



Celtra® Duo

Zirconia-Reinforced Lithium Silicate (ZLS) Block

Technical Monograph

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1. Introduction

1.1 Celtra Duo (ZLS) material overview

Celtra Duo (ZLS) is a Zirconia-reinforced Lithium Silicate high-strength glass ceramic material designed for chairside CAD/CAM applications. It is a fully crystallized tooth-colored material that possesses the unique capability of being processed in either of two ways: Mill, polish and fire or Mill and polish. The final decision as to which pathway remains with the clinician.

1.2 Manufacturing process

Celtra Duo (ZLS) blocks are cast in one homogenous piece. Based on glass technology, the utilization of a continuous pressure-casting production process is employed to manufacture the blocks. Because the material is fully crystallized at the time of manufacture, it does not require a lengthy firing step after milling.

During the manufacturing process, the zirconium is dissolved in the amorphous (glassy) phase, which builds the matrix for the lithium silicate crystals. This results in a larger number of very fine-grained lithium crystallites whose high glass content imparts excellent light-optical and mechanical properties.

The ultra-fine microstructure allows Celtra Duo (ZLS) blocks to be machined in the tooth-shaded state (final crystallized product), and allows for good polishability. The unique microstructure provides excellent esthetics by combining opalescence with translucency, resulting in a highly-esthetic restoration exhibiting a chameleon effect, naturally reflecting the shade of surrounding dentition.

1.3 Indications

Celtra Duo (ZLS) is indicated for single-unit restorations: crowns, inlays, onlays, and veneers.

2. Technical Data

2.1 Material composition

Celtra® Duo (ZLS) Zirconia-reinforced Lithium Silicate blocks for CAD/CAM applications
Material composition:

Zirconia-reinforced Lithium Silicate

Oxide	Weight (%)
Silicon Dioxide	58.0
Phosphorus Pentoxide	5.0
Alumina	1.9
Lithium Oxide	18.5
Zirconium Dioxide	10.1
Terbium Oxide	1.0
Ceria	2.0

10% ZrO₂
Diluted completely in glass-matrix (no crystals)

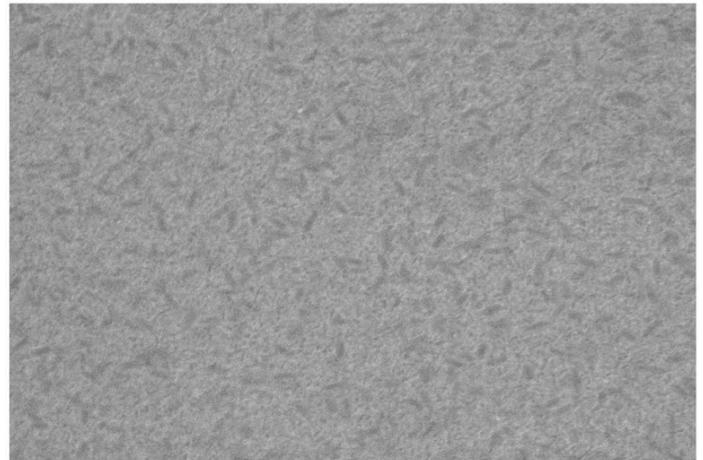
2.2 Microstructure

The microstructure of fully-crystallized (fired) Celtra Duo (ZLS) consists of 58% Silicon Dioxide and 5% Phosphorous Pentoxide plus 1.9% Alumina for increased chemical stability. 10.1% crystallized Zirconium Dioxide adds strength, and 1% Terbium Oxide and 2.0% Ceria have a slight influence on the overall optical properties of the material. An additional 10% Zirconium Dioxide—which is completely diluted in amorphous glass so as not to be crystallized—is added to the composition of Celtra Duo (ZLS) to create a unique fine-grained structure that increases the material strength, yet allows the material to be readily machined.

10% diluted Zirconium Dioxide is unique to the composition of Celtra Duo (ZLS). A Scanning Electron Microscope (SEM) image of the surface of Celtra Duo (ZLS) can be seen in Figure 1.

Figure 1

SEM of fully-crystallized, unpolished Celtra Duo (ZLS) material.



The SEM shows the smaller grain size of Celtra Duo (ZLS). The smaller grain size allows for easy polishability, resulting in a more natural gloss, or shine, and an esthetic result without having to glaze and fire the material.

2.3 Microstructure comparison

Figure 2 is an SEM image of the surface of an IPS e.max® material block. Figure 3 is an SEM image of the surface of a Celtra® Duo (ZLS) material block. The lithium disilicate crystals are larger within the e.max material, and noticeably smaller within the Celtra Duo (ZLS) material.

Figure 2

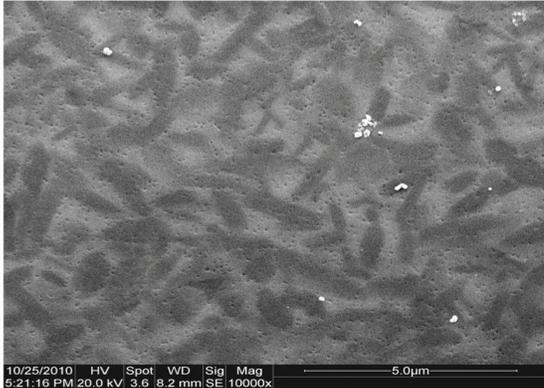
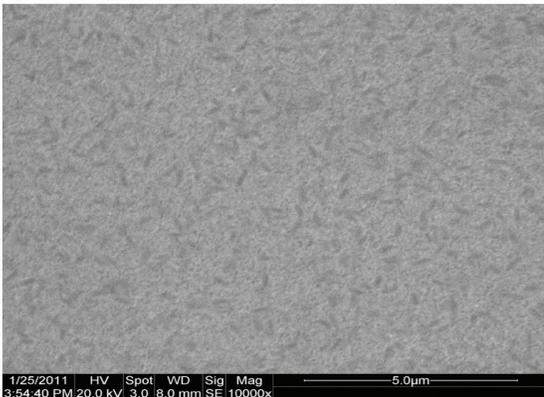


Figure 3



The crystal size of e.max is approximately 3 to 4 micrometers on average. The crystal size of Celtra Duo (ZLS) varies between 400 to 800 nanometers—always below 1 micrometer.

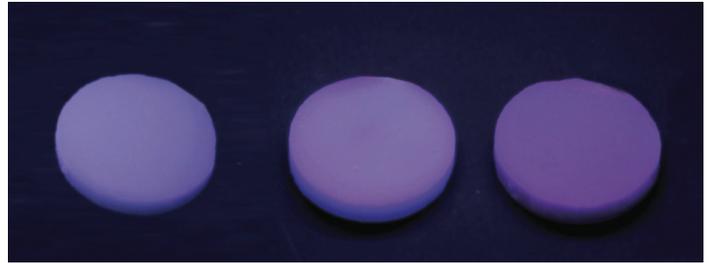
2.4 Microstructure: esthetics

The microstructure of Celtra Duo (ZLS) lends itself to esthetic benefits, due to its high volume of glass and smaller crystal size, natural translucency, opalescence, and fluorescence are emphasized.

Figure 4:
Opalescence



Figure 5: Fluorescence



Due to its smaller particle size, Celtra Duo (ZLS) material provides a natural opalescence (Figure 4), and lifelike fluorescence (Figure 5). These effects are not produced by the pigments or coloring within the material, but rather by a light-scattering effect precipitated by the individual crystal size and the volume of crystals throughout the material.

2.5 Microstructure: radiopacity

Figure 6



Photo Credit: Dr. Bobby Chagger

Figure 6 is a photograph of an IPS e.max CAD material block in the center with a 1mm thick tab cut into the top portion of the block. The e.max block is in its green state (green state = has not been fired in a furnace). To the left of the e.max block is a fully-crystallized (fired) 1mm thick portion of an e.max block. To the right of the e.max block is a Celtra Duo (ZLS) block with a 1mm thick tab cut into the top portion. Figure 7 is an x-ray image of all three items seen in Figure 6. Notice that the 1mm sliver of fully-crystallized e.max cannot be seen at all, nor can the 1mm tab cut into the top portion of the e.max block in the center (green state) as they are not radiopaque. However, the gray area of the 1mm tab cut into the top portion of the Celtra Duo (ZLS) block seen on the right of Figure 7 demonstrates that Celtra Duo (ZLS) is radiopaque. The radiopacity of restorative materials is an important auxiliary to diagnose secondary caries, determine the proximal contour of the restoration as well as its contacts with adjacent teeth, and also to distinguish restorative material from gaps and voids.

Figure 7

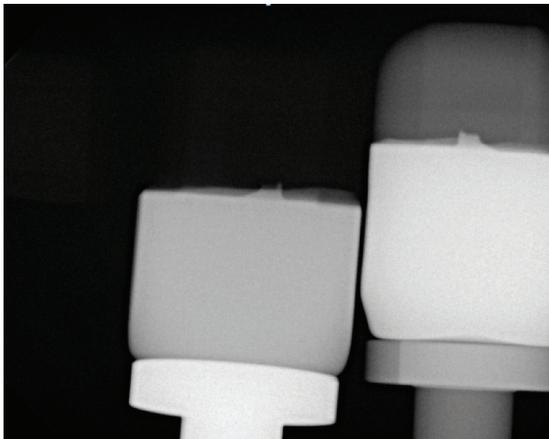


Photo Credit: Dr. Bobby Chagger

2.6 Biocompatibility

Celtra® Duo (ZLS) was tested at NAMSA in respect to biocompatibility according to ISO 10993-2009 and NAMSA concluded that Celtra Duo (ZLS) can be used without any restrictions as a medical device in the European Union, United States of America (FDA) and Canada.

3. In-vitro Investigations

The behavior and performance of Celtra Duo (ZLS) was tested in several in-vitro tests and compared with other materials. These tests provide preliminary information about the performance of the material when it is used for the recommended indications. Note that although these tests are standardized, they only represent a selection of primary features and do not provide a comprehensive overview of the materials' performance in-vivo. The reported values do not represent absolute values. The values are to be used as a reference to compare the performance of different materials when tested under the same conditions.

3.1 Load at fracture for anterior crowns

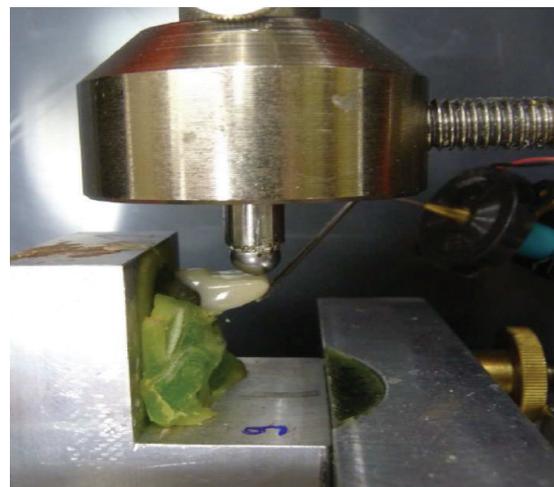
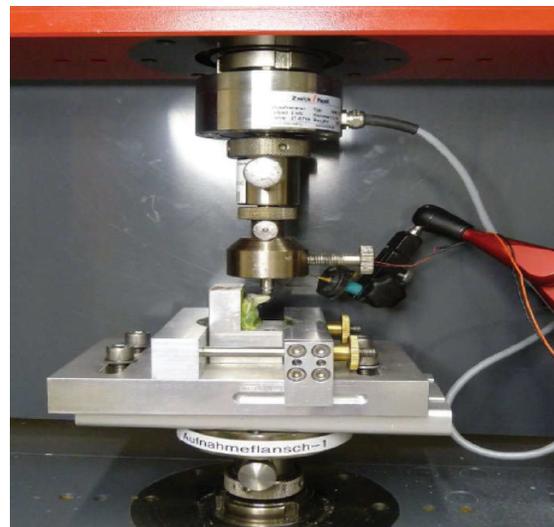
The objective of this test was to determine load an anterior crown can be subjected to before fracturing occurs.

METHOD: Anterior crowns machined from three different materials were tested: Celtra Duo (ZLS) , IPS e.max CAD, and VITA Mark II. All crowns were tested before artificial aging, and again after artificial aging which consisted of 6,000 thermal cycles (41°F/131°F) and 1.2 million chewing cycles. The crowns were luted to an aluminium die with Multilink implant to allow a natural degree of elasticity (Figure 8).

RESULTS: The median load fracture of two materials— Celtra Duo (ZLS) and e.max CAD were nearly identical before aging, coming in at 725N and 701N respectively. After aging, however, the median load at fracture for Celtra Duo (ZLS) increased to 766N, whereas e.max CAD decreased to 485N. VITA Mark II median fracture load results were 554N before aging, and 372N after aging (Figure 9).

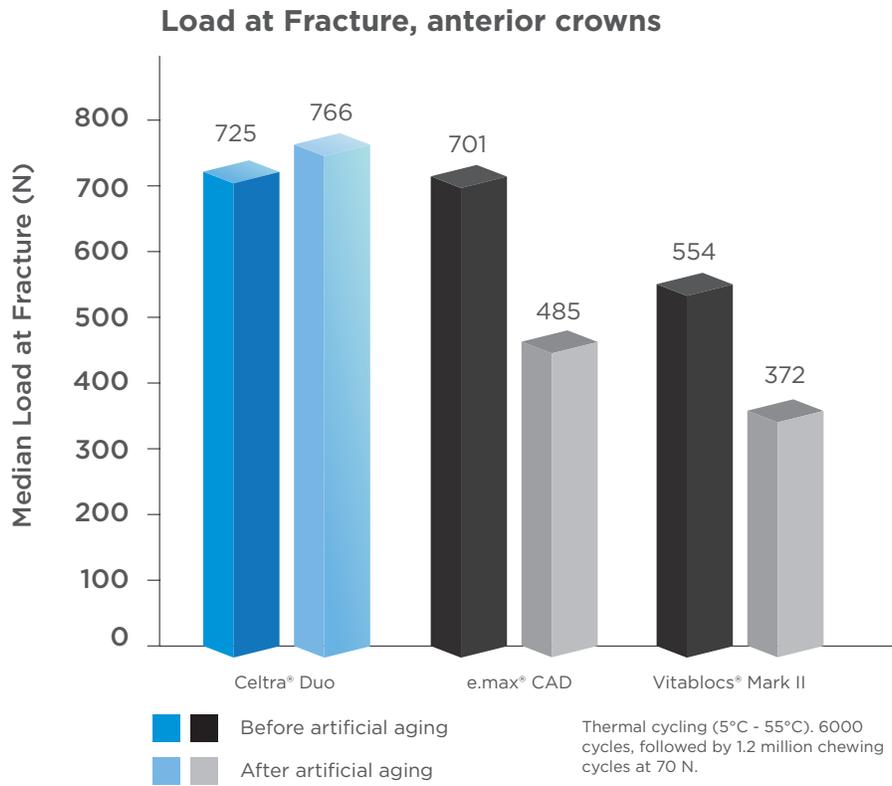
Source: Report from University of Heidelberg; Rues, Schmitter, Rammelsberg, May 2013.

Figure 8: Fracture test set-up



This machine applies, measures, and records the force applied to the crowns, and the instrument with the articulating red arm “listens” for the sound of a crack. When a crack first occurs within the material, it cannot be seen by the naked eye. However, microfractures produce a sonic wave, which is recorded and reported by the instrument, enabling a precise reading of the actual occurrence of the microfracture—and its corresponding force load—before it can be seen.

Figure 9

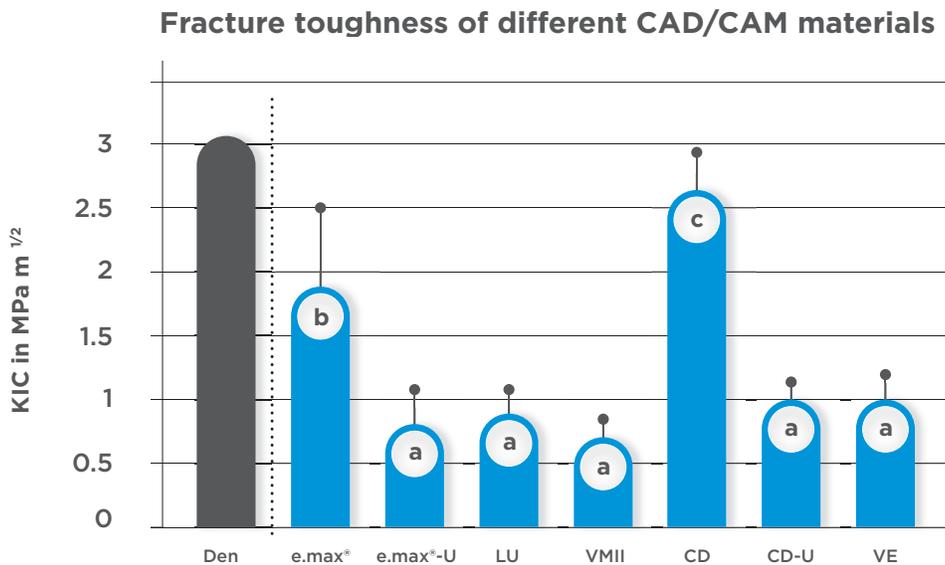


3.2 Fracture toughness

Fracture toughness, known as the K_{IC} value, measures the resistance of a material to the propagation of a crack. It is measured by loading a sample containing a deliberately-introduced contained crack or a surface crack, recording the tensile stress or the bending load at which the crack suddenly propagates. Since we know that the K_{IC} fracture

toughness of human dentin is $3\text{MPa m}^{1/2}$, a material that possesses a K_{IC} value closest to 3 will behave most like natural dentin when subject to masticatory stresses. As shown in Figure 10, the fracture toughness of fired (“CD”) Celtra Duo (ZLS) restorations averaged $2.6 K_{IC}$.

Figure 10



Source: Rania Badawy, Laura Tam, Omar El-Mowafy
 Department of Restorative Dentistry, University of Toronto, Ontario, Canada

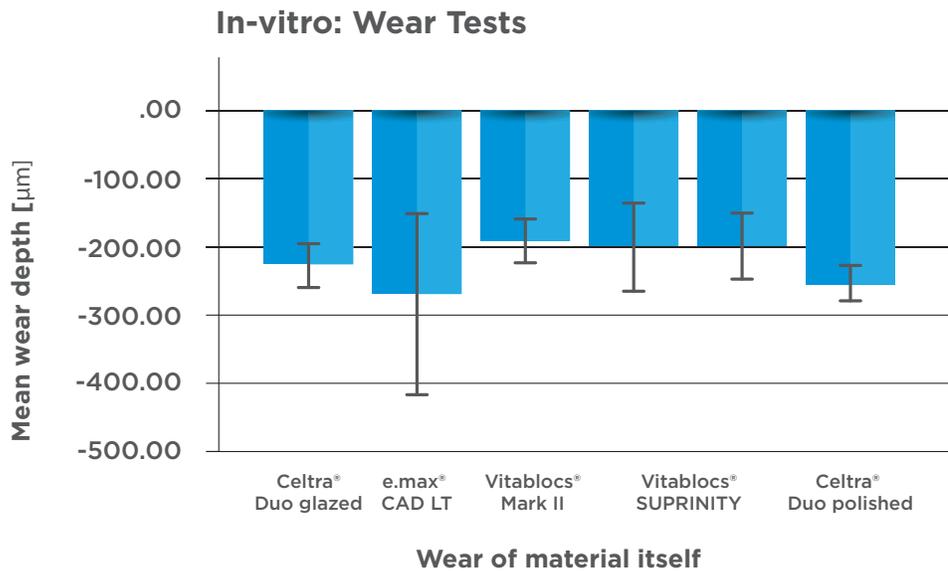
3.3 In-vitro wear tests

Wear has two parts: one is the wear performance of the material itself, and the other is the wear of the natural antagonist. Figure 11 shows the results of wear testing of five different materials, and Figure 12 shows how much wear these same five materials cause to an antagonist material. These tests are done using the pin-on-block method, whereby an antagonist material which has a similar elasticity of natural dentition is pinned down against the material being tested, and then the block is shifted laterally against the surface of the material, lifted off, pinned back down against the surface the material, and shifted laterally against the surface once again.

This sequence is repeated for approximately 1 million cycles (simulating approximately 5 years of masticatory forces), and then wear measurements are determined topographically with the use of a 3D profilometer tactile probe.

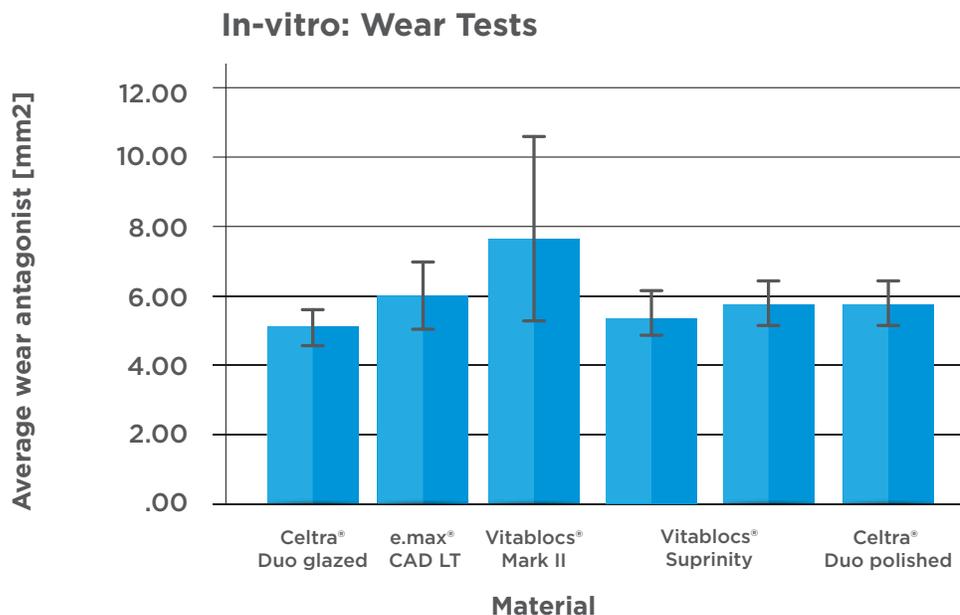
The results show no statistically significant wear difference amongst all materials tested (Figure 11), and all are well within the limits of accepted wear values for dental restorative materials. Likewise, there was no statistically significant difference in the wear of the antagonist—they all behave like any other material to the antagonist (Figure 12).

Figure 11



Source: Dr. Rosentritt; University of Regensburg

Figure 12



Source: Dr. Rosentritt; University of Regensburg

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