Multi-layered 16 Pre-shaded Zirconia
**Hue** is the quality that distinguishes one family of colors from another, e.g., red from yellow or green from blue. If we say, for instance, that a tooth looks yellow or orange, we are describing its hue. That is, hue is used to describe the pigments of a tooth or crown (e.g., red, blue, or yellow). In the Munsell System, there are five principle colors; red, yellow, green, blue, and purple.

**Chroma or saturation** is the quality by which we distinguish a strong color from a weak one. For example: one tooth may look more yellow or orange than another. The higher the chroma of a specific hue, the color is deeper and more pure or intensified.

**Value or brilliance (CIE L* Value)** is the relative darkness or lightness of the hue. The greater the total amount of light reflected, the higher the value. The scale of value ranges from a low of 0 for pure black to a high of 10 for pure white. It is represented by the achromatic axis in the center of Munsell’s cylinder, where white is at the top and black at the bottom. There is a scale of grays ranging gradually from black to white and thus connecting the two extremes. Black has zero brilliance whereas white shows maximum brilliance.

**Translucency**: The degree to which light is transmitted rather than absorbed or reflected. The highest translucency is transparency, while the lowest is opacity. The incisal edges of a natural tooth are translucent, and accurate translucency determination is vital to a restoration’s esthetic success.

The CIE L* Value of the second molar full-contour zirconia crown on the first picture is too high. It is too white and does not match the adjacent teeth. The first molar full-contour zirconia crown in the second picture, however, has a much lower CIE L* Value, harmonizing well with the adjacent teeth. It is important for technicians to make sure that zirconia restorations are not too high in value as there is a tendency for them to look too white in the mouth.
As we move toward the incisal/enamel area, the tooth color dimension gradually changes in the following manner.

- Chroma gradually decreases
- CIE L* Value gradually increases
- Translucency gradually increases

Tooth color reproduction is a skillful combination of hue, value, chroma and translucency. Zirconia that has these factors already built into the disk would be an ideal choice for aesthetics and consistency.

<table>
<thead>
<tr>
<th>Term</th>
<th>Dimensions of color</th>
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<tbody>
<tr>
<td>Hue</td>
<td>Color tone</td>
</tr>
<tr>
<td>Value</td>
<td>Relative lightness/darkness</td>
</tr>
<tr>
<td>Chroma</td>
<td>Saturation/purity of color</td>
</tr>
<tr>
<td>Translucency</td>
<td>Amount of light transmitted</td>
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</table>
Multi-Dimension tooth color... reproducing nature

Each of these natural teeth have multiple dimensions (each dot) of color: multi chroma, multi value, incisal effect & multi translucency

Understand the effects moving towards the incisal/enamel area of ORIGIN multi-layered zirconia

**Decreasing Chroma...** Each layer of the ORIGIN LIVE zirconia Multi has been given different degrees of chroma intensity. The cervical layer having the highest chroma level and the incisal/enamel layers having decreasing degrees of chroma intensity, to better reproduce the natural characteristics of the human tooth. A huge advantage over mono-shaded zirconia disks which give only one shade from the cervical to the incisal/enamel area.

**Increasing CIE L* Value...** towards the incisal/enamel area - The white L* value increases since the lower chroma allows more light transmission, resulting in increased translucency. The L* value does still remain controlled at about a 90% level to inhibit too much of a bright white effect. (Patent pending feature)

**Increasing Incisal/enamel effect...** Increasing incisal/enamel effect – Color pigments have been added at an increasing level towards the top layers to create the same incisal/enamel effects that are found in the shade tab (patent pending feature). Incisal grayish (bluish) or violet effects are more noticeable towards the top layers.

**Increasing Translucency...** One of the major benefits of multi-layered, shaded zirconia discs is that the incisal/enamel areas have a significantly decreased amount of color pigments than cervical areas, thus allowing more light transmission.
Streamlined production

- Working with unshaded zirconia
  - Milling
  - Coloring
  - Drying
  - Sintering

- Working with shaded zirconia
  - Milling
  - Sintering

Color Consistency

Consistency of pre-shaded discs and color reproduction

Each disc and each layer has an exact pre-determined amount of color pigments.

“A” shades discs have consistent redish brown, orange tone that is distinguished from “B” shade discs which have yellowish tones.

Shaded discs are comparatively less technique sensitive than the coloring liquid method. Color liquids tend to get stronger after repeated use due to water evaporation.

The top row is mono-shaded zirconia with a body shade throughout the whole disc, whereas the second row is from a multi-layered disc with an incisal/enamel effect having a gradual change from cervical to top.
Multi-layered zirconia color options

Color options

- **A1 (Multi)**: Lot: 14mm-012514 P9,7 VZI-ZXJ-BPI 1.2325 ORIGIN LIVE Zirconia NS0309-31
- **A2 (Multi)**: Lot: 14mm-012514 P9,7 VZI-ZXJ-BPI 1.2325 ORIGIN LIVE Zirconia NS0309-31
- **A3 (Multi)**: Lot: 14mm-012514 P9,7 VZI-ZXJ-BPI 1.2325 ORIGIN LIVE Zirconia NS0309-31
- **A3.5 (Multi)**: Lot: 14mm-012514 P9,7 VZI-ZXJ-BPI 1.2325 ORIGIN LIVE Zirconia NS0309-31
- **A4 (Multi)**: Lot: 14mm-012514 P9,7 VZI-ZXJ-BPI 1.2325 ORIGIN LIVE Zirconia NS0309-31
- **B1 (Multi)**: Lot: 14mm-012514 P9,7 VZI-ZXJ-BPI 1.2325 ORIGIN LIVE Zirconia NS0309-31
- **B2 (Multi)**: Lot: 14mm-012514 P9,7 VZI-ZXJ-BPI 1.2325 ORIGIN LIVE Zirconia NS0309-31
- **B3 (Multi)**: Lot: 14mm-012514 P9,7 VZI-ZXJ-BPI 1.2325 ORIGIN LIVE Zirconia NS0309-31
- **B4 (Multi)**: Lot: 14mm-012514 P9,7 VZI-ZXJ-BPI 1.2325 ORIGIN LIVE Zirconia NS0309-31
- **C1 (Multi)**: Lot: 14mm-012514 P9,7 VZI-ZXJ-BPI 1.2325 ORIGIN LIVE Zirconia NS0309-31
- **C2 (Multi)**: Lot: 14mm-012514 P9,7 VZI-ZXJ-BPI 1.2325 ORIGIN LIVE Zirconia NS0309-31
- **C3 (Multi)**: Lot: 14mm-012514 P9,7 VZI-ZXJ-BPI 1.2325 ORIGIN LIVE Zirconia NS0309-31
- **C4 (Multi)**: Lot: 14mm-012514 P9,7 VZI-ZXJ-BPI 1.2325 ORIGIN LIVE Zirconia NS0309-31
- **D2 (Multi)**: Lot: 14mm-012514 P9,7 VZI-ZXJ-BPI 1.2325 ORIGIN LIVE Zirconia NS0309-31
- **D3 (Multi)**: Lot: 14mm-012514 P9,7 VZI-ZXJ-BPI 1.2325 ORIGIN LIVE Zirconia NS0309-31
- **D4 (Multi)**: Lot: 14mm-012514 P9,7 VZI-ZXJ-BPI 1.2325 ORIGIN LIVE Zirconia NS0309-31
- **O2M (Multi)**: Lot: 14mm-012514 P9,7 VZI-ZXJ-BPI 1.2325 ORIGIN LIVE Zirconia NS0309-31
- **3M1 (Multi)**: Lot: 14mm-012514 P9,7 VZI-ZXJ-BPI 1.2325 ORIGIN LIVE Zirconia NS0309-31
- **4M1 (Multi)**: Lot: 14mm-012514 P9,7 VZI-ZXJ-BPI 1.2325 ORIGIN LIVE Zirconia NS0309-31
- **5M1 (Multi)**: Lot: 14mm-012514 P9,7 VZI-ZXJ-BPI 1.2325 ORIGIN LIVE Zirconia NS0309-31

Shaded Discs Color Options

<table>
<thead>
<tr>
<th>Thickness (mm)</th>
<th>Multi-layered</th>
<th>Mono-shaded</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>14</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>16</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>20</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>24</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Options:
- **X** indicates color available
- **O** indicates color not available
ORIGIN LIVE zirconia colors were determined under these parameters

1. Sintering Oven

Oven used: ORIGIN DuoTron Pro
Test results show that different brands of ovens may produce different levels of chroma intensity. Under the same conditions (ex. same zirconia, same color method - either from liquid or pre-colored disc), brand A furnace produced an A2 shade while brand B furnace produced an A2.5 or A3 shade. Possible reasons include the heating coil type, heating coil thickness, age of the oven, heating chamber size, temperature schedule, degree of protective glass oxide layer over the heating coil (in the case of an MoSi2 heat source).

2. Glazing parameters

High temperature: 800 °C. Holding time: 1 min 30 sec
The higher glazing temperature you use, the lighter color your glazed zirconia will have. The proper glazing temperature schedule is introduced on page 12 in the Instructions For Use of the ORIGIN LIVE zirconia & ORIGIN CHROMA zirconia coloring system.

3. Glazing without vacuum

Test results show that using vacuum during glazing will create lighter shades in the final glazed zirconia. In addition, the default vacuum level of different brands of porcelain ovens differ from each other. As a result, we have eliminated this varying factor from our standard processing and recommend that you do not use vacuum during glazing. Your glazed zirconia will still look great at the glazing temperature of 800 °C

4. Color conditions when checking shades

Color perception of the final glazed zirconia restoration depends on many factors including: the light source (for example, natural light, fluorescent light, incandescent light, etc), light intensity (3000 K - 6500 K), abundance of light in a room, observation angle, etc. The ORIGIN CHROMA zirconia coloring system was developed based on the following parameters:

Light source: Natural, full-spectrum light
Light intensity (color temperature): 5,000 K (3000K-soft white, 3500-Neutral, 4100 K-Cool white, 5000K-Natural light, 6500K-Bright daylight)
Color reproduction capability (color rendering index) of light source: 90%
Observation angle of the restoration: combination of straight angle and side angle
Color determination: combination of experience of skilled ceramist and colorimeter (Vita® Easyshade Compact)

Color Temperature
Different furnaces produce different results

Test 1. Different Sintering Ovens - Different result in redish brown chroma

Two different ovens were tested for sintering results. The same shade zirconia (either from a pre-colored multi-layered disc or colored by the liquid method) were sintered in different ovens; sample A was sintered using the ORIGIN DuoTron Pro quick mode (3 hrs) and sample B was sintered using a conventional oven with a long cycle time of 8 hours. The shade of sample A came out as intended, whereas sample B from the conventional oven came out with a stronger/higher chroma.

Test 2. Different Temperature Setting - Different result in chroma

The same oven was tested using different temperature settings. As the sintering temperature gets higher, the redish brown chroma of the A2 shade gets weaker. Between 1530 °C (purple bar) and 1550 °C (green bar), the difference was nearly unnoticeable, but between 1570 °C (red bar) and 1530 °C (purple bar) the chroma difference was quite noticeable.
The ORIGIN zirconia color system was developed based on the ORIGIN DuoTron sintering furnace

The Origin Multi-zirconia discs and the Origin coloring system, CHROMA, were developed based on numerous test results utilizing the ORIGIN DuoTron oven which is one component of the Origin CAD/CAM system. The DuoTron gives consistent and reproducible results over long periods of time. Test results show that conventional ovens with a longer sintering cycle (7-8 hours) give a result that is one-half shade to one full shade darker as compared to when the DuoTron oven is used.

More Than just Sintering - Certainty

The final shade results of the 20 pre-colored discs are best presented when sintered with the Origin DuoTron furnace. From this important aspect, the DuoTron provides certainty and consistency.
Patient had a deep disto-lingual caries with a pain. Carious lesion was all removed and RMGI (resin-modified glass ionomer) restorative material was used to fill the pocket. Afterwards a full contour ORIGIN LIVE zirconia crown was seated. The restoration with a reduced L* value on the occlusion area to better match with the unrestored teeth along with high strength was well received by the patient.

The distal area of tooth #11 was minimally reduced and a retention groove was created. The mesial, buccal and lingual sides of tooth #13 were also minimally reduced, preserving the original occlusion. High strength, high translucent ORIGIN LIVE zirconia was used to withstand the minimal prep amount. Incisal Inhancer was applied on the incisal third for a lifelike effect.

Patient has had composite crown with a post for a long time and has wanted a better looking crown. A ORIGIN LIVE full contour zirconia crown was prescribed to replace the composite crown. Patient now has a better self-esteem with improved tooth image.
Clinical Cases

Case 4

This patient was self-conscious with his noticeable gold onlay on his first molar. He wanted an all ceramic full contour zirconia restoration based on the improved aesthetics. ORIGIN LIVE zirconia was prescribed and the restoration exhibits a good match with the adjacent A3 second bicuspid.

Case 5

The patient had their first molar filled with composite for over 10 years without any problems. After experiencing a high degree of sensitivity the patient went in for a check-up. The composite filling area was very large and deep so the dentist prescribed a full crown restoration. An ORIGIN LIVE full contour zirconia crown was made and relieved the patient’s tooth sensitivity while providing a much more aesthetic crown.

Case 6

This amalgam filling on the patient’s bicuspid was very noticeable and after 10 years they desired a more aesthetic option. An all ceramic full contour ORIGIN LIVE zirconia crown was prescribed to replace the old restoration and both the dentist and patient were completed satisfied with the final aesthetics.
Translucency - unshaded zirconia

YTZP Zirconia Translucency Test Results
Comparison of 8 commercially available brands in USA

How we did this test

Test Sample Size and CNC Milling
Multiple small disc samples were created as STL files using Solidworks (Dassault Systems SolidWorks Corporation, MA, USA) 3D design software. Then the samples were milled using each manufacturer's enlargement factor so that the dimensions of each sample would measure 17.5 mm (diameter) X 1.00 mm (thickness) after final sintering and polishing (the samples were slightly thicker than 1.00 mm after milling to allow an exact thickness of 1.00 mm after polishing). An enlargement factor of 1.2500, for example, is equivalent to a shrinkage rate (1/1.2500=0.200) of 20%. This clarification is given since these concepts of enlargement factor and shrinkage rate are often used interchangeably by mistake in the dental industry. The sample thickness of 1.00 mm was chosen, instead of 0.6mm or 0.5mm, since these zirconia materials being tested are primarily and preferably used for full contour crown and bridge applications of which the thickness of the body portion, mesial, ligual and distal area would be normally 1-2 mm in thickness. Test samples of 0.5 - 0.6 mm thick that are found in publications of other manufacturers would be more appropriate for the application of crown and bridge substructures (copings or frameworks).

Polishing & Sintering
After precision CNC milling, both sides of each of the samples were mirror polished using 3M Imperial Wetordry 401 Q (2500A grit) and then surface cleansed with Isopropanol alcohol ((CH3)2CHOH). Each surface was polished to an extent to clearly reflect the light to minimize surface deflection of the light source in the spectrophotometer. Each different brand of zirconia was sintered according to each manufacturer's recommendation as appears in their Instructions For Use manual or published website information. The sintering schedule for each material type is below. To ensure accuracy and consistency in temperature of the sintering chamber, Process Temperature Control Rings (PTCR from Ferro, Netherlands) were used each time multiple samples were sintered. After going through this sintering process, the samples are understood to be fully sintered and no post HIP processing was done.

Measuring the Translucency
One method of measuring translucency is by determining total transmission, including scattering, using a spectrophotometer with an integrating sphere as shown below. Translucency of a material can be expressed as a transmission coefficient or total (direct and diffused) light transmittance(%) as the relative amount of light passing through the unit thickness of the material. Total light transmittance was measured by a double beam-system spectrophotometer (LAMBDA 35, UV/Vis Spectrophotometer manufactured by Perkin Elmer, USA) based on “Standard test method for transmittance and color by spectrophotometer using hemispherical geometry” of ASTM E1348-11 and “Materials and articles in contact with foodstuffs – Test methods for translucency of ceramic articles” of Dansk Standard/EN 1184.
All the samples were cleaned with isopropyl alcohol before light transmittance measurement. Light emitted from a light source (deuterium lamp and halogen lamp) was passed through a sample and scattered, and the light transmission amount was measured using an integrating sphere.
Accuracy (Dimensional stability)

Sample Preparation

Two different zirconia samples were prepared to test the dimensional accuracy for a full mouth case. The samples were milled using a 5 axis milling machine and sintered in the DuoTron Pro oven. The original designed file and scanned sintered file were overlayed using the ORIGIN Inspection software.

Sample A: ORIGIN HSD (Homogeneous Sequential Deposit) method

Sample B: Conventional method (Dry Compaction + CIP process)

Test Result

Sample A which was produced with the HSD method (Homogeneous Sequential Deposit) exhibited a perfect fit without any distortion. Sample B, however, showed open margins on the molars which is the result of uneven shrinkage during sintering. ORIGIN LIVE can be a dependable material for full-arch solid zirconia implant restorations.
ORIGIN LIVE zirconia can withstand the force of a hammer even with walls (buccal, lingual & occlusal) as thin as 0.5 mm - 1.0 mm, the thickness ideally used for full contour applications.

ORIGIN LIVE zirconia can be milled for both (A) substructures or (B) full contour application in one disc. This is due to the fact that the material has both high translucency capability and high green body strength.
Despite the limitations of this study on the evaluation of antagonistic tooth wear, less wear of the antagonistic teeth was shown with polished LIVE zirconia than with the previous dental porcelain or e.max CAD, representing that the LIVE zirconia may be more beneficial in terms of antagonistic tooth wear.
Multi-layered Zirconia
16 Pre-shaded