Zirconia – The whole is more than the sum of its parts

The number of zirconia blank products offered for the various CAD/CAM systems on the market is growing, and the difference in prices is conspicuous. This is why dentists and dental technicians are currently increasingly discussing differences in quality.

This information is intended to contribute to product safety for the benefit of patients, dentists and dental technicians alike. The following explanations offered technical background information on the Cercon smart ceramics® system. We will be happy to assist you further should you require additional information.

Zirconia: High strength – but still ceramics

Most of the experience of dentists and dental technicians resulting from many decades of working with metal ceramics is not applicable to zirconia high-performance ceramics. Zirconia, which is a brittle material, reacts differently from the ductile dental alloys.

Machining the pre-sintered blank in the Cercon brain unit is a highly optimized processing method. No ceramic particles are being torn off, as may be the case with fully sintered blanks or when inappropriate processing methods are used, leading to defects.

Crown or abutment copings must not be given a tapered or feather edge. A chamfered or rounded shoulder preparation promotes the longevity of the framework, in keeping with the specific properties of the material. It is also important to follow the recommendations with regard to connector diameters.

Recommendations for Cercon base zirconia frameworks
Anterior single crowns
- 0.3 mm thickness (0.2 mm in the marginal region)

Posterior single crowns
- 0.4 mm thickness (0.2 mm in the marginal region)

Abutment copings (anterior and posterior)
- 0.4 mm wall thickness
- 3 × 3 mm connector cross-section

DeguDent Cercon base

DeguDent developed its zirconia blanks based on the groundbreaking work of the renowned Swiss Federal Institute of Technology at Zürich, Switzerland (ETH) and brought it to market. A zirconia produced to DeguDent specifications is used in the production of these blanks.

DeguDent is one of the major global producers of zirconia blanks for use in dentistry. We also have considerable production expertise in the realm of prefabricated zirconia abutments.
Only a very few competitors have mastered all the production steps, from raw material to ready-to-use blank in-house. Many of the zirconia blanks advertised worldwide are simply merchandise offered by resellers.

Since the Cercon smart ceramics system was introduced in 2001, almost 2,500,000 Cercon base dental units have been fabricated and inserted. Our calculations tell us that approximately every other zirconia restorative unit inserted in Germany in 2006 was made

from Cercon base. This is an indication of the high level of quality and safety rightly associated with this DeguDent product.

Our quality management system has been certified to EN ISO 13485 according to the requirements of the medical device directive and is audited annually by DEKRA. Our quality management is compliant with EU and FDA requirements.

Apparently low cost may be related to:
- Lack of certification.
- Lack of (annual) audits

Origin of the zirconia material

DeguDent uses exclusively medical-grade zirconia powder sourced from a leading global supplier and supplied to us to the standards of quality that we specify.

We use exclusively new raw materials in the production of Cercon base, never any blended, recycled or waste materials.

The quality of purity of every single batch of raw material is inspected by our own laboratory and in collaboration with an external institute. Because we work with very large batches of zirconia powder, the results obtained remain constant across a large number of Cercon base blanks.

The granularity of the powder is approximately 300 nanometres (0.3 micrometres or 0.0003 millimetres).

Apparently low cost may be related to:
- Use of non-medical-grade materials
- Quality aberrations
- Purity aberrations
- Use of blended source materials (used and new)
- Use of recycled material

Composition of the zirconia material

Cercon base blanks are pre-sintered zirconia blanks that obtain their terminal strings and size following an approximately 6-hour sintering process in the Cercon heat high-temperature sintering furnace.

An yttria-stabilized tetragonal zirconia polycrystalline material (Y-ZTP) is used for producing the DeguDent Cercon base zirconia blanks.

Composition in percent by weight:

> Zirconia and

> Yttrium oxide	approximately 5%
> Hafnium oxide	approximately 2%
> Alumina and silica	less than 1%

Alumina is added to safeguard the longevity of the framework, as it prevents moisture from entering the ceramic material along the grain boundaries ("water corrosion"). Highly translucent zirconia only has a very low percentage of alumina, because alumina gives the restorative material a cloudy appearance.

Zirconia without alumina doping should never be used for dental structures.

Apparently low cost may be related to:
- Deviant composition
- Erratic composition

High density, excellent fit

Once the raw material has passed quality inspection, our production lines press the material into shape, ensuring that the density of the material is identical throughout the entire blank. This uniform density guarantees that the sintering contraction of the milled object results in a framework exhibiting a perfect fit in all its parts.

Once the blank has been pressed, it is cut to the appropriate size (Cercon base 12, 30, 38, 47) and pre-sintered in a process called "bake". The adapter (the blue frame) is then attached, and the product is package for shipping. Each step of the process is subject to stringent in-process controls to ensure a superior quality of the product.

Apparently low cost may be related to:
- Erratic density (especially near the blank margin)

Strength of the zirconia material

We determined the strength of Cercon base (the parameter relevant for dental frameworks) using 4-unit bridges (0.4 wall thickness, > 9 mm² connectors) and obtained a result of 900 MPa. The flexible strength (EN 843-1) of this material is approximately 1,300 MPa. The module of elasticity of Cercon base is approximately 210 GPa (210,000 MPa).

Built-in system safety

All system components of the Cercon smart ceramics system were fine-tuned during the development stage to be compatible with each other.

The zirconia blanks are milled as appropriate for the material using the Cercon brain scanning and milling unit. The cutting geometry of the rotary instruments, as well as their speed and their positions relative to the blank were specifically adapted for the Cercon base property.

The Cercon ceram kiss ceramic veneering material is an improved version of Cercon ceram S and has also been specifically adapted to Cercon base. Both of these products are veneering ceramics developed exclusively for zirconia frameworks; they are not "universal ceramics"

originally designed for veneering other materials and later dubiously labelled “also suitable for zirconia”.

The procedure for machining the pre-centred zirconia was also developed based on research by ETH Zürich and brought to market by DeguDent, the result being the Cercon brain scanning and milling unit. The clinical performance of the frameworks fabricated using this scanning and milling process was first examined at the University of Zürich.

Scientific monitoring of the Cercon smart ceramics system began as early as during the developing phase. It includes hospitals and private practices in various countries and continues in progress as per the time of this writing. The scientific results obtained have been documented in two publications entitled *Scientific Research*, vols. I and II.

Apparently low cost may be related to:
- No research effort
- No development effort
- No clinical monitoring
- No clinical documentation
- No technical consultations

Unity of material and sintering process

The finer the grain, the lower the sintering temperature – this is how the relationship between the type of zirconia used and the sintering process can be summarized.

Fine-grained zirconia features higher sintering activity, since the ratio between the surface and the volume of the individual crystallite is higher than for coarser-grained powders. This allows the sintering temperature to be reduced, and the texture is still fine-grained after sintering. This exerts a positive influence on the strength of the densely sintered workpiece and, consequently, a sign of quality.

Cercon base should only be sintered in the Cercon heat sintering furnace approved and recommended for this purpose. Only the use of this furnace ensures that the material and the sintering cycle match perfectly. Cercon heat offers an optimized temperature distribution and profile (heating, holding, cooling), parameters that determine the quality of the sintering result. Low sintering temperatures also have economic benefits: The final temperature is attained more quickly, with less wear and tear on the heating components.

Apparently low cost may be related to:
- More coarsely grained zirconia

Finishing zirconia

The veneering surface of the zirconia framework can be like a sandblasted with alumina (110-125 µm, max. 3.5 bar) without adversely affecting the framework. In the development process of Cercon base, the step had been included from the very beginning; no negative results have been seen.

In addition, studies at the University of Kiel, Germany (Prof. Kern) have shown that sandblasting the internal surfaces of zirconia copings (not just specifically Cercon base copings!) improves the strength of the bond with the adhesive cement.

Unlike metal frameworks, ceramic frameworks should not be finished or worked over with rotary instruments in their entirety. The general rule is: No finishing should be performed on ceramic workpieces once sintered, especially not in the area of the connectors, which are subjected to high loads. It is recommended to perform minor adjustments – if required at all – using rotary instruments in the high-speed handpiece with ample irrigation.

Occasionally, an “annealing” or “firing step” has been recommended to minimize or eliminate surface defects created by modifying the framework after sintering. We do not consider this step suitable for repairing defects and therefore do not recommend it.

The fit of zirconia

Ceramic materials generally withstand compressive forces better than tensile forces. This is why the fit of zirconia copings (for single crowns or abutments) should be adjusted to seat on the prepared teeth without any friction or jamming, both of which would create tensile loads. This prevents any damage to the frameworks caused by an excessively tight fit.

Zirconia is zirconia is...

DeguDent continues to work on improving zirconia at a dental material. According to the current state of the art, however, it may be said that Cercon base is a high-quality material that covers a broad range of indications and that can hardly be surpassed.

One of the possible disadvantages of other materials is that they may be more time-consuming to process or that they may be suitable only for special indications, such as framework designs subjected to limited loads (single crowns or shorter bridges).

To eliminate even the slightest risk to patients, dentists and dental technicians, DeguDent will bring any new zirconia materials to market only after additional data on the clinical performance of Cercon smart ceramics or the current Cercon base zirconium material have been made available. Although the currently published data on the Cercon system are certainly superior in scope to the available data of certain of our competitors, in terms of both quality and quantity, we will be awaiting future results before spreading rumours of any new zirconia developments.

Quality materials require quality procedures

In addition to the raw material, blank processing, framework design and sintering quality, as described above, the following aspects are also important:

Dentist-related:
- Taking into account the contraindications bruxism or therapy-resistant parafunction
- Chamfered or rounded shoulder preparation, no (!) feather edge
- Bridge designs with no more than two pontics between abutments
- Glaze firing after occlusal adjustment, polishing of at least the finished/adjusted areas
- No provisional or extended trial insertion of the restoration

Lab-related:
- Balanced support the ceramic veneer by building up/designing a uniformly reduced

anatomical framework shape
- Compliance with recommendations on crown wall thickness
- Compliance with recommendations on the strength of the connectors between pontics (9 mm² cross-section)
- Avoidance of corners or sharp edges
- Premature contacts should be adjusted using only rotary instruments in a high-speed handpiece and proper irrigation, exerting low instrument pressure
- Compliance with the steps described in the instructions for use, including firing recommendations (temperature control!)

Contact

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