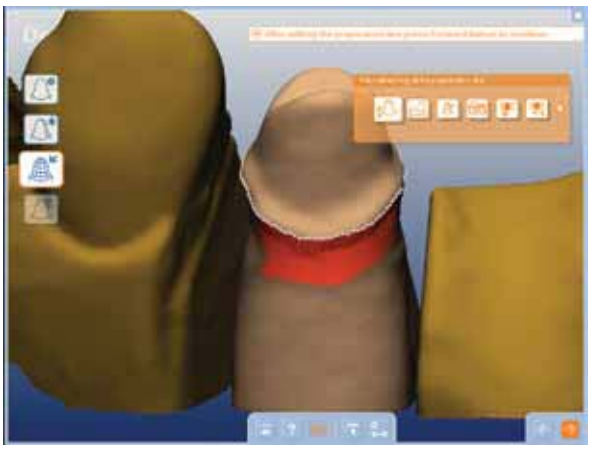
Image 12. *(below middle) Blocking out Sharp Angles*

Image 13. *(below right) Wrong Die Preparation for Scanning*

defects. In most cases you will need a model with removable dies. These dies must be 100 percent stable and be able to be taken in and out of the model repeatedly with precision. The scanners can only read what they can see. When trimming the die, the margins have to be fully exposed (**Image 10**). Software, such as the Cercon Art 3.0.1, will automatically detect the margins, which can speed the design process (**Image 11**). In most cases, the CAD software will be looking for the undercuts, so the better the die is ditched, the more accurate the design. Also, take a close look at the die for sharp line angles and large undercuts. Most software will automatically block out the undercuts, but in severe cases you should manually block out the large undercuts (**Image 12**).

Today's milling machines, like the Cercon Brain's® or Expert's® smallest bur has a radius of 1 mm, which needs to get into the smallest line angles when milling. The Cercon Art 3.0.1 has specific tolerances built into the software that allows for a digital blockout, but in severe cases it is recommended to use a small amount of block out wax to soften those sharp line angles. With zirconia we are milling something that is 50 percent larger in volume than the sintered product so this is less of an issue. However, as we begin milling resins, it is a one to one milling ratio and it becomes more difficult.

Another factor that affects the fit is the die stone surface. With most crown and bridge cases we paint on die spacers and mark the margins, but these are a reflective or shiny surface or a color that the laser cannot read (**Image 13**). When using the software to design a case, closely examine the point cloud and the surface of the die. If there are voids, or inclusions or anything that does not look normal do not proceed (**Images 14 and 15**). You



need to either clean or treat the die. There are a number of materials, such as the Cercon Scan Spray, that are specially designed to pre-treat the dies prior to scanning (**Image 16**). This spray is a special non-reflective material that is ideal for scanning. It is important to only use a very light application (**Image 17**). Any build-up of scan spray will have a negative impact on the fit of the final restoration (**Image 18**). After spraying, simply rescan and begin the design process.

During the design process of the Cercon Art 3.0.1 the software will identify the undercut below the margin and select it for you. This feature allows you to quickly design a case. However sometimes the margin preparation is not clearly defined and you will need to make a manual selection, especially on beveled surfaces. You have 100 percent control over the margin location. Margins designed too short or overextended will be milled accordingly (**Images 19 and 20**).

Software like the Art 3.0.1 allows for a wide range of fit options. You can use the virtual die spacer to make the Cercon copings as tight or as loose on the dies as you want. This is an individual preference and the fits can be fine tuned (**Image 21**). It is important to understand the difference between the fit of a porcelain fused to metal restoration on the model as opposed to a restoration that was designed with a virtual die spacer. With a PFM we apply the die spacer and wax directly to the die. Once completed, our perceived fit of the PFM is with the die spacer still in place. With a restoration that was designed digitally with a virtual die spacer, the fit will appear looser on the die because the die spacer is not there. This is a true representation of how the zirconia restoration will fit in the patient's mouth.

Today, there are many places to purchase zirconia blanks and it is important to remember that not all zirconia is the same. Zirconia will vary in particle size, additives, sintering temperature and on how the blanks are processed. In their manufacturing process the blanks density must be carefully controlled. If not, when sintering there will be an uneven shrinkage of the material. This is especially noticeable on large cases. Also, be sure your supplier has FDA approval for their zirconia. This is critical from a safety and regulatory stand point. Ask for written proof to be sure.

Milling machines vary greatly by accuracy, number of axis and price. Most of today's milling machines

Image 14. *Missing Data Points on the Occlusal*

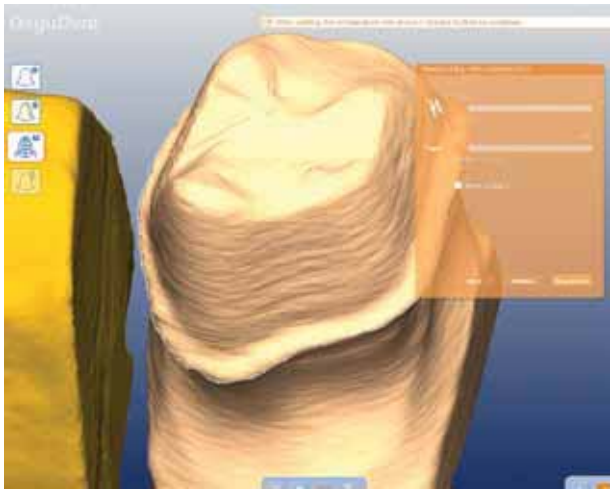


Image 15. *(right) Poor Data Collection*

Image 16. *(below left) Cercon Scan Spray*

Image 17. *(above) Properly Sprayed Die*

Image 18. *Die With too Much Scan Spray*

Earn CDT/RG credits for this article and quiz!

Receive ½ point CDT/RG documented scientific credit for reading this article and passing the quiz. To get your credit, complete the quiz located on the FDLA Web site at www.fdla.net using the Newsletter link. Once you have completed the quiz, fax it to FDLA at 850-222-3019. This quiz is provided to test the technician's comprehension of the article's content and does not necessarily serve as an endorsement of the content by FDLA.

CONTINUING APPROVED EDUCATION

use stepping motors or servo motors (electric motors) for driving the milling axis. The ballscrew is driven by a belt transmission, which positions the axis. This type of mechanical control and drive has a certain inertia which has a negative effect on accelaration and precision. Accuracy is measured by the ability for a bur to achieve the same position repeatedly, and today's milling machines have a repeatability of about 20 microns. The next generation of milling machines utilize contact free linear induction motors that are steered by magnets (**Image 22**). This technology allows for an accuracy of about 2 microns. While this is significant it is important to remember this is just one more factor that affects the fit of the final restoration.

Remember that every milling machine will require periodic maintenance and calibration. Before purchasing, be sure you have a full understanding of the warranty and associated costs. Depending on your business model it may be wise to just scan and design cases in your laboratory and utilize an outsourcing facilty.

The fit or the marginal accuracy of a finished zirconia restoration relies on a number of factors. It is important to break the process down into segments to see where things can be improved. Every piece that you can fine tune will improve the final fit. Some things you can control and others rely on the type of equipment you are utilizing. By following these guidelines, you can achieve repeated and excellent results (**Image 23**).

About the Author:

Arlo King, CDT, director of education and technical services, joined Dentsply International after 20 years of experience in dental laboratory education with the U.S. Air Force. He has designed and written numerous advanced dental laboratory training courses and taught at a prosthodontics postgraduate course for six years. His experience includes a position at the U.S. Air Force Dental Investigation Service where he tested and evaluated dental products. King has been a contributor to numerous dental journals including *Dental Clinics of North America* and *Quintessence* and was the 2007 NADL Educator of the Year. He is a CDT in both dental ceramics and crown and bridge and on the ADA ad hoc committee for CAD/CAM.

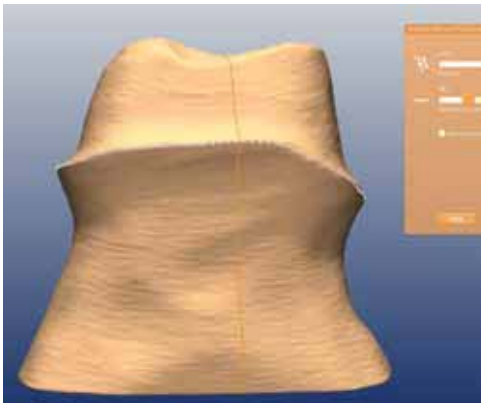


Image 19. *(above) Proper Margin Placement*

Image 21. *(above) Setting the Die Spacer and Coverage*

Image 22. *(above right) Cercon Expert*

Image 20. *(below) Margin Needing Adjustment*

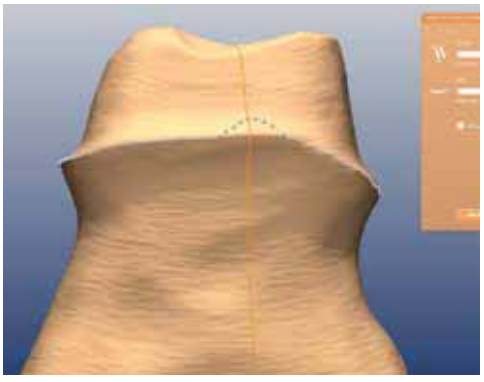


Image 23. *(right) Completed Cercon Substructure*

focus Magazine Article Quiz
4th Quarter 2009

"Fit Factors of Milled Zirconia Restorations"

By: Arlo King, CDT

(Course #: 19440)

1. Which of the following scanners are currently available in today's market?

   a. Laser
   b. Contact
   c. Cone beam
   d. All of the above

2. Prior to pouring your impression what do you need to consider?

   a. Color of your die stone
   b. Strength of your die stone
   c. Size of your die stone
   d. Non of the above

3. Lasers are a concentrated mix of a combination of colors. Which of the following colors is in the center and the most important?

   a. Blue
   b. Yellow
   c. Green
   d. Red

4. By examining your point cloud you can best determine whether or not your die stone is the correct color.

   a. True
   b. False

5. Which of the following colors are the best for die stones when using a laser scanner?

   a. The color makes no difference
   b. Pure white
   c. Gray or dark colors
   d. Yellow to orange

6. If your die appears to have a hole or a spiky surface when using a laser scanner this could mean...

   a. The die stone contains too much orange
   b. The die stone contains reflective particles
   c. The die stone is the wrong size
   d. None of the above

7. In today's milling machines, the smallest bur available has a radius of ____ mm.

   a. 3 mm
   b. 2 mm
   c. 1 mm
   d. .5 mm

8. Uncontrolled density in zirconia blanks can lead to uneven shrinkage during the firing process.

   a. True
   b. False

9. Today's milling machines have a repeatability of how many microns?

   a. 2
   b. 10
   c. 20
   d. 25

10. The next generation of milling machine will utilize contact free linear induction motors which will be steered by _____.

    a. Magnets
    b. The operator
    c. The manufactured
    d. Batteries

Passing quiz grades are worth ½ point documented scientific credit towards your CDT or RG renewal.
Look for more quizzes in future issues of *focus* magazine!

Your must submit your completed quiz to FDLA by fax at (850) 222-3019 or by mail to the address below.

Name:_____ CDT #:_____ Date:_____

FDLA, 325 John Knox Rd, Ste L103, Tallahassee, Florida 32303 · (850) 224-0711 phone · (850) 222-3019 FAX