Celtra® Duo

Zirconia-Reinforced Lithium Silicate (ZLS) Block

FactFile

The product name Celtra® stands for a new generation of high-strength dental ceramic and defines a new class of material referred to as “zirconia-reinforced lithium silicate ceramic” (ZLS).

Celtra Duo is a CAD/CAM block developed specifically for chairside use with CEREC®.

Properties of zirconia-reinforced lithium silicate ceramic (ZLS)

In addition to lithium oxide and silicon dioxide, Celtra contains approximately 10% zirconium dioxide (ZrO_2) in highly dispersed form in the glass phase of the ceramic. This prevents crystallization of the zirconium oxide, lends this material to its high translucency and opalescence, and avoids the more opaque look one is used to with zirconium oxide ceramics. Furthermore, the highly dispersed ZrO_2 content generates considerably more nuclei for forming the crystallization phase and already encourages the formation of crystallization nuclei at lower energy input due to its more favorable thermodynamic parameters (Fig. 1).

This tends to result in a greater number of smaller crystallites rather than fewer large ones, which is why the glass phase of the ZLS glass ceramic is present at a higher ratio when compared with conventional lithium disilicate ceramics. The formed crystals (Fig. 1, right: approx. 0.6-0.8 µm) are significantly smaller than those in lithium disilicate ceramics (Fig. 1, left: 2.5 µm).

The 10% content of zirconium oxide is virtually dissolved at the molecular level. The resulting structural characteristics in ZLS lead to the special properties of this material class:

- High intrinsic strength of 420 MPa[1]
- Easier grinding and polishing in final crystallized state
- High level of translucency and opalescence resulting in excellent esthetic properties

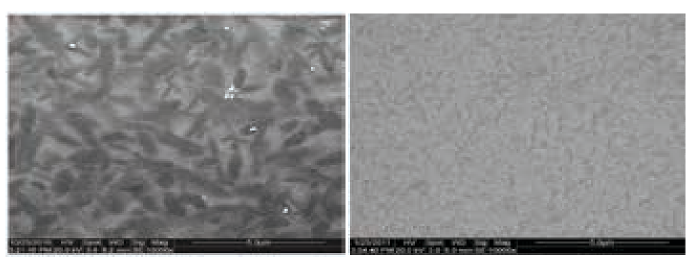


Fig. 1 Scanning electron micrographs of polished ceramic samples
Left: lithium disilicate with predominantly large crystals (dark)
Right: ZLS with fine crystalline structure (dark) and large glass ratio (light)

What is Celtra® Duo?

Celtra Duo is a CAD/CAM block based on the properties of ZLS developed specifically for chairside use with CEREC®.

Due to the easier grindability of ZLS, Celtra Duo can be processed in the grinding unit of the CEREC system in its fully crystallized tooth colored state. Due to its proprietary Zirconia-reinforced Lithium Silicate (ZLS) microstructure, Celtra Duo (ZLS) provides CEREC dentists with a material that gives them the highest level of freedom, control, and workflow flexibility, resulting in a final restoration in which they have complete confidence with respect to the clinical, functional, and esthetic end result.

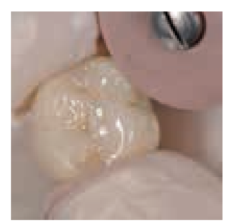
Processing Simplicity

Celtra Duo (ZLS) offers two processing pathways, and each one is considered quite simple, especially compared with other zirconia-based materials. One pathway does not include firing, and the other pathway does, as shown below:

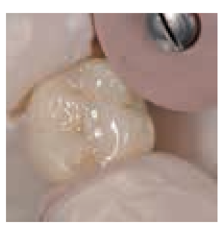
Choice in Process Flow

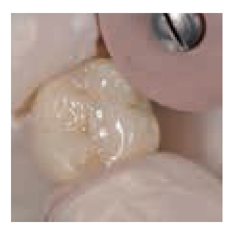
Option 1:
Polish & Place (210 MPa)

Option 2:
Glaze/Stain, Fire,
& Place (370 MPa)



Option 3:
Polish, Fire
& Place (370 MPa)





Firing times vary on oven and process used.

Celtra® Duo compared to other systems, esthetic properties

Celtra Duo is available in the variants HT (high translucency) and LT (low translucency). At first glance, the Celtra Duo blocks may appear somewhat darker or more chromatic than accustomed to by experienced CEREC® users (Fig. 2). This is due to the inherent opal effect and the shading selected in terms of desired dental restoration (Fig. 2).

Fig. 2 Chameleon effect of Celtra Duo based on high translucency and opalescence. It should be noted that the block initially appears somewhat darker, but that the ground restoration then meets the tooth color to be achieved.[2]

Mechanical properties

In a study at Heidelberg University, anterior crowns made of Celtra® Duo (glazed), lithium disilicate (e.max®) and feldspar ceramic (Vita Mark II®) were loaded orally at the incisal edge. The crowns were fixed to CoCr cores using a composite cement. One half of the samples was tested for static strength, the other half was loaded mechanically 1.2 million times at 86 N following thermocycling (5°C/55°C 6,000 cycles). Then the strength of the crowns was tested mechanically until complete failure. Not only was the breaking strength tested here (Fig. 3), the incidence of first defects in the framework was also recorded via acoustic detection, ie cracks which already occur during lower loads. This test showed that first cracks or damage prior to aging for Celtra Duo occurred at considerably higher loads (667 N) than for lithium disilicate (525 N). After aging, Celtra Duo only showed first cracks at 742 N, whereas with lithium disilicate they already occurred at 402 N. Celtra Duo demonstrated no statistically significant drop in loading capacity after aging when using glaze ("aged" from previously 725 N to 766 N) in this simulation of chewing compared to lithium disilicate (aged from previously 701 N to 485 N) and feldspar ceramic (aged from 554 N to 372 N). In conclusion, while glass ceramics usually lose some of their strength in the aging process, Celtra Duo retains its high level of strength—a strength that contributes to the long-term safety of the restoration.

Load at Fracture, anterior crowns

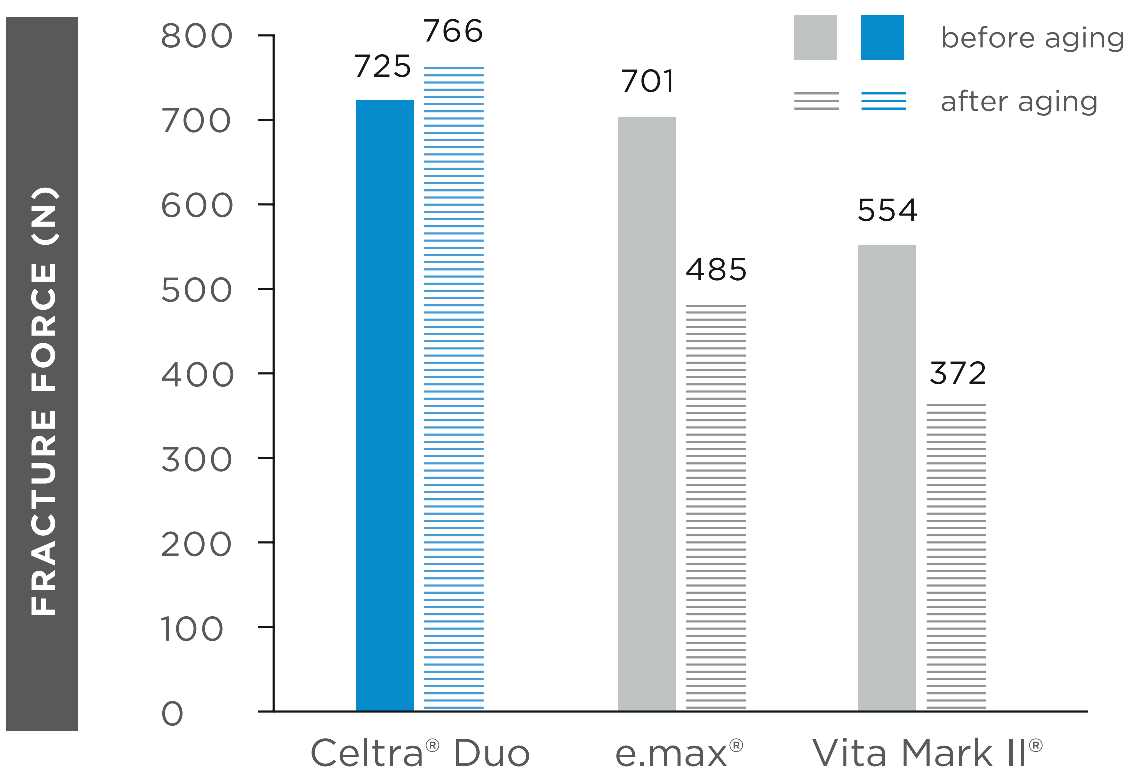


Fig. 3 Breaking load in Newton (median) for anterior crowns after 1.2 million cycles of mechanical loading of the incisal edge orally prior to and after thermocycling (TC, 55°C/5°C)[3]

Mechanical properties (continued)

Flexural strength: Biaxial B3B method

In a study conducted by dental faculty at universities in Germany, Chile, and Austria, eight representative chairside CAD/CAM materials ranging from polycrystalline zirconia (e.max® ZirCAD; Ivoclar Vivadent), reinforced glasses (Vitablocs Mark II®, VITA; Empress® CAD, Ivoclar Vivadent), and glass ceramics [e.max CAD, Ivoclar Vivadent; Suprinity®, VITA; Celtra® Duo, Dentsply Sirona] to hybrid materials (Enamic®, VITA; Lava® Ultimate, 3M ESPE) have been selected. Specimens were prepared with highly polished surfaces in rectangle plate (12 x 12 x 1.2cm^3) or round disc (0 = 12 mm, thickness = 1.2 mm) geometries. Specimens were tested using the B3B assembly and the biaxial strength was determined using calculations derived from finite element analyses of the respective stress fields.

Biaxial strength of Celtra Duo was determined to be above 600 MPa (similar to the biaxial strength of e.max CAD). However, Celtra Duo's strength is attained in its "just polished" state, whereas e.max CAD's strength is attained only after firing.

Also, while this study was being conducted, an interesting and unexpected observation occurred during preparation of specimens for this study: a whole set of specimens sectioned using a diamond saw were discarded due to macroscopic cracks running from the edges to the interior of the discs/plates. This was observed for VITA Suprinity and the partially crystallized e.max CAD blocks, but to a lesser extent. The problem was not observed for Celtra Duo.[4]

Wear, strength, modulus, and hardness

A study was designed and conducted to measure the mechanical properties of several CAD/CAM materials, including lithium disilicate (e.max CAD), lithium silicate/zirconia [Celtra Duo (ZLS)], three resin composites (CERASMART™, Lava Ultimate, Paradigm™ MZ100), and a polymer infiltrated ceramic (Enamic).

CAD/CAM blocks were sectioned into 2.5 mm x 2.5 mm x 16 mm bars for flexural strength and wear testing. e.max CAD and half the Celtra Duo specimens were treated in a furnace. Flexural strength specimens (n = 10) were tested in a three-point bending fixture. Vickers microhardness (n = 2, 5 reading per specimen) was measured with a 1kg load and 15 second dwell time. The CAD/CAM materials as well as labial surfaces of human incisors were mounted in a UAB wear device. Cusps of human premolars were mounted as antagonists. Specimens were tested for 400,000 cycles at 20 N force, 2 mm sliding distance, 1 Hz frequency, 24o C, and 33% glycerin lubrication.

Volumetric wear and opposing enamel wear were measured with non-contact profilometry. Data were analyzed with 1-way ANOVA and Tukey post-hoc analysis (alpha = 0.05). Specimens were observed with SEM.

The properties were different for each material ($p < 0.01$). In general, e.max CAD and Celtra Duo (ZLS) were stronger, stiffer, and harder than the other materials. e.max CAD, Celtra Duo (ZLS), Enamic, and enamel demonstrated signs of abrasive wear, whereas CERASMART, Lava Ultimate, and Paradigm MZ100 demonstrated signs of fatigue.

Overall, the "hybrid" materials (CERASMART, Lava Ultimate, Paradigm MZ100, and Enamic) had a lower flexural strength than the glass ceramics [e.max CAD and Celtra Duo (ZLS)]; the resin composites had a lower elastic modulus and hardness than the infiltrated ceramic, which in turn had a lower elastic modulus and hardness than the glass ceramics.[5]

Technical data on Celtra® Duo

	Celtra Duo directly from the CEREC® MC XL and polished	Celtra Duo with glaze firing
CTE 500°C [$*10^{-6}$ 1/K]	approx. 11.8	
Intrinsic flexural strength ex works [MPa]	420	
Flexural strength [MPa]	210	370
E-modulus	approx. 70	
Crack resistance (SENVB) [$MPa \cdot m^{-0.5}$]	2.0	
Hardness [HV]	approx. 700	
Chem. solubility [$\mu g/cm^2$]	< 40 (intrinsic)	< 20 (solubility glazing)
Crystallization temperature [°C]	already fully crystallized	
Softening temperature [°C]	approx. 800	
Transformation temperature [°C]	approx. 620	
Density [g/cm^3]	2.6	

1 internal measurements, 3-point flexural strength, data available upon request
2 Results of a user study with a total of 125 restorations, results available upon request.
3 Rues, D. Müller, M. Schmitter, Heidelberg University 2012, data available upon request.
4 Wendler M, Belli R, et al. Chairside CAD/CAM materials. Part 2: Flexural strength testing. *Dent Mater*. 2017 Jan;33(1):99-109. doi: 10.1016/j.dental.2016.10.008. Epub 2016 Nov 21.
5 Lawson NC, Bansal R, Burgess JO. Wear, strength, modulus and hardness of CAD/CAM restorative materials. *Dent Mater*. 2016 Nov; 32(11):e275-e283. doi: 10.1016/j.dental.2016.08.222. Epub 2016 Sep 14.

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