Cercon®

Zirconia

Compendium — Clinical Manual

Evidence of Clinical Performance

Dentsply Sirona Lab

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Introduction

The range of indications for all-ceramic restorations has expanded constantly since the beginning of the 1980s. New ceramic materials with improved fatigue strength and innovative adhesive technologies have been the driving forces behind the rapid development and increasing popularity of all-ceramic restorations.

If we look back at developments in dental prosthetics, all-ceramic restorations are one of the fastest-growing treatment areas along with implant prosthetics. Zirconia, inspired by CAD/CAM technology, has made its way into restorative dentistry and made new indications for all-ceramic restorations a reality.

Since the introduction of Cercon high-performance ceramics almost 20 years ago, numerous advancements in CAD/CAM technology and materials have resulted in a consistent expansion of indications for zirconia restorations. Indications now range from single crowns and bridges to implant-prosthetic suprastructures and retaining elements for removable dentures.

With more than 25 internationally published clinical studies, Cercon ceramics are among the best documented and studied dental zirconia materials in the world. The consistent analysis of these data has led to numerous improvements in the clinical safety of the material.

The development of translucent zirconia variants (Cercon ht/Cercon xt) has not only improved the optical properties of the restorations but has also facilitated fully contoured monolithic zirconia restorations. Monolithic Cercon ht/Cercon xt restorations show very little antagonist abrasion if properly polished. Due to the high mechanical strength of the material, these restorations can be fabricated in thicknesses once only achievable with cast metal restorations.

Today, zirconia restorations can be designed as veneered, partially veneered, or unveneered restorations — their processing and indication range is approaching that of classic metal-ceramic restorations. The extra-translucent Cercon xt, with its even higher translucency but reduced strength, is predestined for single crowns and three-unit bridges (up to the 2nd premolar).

However, not only the processing technologies and materials were improved, but also clinical recommendations — from preparation to cementation — were adapted to the new findings.

This clinical guide summarizes special aspects of the different variants of the material, presenting new findings on the clinical procedure (preparation, impression-taking, cementation) and the available evidence on the clinical performance of zirconia in compact form.

It is intended as a body of reference to facilitate your daily work in the dental office or laboratory.

Acknowledgment

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Cercon® at a glance

History

One-stop competence in materials technology

Research and development, proprietary formulas, and in.house production.

- 2001 Cercon base (white) introduced
- 2003 Cercon base colored introduced
- 2011 Cercon base light/medium/colored introduced
- 2011 Cercon base ht (High Translucency) white introduced
- 2012 Cercon ht light and medium introduced
- 2015 Cercon ht 16 Vita shades + concept introduced
- 2017 Cercon xt 16 Vita shades + concept introduced

Material

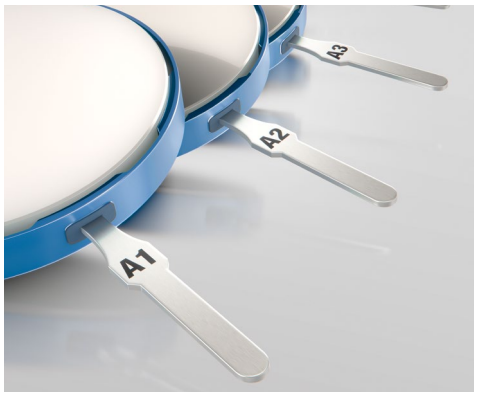
- Zirconia (Y-TZP)
- Fine-grained
- High sintering activity
  Strength approx. 1,200 MPa (Cercon base and Cercon ht)
  Strength approx. 750 MPa (Cercon xt)

Biocompatibility NAMSA

The biological risks for all Cercon zirconia products were extensively assessed by NAMSA in a study. The result proves the excellent biocompatibility of Cercon products.

Shade concept

A further milestone was reached with the introduction (US/CAN in July 2015, Germany in September 2015) of the pre-shaded Cercon ht discs in the 16 Vita shades (+ bleach). It allows the lab to execute its zirconia restorations in very simple steps, reproducing the 16 Vita shades. The primary goal is the fast and easy reproduction of all 16 Vita shades, whether using one of the 16 pre-colored discs or only a selection of them.



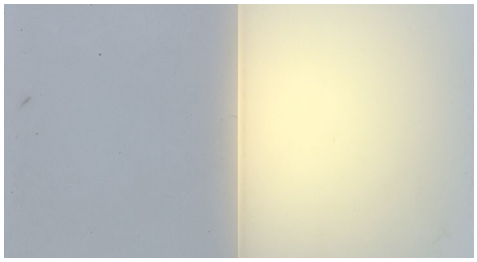
This allows the laboratory to choose the most effective method for a given case:

- Dipping (white disc + dipping shades)
- Selecting and milling a blank in the specified tooth shade (16 Vita shades + bleach)
- Simple staining concept for a specific selection
- Veneering concept for all shades

Cercon® at a glance

Translucency

Cercon not only has the advantage of being extremely strong, but the material is also translucent. Its high level of light transmission allows the fabrication of natural-looking restorations. At the same time, semi-opaque variants (Cercon base) allow the use of its material even on discolored tooth stumps.



Quality levels

The new Cercon ht and Cercon xt shade concept covers five different performance levels:

+ **Glazed**
+ **Stained and glazed**
+ **Cut-back technique**
+ **Partially veneered**
+ **Fully veneered**

Depending on the customer's wishes or budget, all work can now be carried out in Cercon ht/Cercon xt, with varying levels of time and effort on one hand and profits on the other.

Clinical benefits

The static fracture resistance and fatigue strength of veneered crown and bridge restorations based on zirconia (Cercon base and Cercon ht) is higher by a factor of 2 to 5 compared to other all-ceramic systems (glass ceramics, alumina, lithium disilicate).

The combination of high flexural strength and fracture toughness of Cercon base/Cercon ht is the basis for the long-term clinical success of these restorations.

The combination of multiple desirable properties (biocompatibility, strength, translucency, low thermal conductivity) makes yttria-stabilized zirconia an ideal material for fixed prosthetic restorations characterized by the following clinical benefits:

- Broad range of indications in the anterior and posterior region
- Try-ins with occlusion check are possible
- Temporary cementing is possible (except for Cercon xt)
- Conventional cementing is possible

Indications for veneered and fully contoured restorations made of Cercon base, Cercon ht and Cercon xt

20 years of consistent innovation

Since the introduction of Cercon, an advanced zirconia-based ceramic system, 20 years ago, its indication range has been continually broadened based on consistent improvements in the material.

Three material variants Many indications

Whereas the first available variant (Cercon base) was designed exclusively for the production of veneered restorations, implant abutments, and telescope crowns, the development of new, high translucent variants (Cercon ht) have made it possible to improve the optical properties of the framework materials. In addition, Cercon ht exhibits a very low antagonist abrasion when polished. Thus, both veneered and full contoured Cercon restorations can now be produced for the following indications (the extra-translucent variant Cercon xt was designed especially for the anterior region):

Veneered restorations

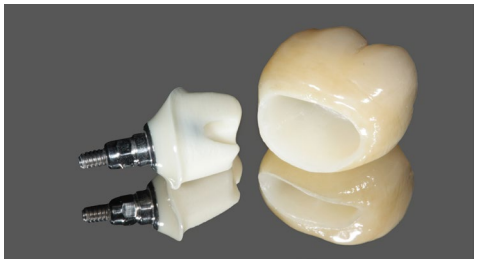
Veneered restorations

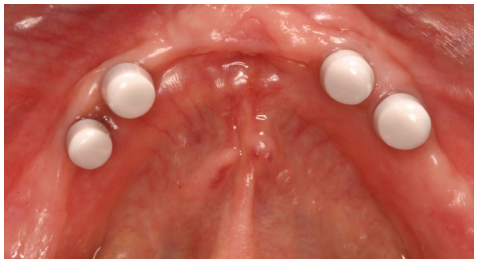
- Fully or partially veneered crowns in the anterior and posterior region
- Fully or partially veneered anterior or posterior bridges without cantilevers with a maximum of two pontics (Cercon xt: one pontic)
- Fully or partially veneered anterior or posterior bridges with cantilevers (cantilever of no more than one premolar width) (not for Cercon xt).
- Partially veneered adhesive bridges in the anterior region to replace a missing tooth

Implant superstructures Double crowns

Other indications

- Custom-made and prefabricated implant abutments (not US/CAN)
- Ceramic primary crowns





Indications for veneered and fully contoured restorations made of Cercon base, Cercon ht and Cercon xt

Monolithic restorations

Full contoured (monolithic) restorations characterized exclusively by a framework-dyeing process and by staining are suitable for the following indications:

- Full contoured crowns in the posterior region
- Full contoured anterior or posterior bridges with cantilevers with a maximum of two adjacent pontics (Cercon xt: one pontic) up to the second premolar
- Fully anatomical bridges with a cantilever of no more than one premolar width in the posterior region (not for Cercon xt)

Veneered and full contoured Cercon restorations (except adhesive bridges) can be used to restore both natural teeth and implants.

Contraindications

Veneered restorations are contraindicated in the following situations:

- Bruxism
- Insufficient available space

In addition, it should be noted that implant superstructures carry an inherently increased risk of technical complications in the form of veneer fracture. Multi-unit implant-supported bridges should therefore be designed as full contoured restorations.

Non-approved types of restorations

The following indications are not sufficiently clinically backed at this time and are therefore not approved by the manufacturer:

- Inlay bridges
- Custom-made endodontic posts
- Custom-made endosseous implants

General preparation recommendations for Cercon® restorations

All-ceramic restorations made of Cercon base, Cercon ht and Cercon xt can be fabricated as ceramically veneered or as full contoured (monolithic) restorations.

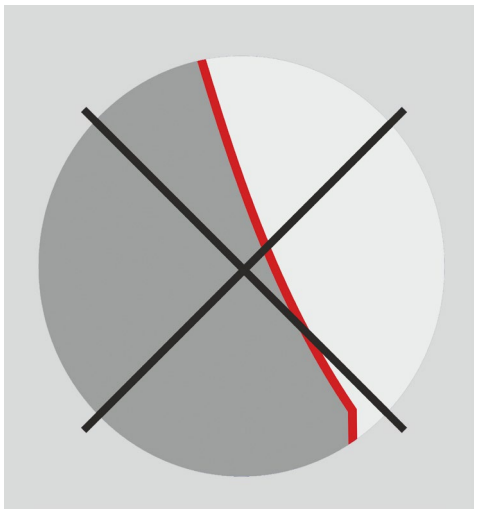
Irrespective of the design, a preparation suitable for the material must ensure that the following design parameters are assured during laboratory fabrication:

Preparation margin

The preparation margins of zirconia restorations should be designed as a chamfer or a shoulder with a rounded internal line angle. Feather-edge preparation margins are not recommended.

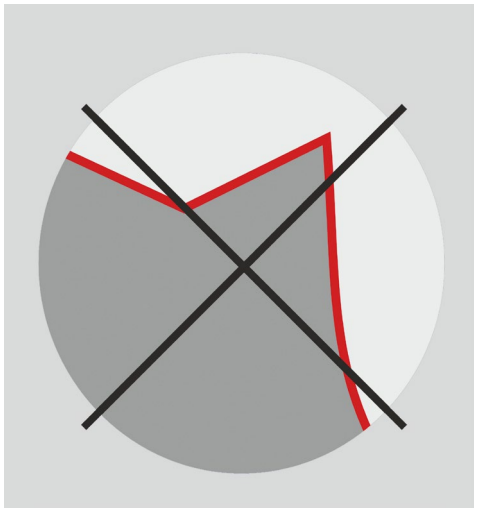
Other guidelines

- Preparation tapers: 6°–8°
- Rounded line angles and edges
- Flattened cusp-fossa profile relief



Minimum wall thickness

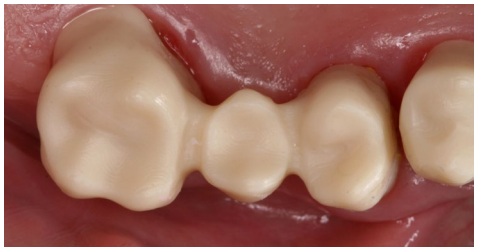
The minimum wall thickness of a restoration depends on the indication. A minimum wall thickness of 0.4 mm (Cercon xt: 0.7 mm) for veneered crowns must be respected in the anterior and posterior regions. Bridges require a minimum wall thickness of 0.5 mm (Cercon xt: 0.7 mm). Monolithic crowns also require a minimum wall thickness of 0.5 mm (Cercon xt: 0.7 mm).



Connector cross-section

When planning the preparation for all-ceramic bridges, the required cross-sections of the connectors must be taken into account. The minimum connector area for zirconia bridges is:

- for three-unit anterior bridges: 7 mm^2 (Cercon xt: 12 mm^2)
- for four-unit anterior bridges: 9 mm^2
- for three-unit posterior bridges: 9 mm^2 (Cercon xt: 16 mm^2)
- For four-unit -posterior bridges: 12 mm^2



In the case of 4-unit bridges, the thickness of the framework walls should be increased to 0.6–0.7 mm occlusally and on the pontic-facing surface.

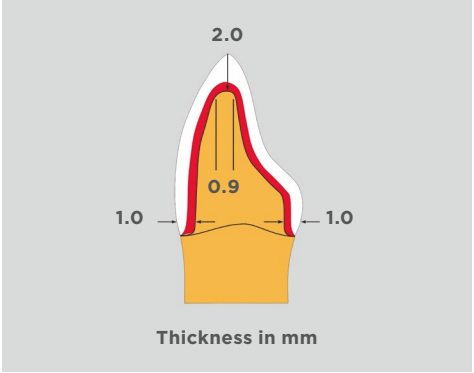
Preparation recommendations for Cercon® restorations veneered with dental ceramics

Anteriors

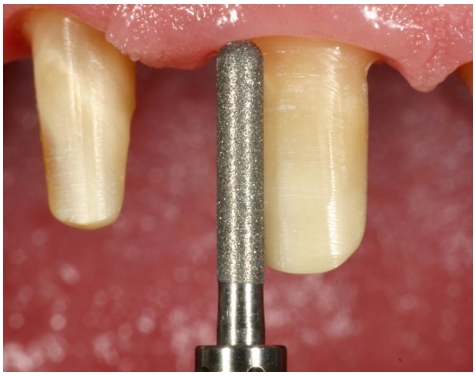
Cercon restorations can be produced as fully veneered or partially veneered crowns and bridges. For fully veneered anterior restorations, the minimum circular reduction must be 1.0 mm throughout; in addition, the taper of the prepared axial surfaces must be 6° to 8°. All transitions between the axial aspects, the palatal and incisal surfaces, must be rounded (minimum radius: 0.4 mm). For esthetic reasons, the incisal reduction should be 2.0 mm. The minimum width of incisal edges in an orovestibular direction should be at least 0.8 to 0.9 mm for CAD/CAM-fabricated restorations in order to ensure an exact reproduction of the internal framework surfaces by the milling unit.

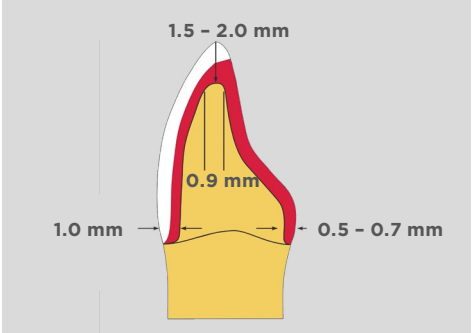
The use of a diamond-shaped instrument (e.g., Marxkors' palatal grinder) is recommended for shaping the palatal contour of the upper anteriors and canines. This instrument can also be used to round out the transitions between the axial walls and the incisal edges. For partially veneered restorations, palatal reduction can be kept to between 0.5 and 0.7 mm, provided that these aspects are mere exclusively of zirconia. This design is suitable for restorations with considerably reduced vertical space (e.g., deep bite or palatal tooth tilting). The veneered vestibular aspect requires a minimum reduction of 1.0 mm. The preparation margin should in any case be designed as a chamfer or shoulder.

The use of rotating instruments of medium grain size is recommended for finishing the preparation.



Thickness in mm





Minimum thickness of the material, Cercon ht

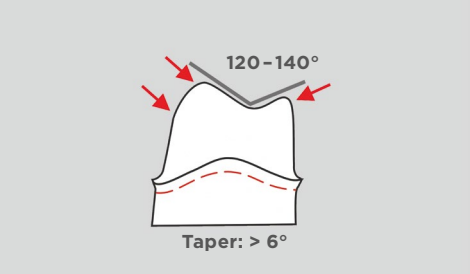
Preparation recommendations for Cercon® restorations veneered with dental ceramics

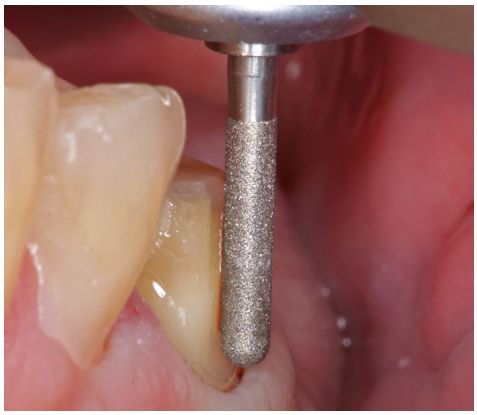
Posteriors

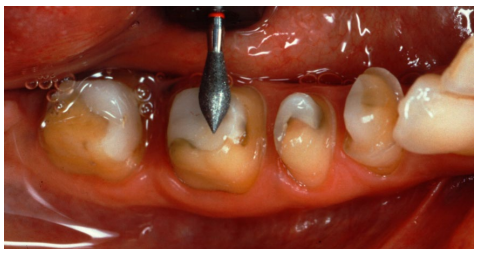
An overall minimum occlusal thickness of 1.0 mm is required for fully veneered restorations in the posterior region. Given the minimum wall-thickness requirements, it is advisable to reduce at least 1,5 mm on the occlusal aspect. The taper of the axial prepared surfaces should be between 6° and 8°. Transitions between axial walls and occlusal surfaces should be rounded, with the occlusal profile a simplified representation form of the occlusal surface. An opening angle of the occlusal surfaces of 120° to 140° ensures an exact reproduction of the internal surfaces of the restoration during milling and facilitates a good internal fit.

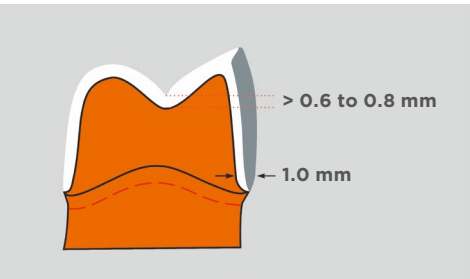
For the preparation of the occlusal aspects, the diamond-shaped instrument recommended above, guided perpendicularly to the tooth axis, has proven particularly suitable. This instrument can also be used to round out the transition zones from the axial surfaces to the occlusal surfaces if guided parallel to the tooth axis and if the transition zones are rounded with the tapered instrument tip.

For partially veneered restorations, tissue removal can be reduced, depending on the extent of the veneered part. For vestibular veneers, an occlusal and palatal reduction of 0.6 to 0.8 mm is sufficient. On the vestibular aspect, a minimum reduction of 1.0 mm is required.









Material selection for anterior restorations

Transluzenz

Cercon zirconia is available in different shades and translucencies. The classic variant Cercon base, which has been available for almost 20 years, is a semi-opaque material particularly suitable for the treatment of discolored preparations. This classic partially yttria-stabilized ZrO2 material exhibits high strength and helps avoid the well-known dark margins of metal-ceramic restorations even in the event of gingival recession, as the framework can be dyed in common dentin shades.

By comparison, the more translucent variant Cercon ht offers significantly greater light transmission at the same strength and is therefore particularly suitable for the treatment of slightly to moderately discolored preparations. Due to the long-term flexural strength, which is comparable to that of Cercon base, Cercon ht crowns and bridges can be used for the same range of indications and offer the same flexibility with regard to possible cementation options (temporary, conventional, adhesive).

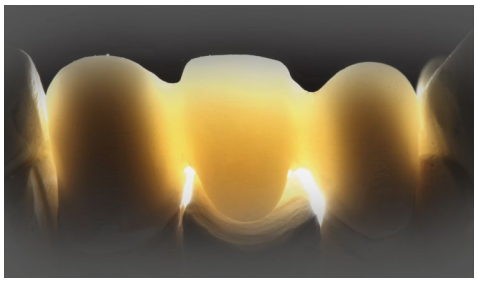
Cercon xt offers a further increase in translucency. With almost 20% more translucency than even Cercon ht, this variant is tailor-made for monolithic anterior crowns and three-unit anterior bridges. It is suitable for preparations that are not or only slightly discolored. Due to the reduced strength compared to the other two Cercon variants, however, a modified minimum thickness (0.7 mm) and a larger cross-section of the connectors (12 mm^2) must be provided for anterior bridges. Furthermore, Cercon xt restorations are not suitable for temporary cementation.

For optimal esthetic results in anterior restorations, the appropriate material should be selected based on the degree of discoloration of the prepared tooth:

Cercon base: Heavy discoloration or metallic post-and-cores

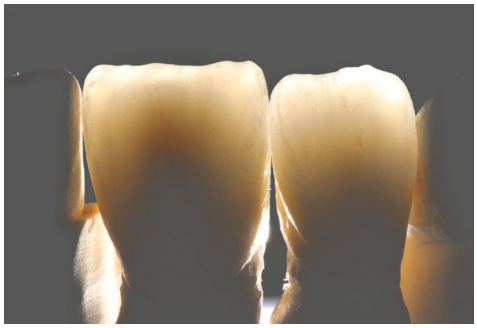
Cercon ht: Slight to moderate discoloration

Cercon xt: No or minimal discoloration



Shade communication

By varying the degree of light transmission, esthetic results can be improved without the need for adhesive cementation. Although this is a great opportunity, it also represents a new challenge for communication with the dental laboratory. While the degree of discoloration of the prepared tooth was irrelevant for the classic zirconia materials, information on the shade of the prepared tooth is essential when working with translucent zirconia. If a framework with high translucency is used on discolored tooth hard tissue in the anterior region, the tooth shade will cause graying. This is a familiar phenomenon with transparent glass ceramics. The problem can definitely be avoided by providing the dental laboratory with information on the degree of discoloration of the prepared tooth so that the correct translucency can be selected for the framework (Rinke and Fischer, 2012). The simplest way to do this is to take a digital photo of the preparation and to use a shade reference that reflects the target shade. Although translucent zirconia does not generally require adhesive cementation for reasons of long-term stability, attention should nevertheless be given to the aspect of cement selection.



Cementing

With classic zirconia variants, the esthetic results were only minimally influenced by the cement.

Visible changes were sometimes seen but only in the cervical areas. With the introduction of translucent zirconia, the optical properties of the cement became more important. Since translucent frameworks can only be used for preparations with no or only minor discoloration, it does not make sense to use an opaque cement – translucent temporary and definitive cements should be used wherever possible.

However, it should be noted that temporary cementation of restorations made of the extra-translucent Cercon xt is not possible.

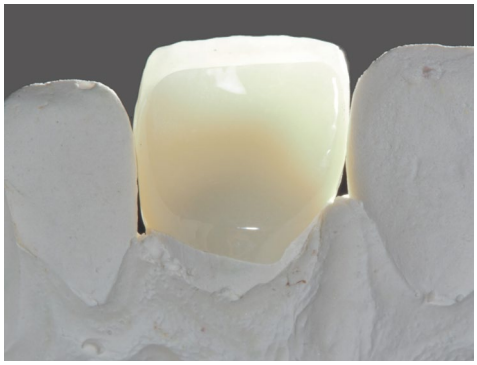
Material selection
for anterior restorations

Available space

Zirconia restorations can be designed as partially veneered restorations in situations with a reduced amount of available space in the maxillary anterior region. With a strictly vestibular veneer, the thickness of the restoration can be reduced to the respective minimum (Cercon ht: 0.5 mm) on the palatal aspect.

In the vestibular area, a reduction of 1.0 mm must be ensured to obtain sufficient space for the framework and its veneer. This design facilitates a minimally invasive preparation that minimizes the risk of endodontic complications, due not least to minimal palatal reduction. Partial veneers can be used for both single crowns and for bridges.

In principle, partially veneered anterior restorations are also possible with Cercon xt. However, it should be noted that the minimum thickness of 0.7 mm must be maintained.



Monolithic anterior restorations

Cercon xt is suitable for monolithic anterior restorations due to the further increased light transmission.

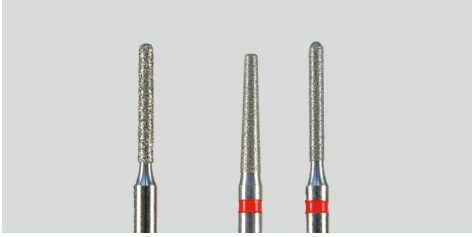
The optical properties of this zirconia variant — almost equivalent to the optical properties of high-strength glass-ceramics — allow attractive esthetic customization using the staining technique. The monolithic restoration design also eliminates the risk of veneer fractures.

Monolithic anterior restorations made of Cercon xt should preferably be used on preparations that are only slightly discolored or not discolored at all. Otherwise, the discoloration may shine through in the case of severely discolored hard tissue or metal post-and-cores.

Preparation recommendations for fully contoured (monolithic) restorations made of Cercon® ht

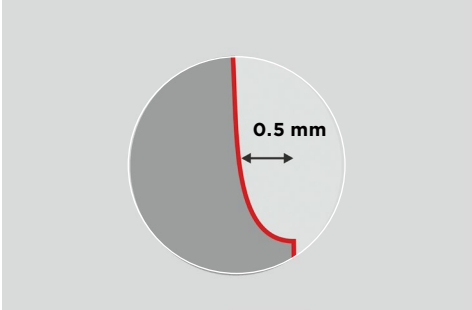
Minimal tooth reduction

The advantage of fully contoured zirconia restorations made of Cercon ht includes the minimally invasive preparation; the amount of tissue removal required is close to that for a classic full cast crown. The occlusal minimum thickness is 0.5 to 0.7 mm, and the reduction near the preparation margin should be at least 0.5 mm.



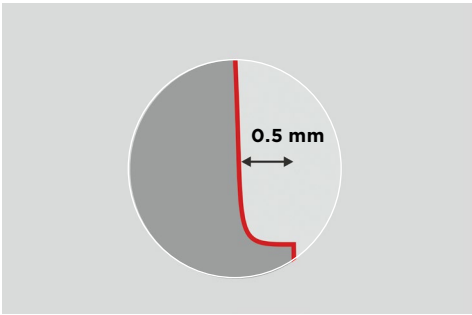
Preparation margin design

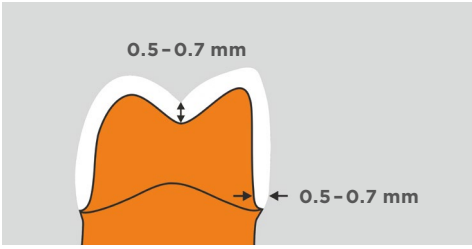
Even with fully contoured zirconia restorations, the preparation should be designed with a chamfer or shoulder margin with a rounded internal line angle. Due to the reduced preparation depths, preparation instruments with reduced diameters can be used. The other preparation parameters (preparation taper of 6° to 8°, simplified design of the occlusal relief) are based on the well-known recommendations for veneered zirconia restorations.



Clinically relevant benefits

Given to the highly conservative preparation, fewer biological complications (endodontic treatments) can be expected. Furthermore, the reduced occlusal reduction compared to a veneered restoration may facilitate an improved retention for crowns and bridges because the residual tooth can be higher. Accordingly, conventional cementation is possible more often. This aspect is particularly beneficial in the case of restorations presenting with an increased risk of retention loss (three- to four-unit posterior bridges in the mandible).





Preparation recommendations for fully contoured (monolithic) restorations made of Cercon® xt

Basic preparation recommendations

Essentially, the same basic preparation requirements apply to all-ceramic restorations made of the highly translucent Cercon xt as to Cercon base or Cercon ht: preparation taper of 6° to 8°, simplified occlusal relief, and preparation designed with chamfer or shoulder with a rounded internal line angle.

Special preparation parameters

When fabricating crowns and bridges from the extra-translucent Cercon xt, the material properties must also be considered when evaluating the preparation recommendations.

Cercon xt has a flexural bending strength of approx. 750 MPa — less than Cercon base or Cercon ht. The minimum wall thickness must be adjusted accordingly.

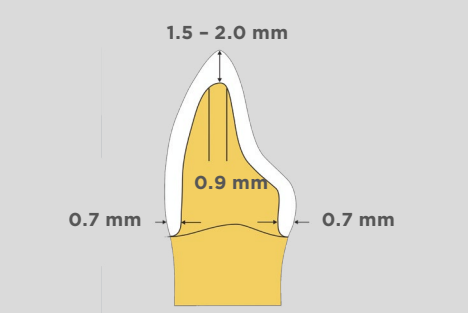
For single crowns in the anterior region, a minimum circumferential material thickness of 0.7 mm must be ensured. In the incisal area, a greater reduction of at least 1.5 mm should be performed, mainly for esthetic reasons.

In the maxillary anterior region, it must be ensured during palatal preparation that the material thickness does not fall short of the minimum thickness even after possible intraoral adjustments of the restoration. Experience has shown that a preparation depth of 0.8 to 0.9 mm in this area provides a sufficient safety buffer for any necessary adjustments.

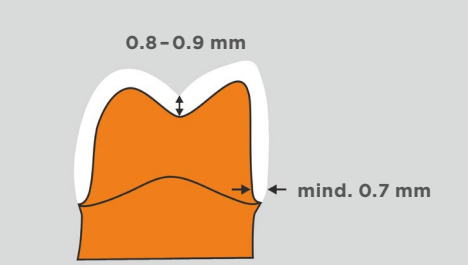
In the posterior region, too, a minimum circumferential material thickness of 0.7 mm must be provided for. Occlusally, the reduction should be approximately 0.1 to 0.2 mm greater in order to ensure a sufficient thickness of the material even after any necessary adjustments.

Bridge designs

For anterior bridges, the cross-sectional area of connectors must be increased to 12 mm^2, which is more than for Cercon base and Cercon ht. Due to the already mentioned reduced flexural bending strength of Cercon xt, the indication range of bridges made of this material is limited to three-unit bridges to replace the second premolar. The required minimum cross-sectional area of connectors for posterior bridges is 16 mm^2.



Minimum thickness of the material, Cercon xt



Minimum thickness of the material, Cercon xt

Occlusal adjustment and polishing of fully contoured (monolithic) Cercon® ht/Cercon® xt restorations

Low antagonist abrasion

Polished zirconia surfaces exhibit very little abrasion on antagonistic tooth surfaces. When monolithic zirconia restorations are delivered, a smooth and highly polished restoration surface must therefore be ensured. From a practical point of view, it is advisable to perform the occlusal adjustment while the restoration is still uncemented. For intraoral grinding of monolithic zirconium oxide ceramic restorations, the use of special diamond instruments with high cutting performance and a long service life (e.g., ZR-Schleifer; Gebr. Brasseler, Lemgo, Germany; or K-Diamonds; Edenta, Au, Switzerland) is recommended.

Occlusal adjustments

Adjustment of the static and dynamic occlusion is followed by a multi-stage polishing procedure, which is carried out extraorally. Diamond-reinforced silicone polishers are used first, followed by polishing with a diamond polishing paste. If additional occlusal adjustments are necessary after cementation, the following instruments have been shown to be useful for intraoral use:

Intraoral polishing

- Occlusal adjustment: ZR diamonds (Gebr. Brasseler) and K diamonds (Edenta);
- Pre-polishing (silicone polisher): StarGloss (Edenta); EVE DiaCera (EVE Ernst Vetter, Pforzheim, Germany), and 94000 C/M/F (Gebr. Brasseler);
- High-gloss polishing: OptraFine HP Polishing Paste (Ivoclar Vivadent, Schaan, Liechtenstein) and DirectDia Paste (Shofu Dental, Ratingen, Germany).

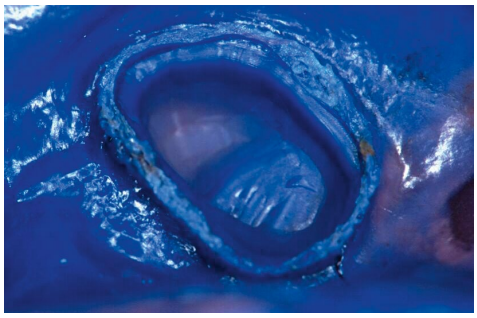
The final high-gloss step is carried out with diamond polishing paste and a nylon brush without water spray.

Impressions for all-ceramic restorations made of Cercon® base and Cercon® ht/Cercon® xt

Impression techniques

The impression can be taken in the usual way using impression materials commonly used in prosthetics (hydrocolloid, polysiloxane, polyether) and common impression procedures (double-impression technique, double-mix technique, monophase technique).

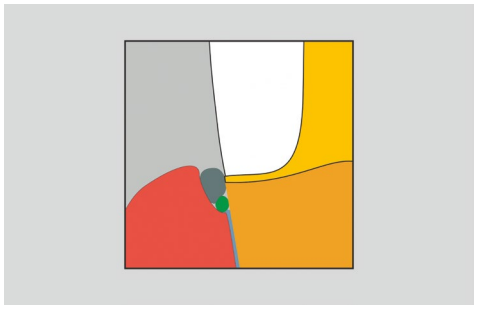
With polysiloxanes, the double-impression, the double-mixing and the monophase technique can all be used (e.g., Aquasil Ultra; Dentsply Sirona, Bensheim, Germany). With polyethers, only the double-mixing and monophase technique are available.



Implementation

The use of braided retraction cords (e.g., Ultrapak; Ultradent Products, Cologne, Germany) with the double-cord technique has proven to be particularly effective in helping reproduce the preparation margin.

For this technique, a thin cord is first applied to the sulcus and remains there during the entire impression procedure. A second, thicker cord is placed on top, to be removed only shortly before the impression is taken. The first cord serves to block bleeding from the sulcus. At the same time, it prevents the gingiva from folding back onto preparation margin. The second thread is intended to achieve increased lateral displacement of the gingiva so that the impression material ideally surrounds the preparation margin by approximately 0.5 mm.



Provisional restoration

For both the double-impression technique and the double-mixing technique, it is recommended to distribute the impression material by air jet after applying the low-viscosity component. The air flow should be directed into the sulcus to ensure good adaptation of the impression material to the preparation surface.

The prepared teeth can be restored with provisionals using commercially available temporary crown and bridge materials. If ultimate adhesive cementation is planned, a eugenol-free temporary cementation material (e.g., Integrity Temp Grip; Dentsply Sirona) should be used to place the provisionals.

Cementing all-ceramic restorations made of Cercon® base, Cercon® ht or Cercon® xt

Temporary cementing

Thanks to the high flexural and fatigue strength of frameworks made of partially yttria-stabilized zirconia, it would appear that provisional cementing (e.g., using Integrity Temp Grip; Dentsply DeTrey, Konstanz, Germany) is possible in a manner similar to metal-ceramic restorations. Clinical studies (Rinke and Jenatschke, 2003; Rödiger et al., 2010) have shown that zirconia restorations can be provisionally cemented without ceramic shoulders for a limited period of time.

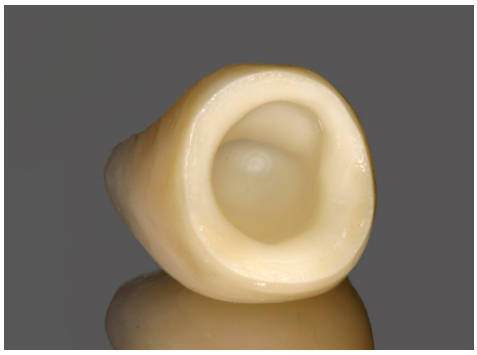
It should be pointed out that the removal of provisionally cemented zirconia restorations is associated with a risk of damage, especially when certain peak loading levels are exceeded. For bridge designs that include ceramic shoulders, immediate definitive insertion (conventional or adhesive) is therefore recommended, since the ceramic shoulders are more prone to fracture when removing temporarily cemented bridges.

Provisionally cemented zirconia restorations should be worn only for a short period of time (2 to 3 weeks), as a creeping loss of retention or loosening of the restoration, which may well go undetected, may result in damage to the restoration even during normal masticatory function. When removing restorations prior to definitive cementing, the possible clinical advantage of providing a provisional restoration should be weighed against the risk of damage to the restoration.

To prevent damage to the ceramic veneer, special tools with plastic tips are required (e.g., crown-removing forceps by Stoma, Eppingen-Liptingen, Germany) to remove provisionally cemented restorations. Any direct contact between metallic tools and ceramics must be avoided.

The use of a transparent temporary cement (e.g., TempBond clear, Kerr Hawe, Karlsruhe) is recommended for the temporary cementation of zirconia restorations made of the highly translucent Cercon ht.

Important
Temporary cementation is recommended only for restorations made of Cercon base or Cercon ht



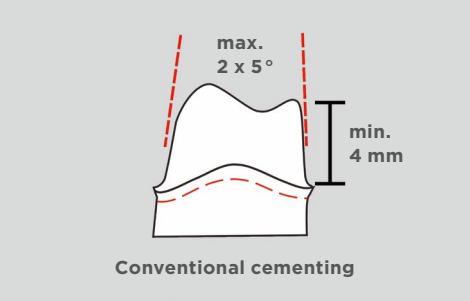
Cementing all-ceramic restorations made of Cercon® base, Cercon® ht or Cercon® xt

Conventional cements

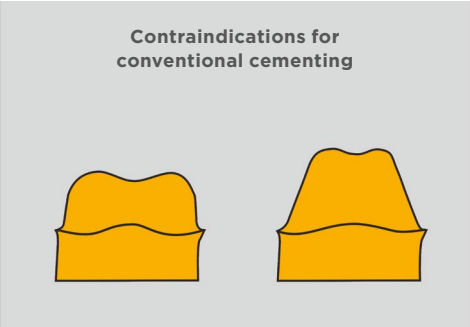
In principle, all types of conventional cements are suitable for cementing Cercon restorations. Conventional cementation can be recommended if the following conditions are met:

- Preparations with a sufficient residual height of 4 mm
- Preparation taper of 3° to 5°

However, phosphate cements and glass-ionomer cements exhibit virtually no adhesion to natural teeth or restorative materials. These cements should therefore not be used in indications with an increased risk of retention loss, such as bridges in the mandibular posterior region.

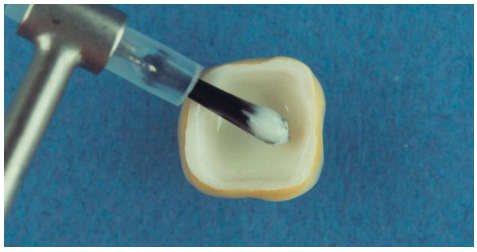


Conventional cementing



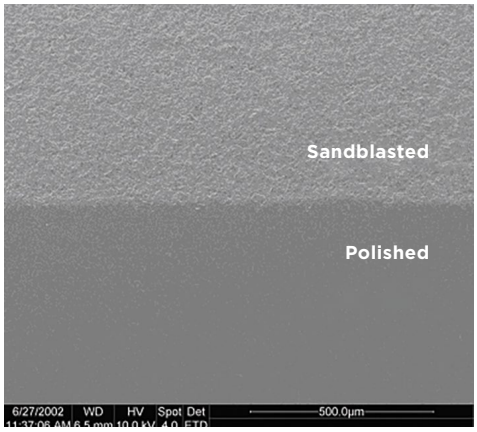
Resin-modified glass-ionomer cements

Several in-vitro studies as well as clinical studies (Ortrop et al., 2012; Rinke et al., 2013) have shown that the retention of zirconia crowns cemented with resin-modified glass-ionomer cements (e.g., Permacem 2.0; DMG, Hamburg, Germany; or FujiCEM Plus; GC, Bad Homburg, Germany; or Meronplus; Voco, Cuxhaven, Germany) is significantly higher than with conventional zinc phosphate cements or pure glass-ionomer cements. A further advantage is that the resin-modified glass-ionomer cements are available in different shades and translucency levels. Improved retention and more favorable optical properties are the reasons why resin-modified glass-ionomer cements should be preferred to unmodified zinc phosphate or glass-ionomer cements.



It is not necessary to condition the preparation; the cementation surfaces of the restorations should be roughened by sandblasting (alumina 50 µm, 1–2 bar) to improve retention.

Important
Conventional cementing is recommended only for restorations made of Cercon base or Cercon ht.



Cementing all-ceramic restorations made of Cercon® base, Cercon® ht or Cercon® xt

Adhesive cementing

Zirconia restorations can be adhesively cemented to improve retention in high-risk indications (e.g., short or severely tapered dies, multi-unit bridge designs). For this purpose, self-adhesive cements (Piwowarczyk et al., 2005) such as Calibra Universal (Dentsply Sirona) can be used, or composite cements with special ingredients that chemically bond to zirconia (e.g. a reactive phosphate monomer or a special zirconia primer). In particular, the use of resin cements with reactive monomers (e.g., Panavia 21 TC or Panavia f 2.0; Kuraray) has been validated by numerous in-vitro and clinical studies.

Self-adhesive cements

The application of self-adhesive cements does not require any special conditioning of the tooth structure and can be carried out with relative drying. The cementation surfaces of the restoration should be sandblasted to improve retention (50-µm alumina, 1 to 2 bar). The self-adhesive cement is placed inside the restoration, or after the restoration is positioned on the dried preparation. For easy removal of any excess, the material is polymerized for 3 to 5 seconds with a polymerization light. The restoration will already be fixed in place at that time, so the excess cement can be easily removed with a dental probe.

Clinical benefits

Self-adhesive cements offer the following clinical benefits:

- Increased retention compared to conventional cements
- Availability in different shades and translucencies
- Easy handling and safe excess removal

Universally applicable

Selbstadhäsive Befestigungszemente sind universell für die Befestigung aller Zirkonoxidvarianten (Cercon Base, Cercon ht, Cercon xt) geeignet.

Resin cements with separate bonding agents

Maximum retention after cementation can be achieved with resin cements with separate bonding agents. Technical and clinical aspects must be considered when looking for the most suitable cement.

- A chemical bond to the zirconia must be established. This is achieved by certain ingredients of the adhesive material (e.g., reactive phosphorous monomer (Panavia; Kuraray) or by a special primer (Monobond Plus; Ivoclar Vivadent; or Primer A-Z; Shofu Dental).
- The hard tissue of the tooth or teeth must be conditioned. It should be noted that in the prepared teeth present a substrate that is almost exclusively dentin and that absolute drying is usually impossible or at least very difficult.

Against this background, the application of bonding systems with self-etching primers is a suitable option. Unlike the total-etch technique with its use of phosphoric acid, no flushing of the acid component is necessary, so these bonding systems with self-etching primers can also be applied after relative drying. Commercially available cementing systems with self-etching primer/bonding systems include:

- Panavia 21, Panavia F2.0; Kuraray
- ResiCem; Shofu Dental
- Multilink; Ivoclar Vivadent

When self-adhesive bonding systems are used, conditioning is thus performed simply by applying a special bonding agent. After a certain period of exposure, which depends on the material, the die is gently dried and will be ready for cementation. As with conventional cementation, the crowns are sandblasted and, depending on the type of cement, conditioned by applying an additional bonding agent. To prevent residual resin from entering the sulcus and to avoid contamination with sulcus fluid, a thin retraction cord (e.g., Ultrapak size 00 or 0) should be used in the case of subgingival crown margins.

	Cercon base	Cercon ht	Cercon xt
Flexural Strength	>approx. 1,200 MPa	> approx. 1,200 MPa	>approx. 750 MPa
Translucency	low	moderate	high
Laboratory procedures	Fully veneered (Monolithic: only primary copings)	Monolithic Partially veneered Fully veneered	Monolithic Partially veneered
Adhesive cementing	Provisional Conventional Self-adhesive Adhesive	Provisional Conventional Self-adhesive Adhesive	(conventional) Self-adhesive Adhesive
Conditioning	Sandblasting	Sandblasting	Sandblasting
Indications	Crowns Bridges without cantilevers (with at most two adjacent pontics) Bridges with cantilevers (at most one premolar width) Abutments (two parts) Primary copings	Crowns Bridges without cantilevers (with at most two adjacent pontics) Bridges with cantilevers (at most one premolar width) Abutments (two parts) Primary copings	Crowns Bridges without cantilevers (at most three units, up to the second premolar)

Trepanation and removal of Cercon® restorations

Trepanation

The trepanation of Cercon restorations can be carried out within a reasonable time frame and without any further clinical problems if tools are selected that are suitable for the material. A two-stage procedure is recommended for preparing the access cavity. First, the ceramic veneer is removed with a diamond instrument, but without perforating the framework.

Specially coated diamond instruments should be used for trepanation with more powerful removal performance than conventional diamond instruments.

In a second step, the ceramic framework is perforated with a diamond-coated instrument of the correct size. A distance of 0.5 mm from the ceramic veneer should be maintained to keep parts of the veneer from chipping off as the framework is cut.

The structural integrity of Cercon crowns is maintained even after the access cavity has been created, so the restoration can be left as in place. The trepanation is most easily closed with an adhesively anchored composite filling.

Removal

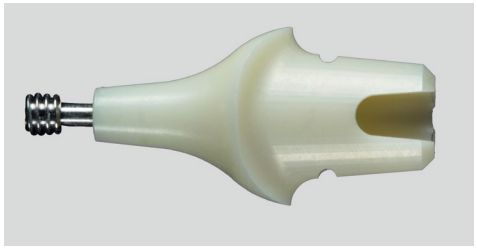
The radiopacity of Cercon restorations is similar to that of metal-ceramic restorations. To remove a Cercon restoration, the restoration must be split along the axial wall up to the center of the occlusal surface or the incisal edge. The restoration is then bent upward with a suitable instrument, causing it to fracture. In the case of adhesively bonded restorations, cement residue on the tooth surface can be removed with an ultrasonic instrument.

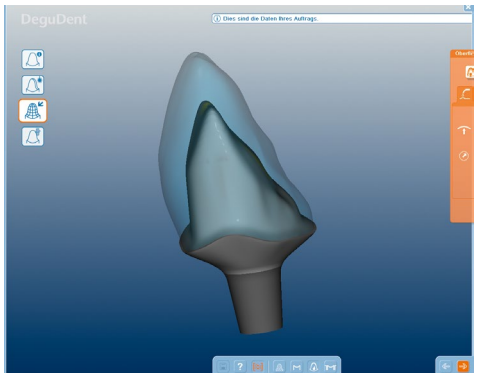
Implant abutments made of Cercon® base or Cercon® ht

Production techniques

There are three different types of all-ceramic zirconia abutments:

- Prefabricated abutments made purely of zirconia and containing a central retaining screw as the only metallic component.
- Custom abutments fabricated from pure zirconia by CAD/CAM techniques
- Two-piece zirconia abutments in which the implant connection is made via a metallic abutment base, which is then bonded with a custom zirconia part.





Clinical benefits

One- and two-piece zirconia abutments can support implant-supported fixed single-tooth restorations in the anterior and posterior regions, as has been shown by clinical studies with observation periods of up to 5 years.

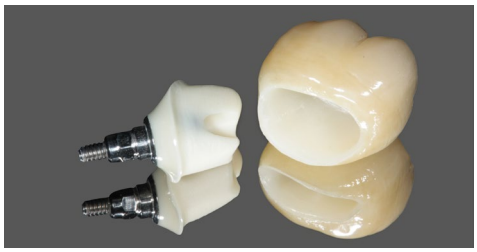
Prefabricated abutments

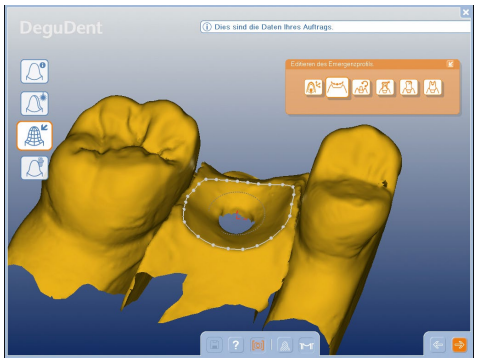
A restoration with all-ceramic abutments for anterior single-tooth implants has esthetic benefits because metallic components are prevented from shining through, which is particularly important in conjunction with peri-implant soft tissue less than 3 mm in thickness. Prefabricated all-ceramic abutments are particularly suitable for clinical situations in which a largely optimal abutment geometry has already been achieved and only minor modifications to the abutments is required. Such modifications must be kept to a minimum. In particular, care must be taken to ensure that the wall thickness of the zirconia abutments is never less than the minimum of 0.5 to 0.7 mm.

Implant abutments made of
Cercon® base or Cercon® ht

Advantages of custom abutments

One limitation of prefabricated abutments is that the specified sizes cannot always be optimally adapted to the individual shape of the sculpted peri-implant soft tissue. Furthermore, the preparation margin for the superstructure cannot always be placed to accommodate the contours of the marginal gingiva. From the point of view of good esthetics with invisible crowns and simple removal of cement residues, the preparation margin should be approximately 1 mm below the height of the marginal gingiva. Individually fabricated abutments have the advantage that they can be adapted to the soft-tissue situation in terms of soft-tissue support and a slightly subgingival position of the preparation margin. Especially for posterior restorations, the shapes of prefabricated abutments differ greatly from the natural abutment geometry and the sculpted soft-tissue profile, so custom all-ceramic abutments should be given preference. Due to the complex connection geometry, one-piece custom zirconia abutments can only be fabricated with sufficient precision using CAD/CAM procedures and central manufacturing. Two-piece zirconia abutments, by contrast, can also be fabricated directly in the dental laboratory with most common dental CAD/CAM systems. After scanning the master cast, a titanium base suitable for the implant system used is selected. This is the basis for designing the individual zirconia abutment, which can be milled from pre-sintered zirconia using conventional dental milling units. The densely sintered abutment is bonded to the titanium base, then finished and polished.





All-ceramic superstructures made of Cercon® base or Cercon® ht

Anterior single crowns

Both veneered and monolithic restorations made of Cercon base, Cercon ht or Cercon xt can be used to restore endosseous implants.

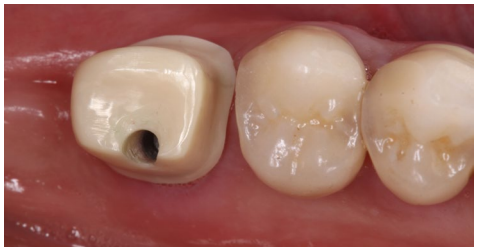
All-ceramic single crowns on all-ceramic abutments may yield a better esthetic result than metal-supported restorations, especially if the thickness of the peri-implant soft tissue is reduced (less than 2 mm). All-ceramic crowns have not shown an increased rate of technical complications (framework fractures, chipping) in this indication. On the basis of the available clinical data, this form of care is scientifically validated and may be considered suitable for clinical use.

Posterior single crowns

By contrast, veneered all-ceramic single crowns with zirconia frameworks exhibited a higher rate of complications in the form of extensive chipping when used to restore implants with prefabricated abutments in the posterior region. From the available clinical data it may be concluded that the technical complication rate of all-ceramic superstructures can be reduced by using custom all-ceramic abutments. Alternatively, fixed superstructures can be fabricated as monolithic restorations made of Cercon ht, thus avoiding the risk of technical complications in the form of chipping.

Advantages of custom abutments

However, the use of custom abutments also makes sense when fabricating monolithic restorations, as there are two further aspects that justify the routine use of custom abutments four implant-supported restorations in the posterior region beyond the avoidance of technical complications.



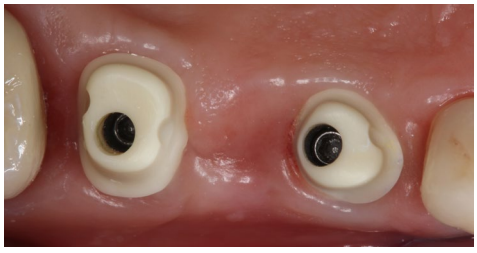
All-ceramic superstructures
made of Cercon® base or Cercon® ht

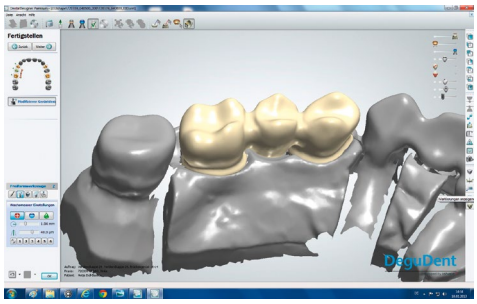
Due to their larger surface area, custom abutments improve the retention of the superstructure, so that temporary cementation is possible in suitable cases without an increased risk of retention loss. Furthermore, the individual abutments permit moving the cement line to the equigingival or slightly subgingival region, facilitating safe and easy removal of excess cement.

This is further supported by selecting a suitable adhesive, meaning that conventional cements or self-adhesive cements (e.g., Calibra Universal; Dentsply Sirona) should be preferred to dual-curing resin cements. This is all the more important in that incomplete cement removal can result in iatrogenic periimplantitis.

Bridge restorations

Only limited clinical data currently exist on all-ceramic bridge superstructures. On the basis of the data that we do have, however, we can see that short-span bridges — especially in the anterior region — carry a relatively low risk of technical complications (Kim et al., 2012). Multi-span unit veneered all-ceramic bridges (up to 10 units), by contrast, frequently exhibited technical complications in the form of extensive chipping (Larsson et al., 2012). For this reason, the use of veneered superstructures should be limited to short-span bridges (three-unit bridges) until further clinical data has become available. Multi-unit bridges in the posterior region, on the other hand, should preferably be designed as monolithic structures.





Clinical performance of Cercon® restorations

High framework stability

Since the year 2000, more than 50 clinical studies have been published internationally that have examined the clinical performance of zirconia crowns and bridges. Published clinical studies on zirconia confirm the high framework stability of crowns and three-unit bridges after observation times of 3 to 5 years (Raigrodski et al., 2012; Tritawana et al., 2012; Layton and Wennerberg, 2014; Takeichi et al., 2014).

Posterior bridges

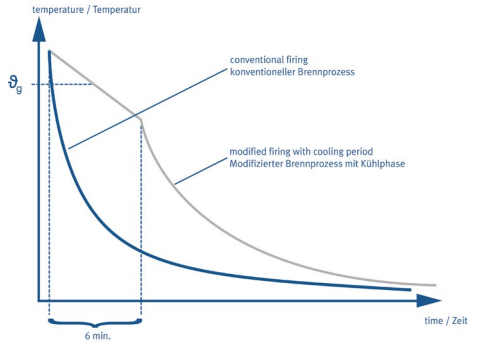
Posterior Cercon bridges have been documented in prospective studies with mean observation times of 10 years. There were no significant differences in survival rates compared to metal-ceramic posterior bridges (Sailer et al., 2018).

Single crowns

Bridges without cantilevered pontics

For single crowns and three-unit bridges based on zirconia in the anterior and posterior regions, framework stability can be assumed to be equivalent to that of metal-supported restorations. At the same time, however, these studies have shown that technical complications in the form of chipping frequently occur in all-ceramic restorations based on zirconia. The exact cause of the increased incidence of chipping in these restorations had long remained unknown, but what was shown was that there was an increase especially in the posterior region (Raigrodski et al., 2012; Tritawana et al., 2012). Several in-vitro studies have shown that especially a pronounced fully contoured framework design, (as well as long-term cooling after veneering) can reduce the risk of failure (Chaar et al., 2012; Tan et al., 2012). In a prospective study, these attempts at optimization (fully contoured framework designs and long-term cooling) were clinically tested on molar crowns. After five-years of observation, there was no statistically significant difference in the chipping rates of metal-ceramic and all-ceramic single crowns (Rinke et al., 2015).

Chipping prevention

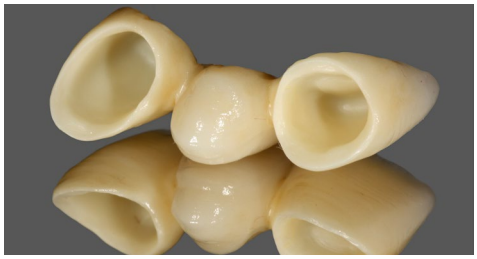


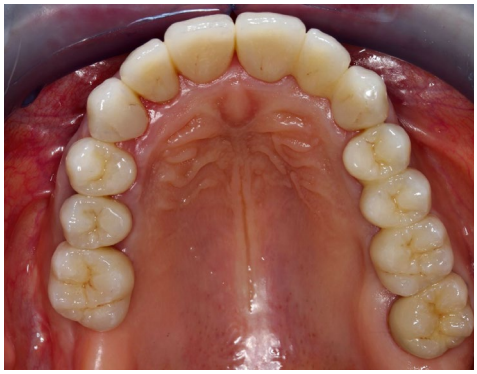
Other possible solutions include overpressing the veneer or producing CAD/CAM veneers bonded to the zirconia by adhesively or by using a glass solder (Chaar et al., 2012; Guess et al., 2012; Schmitter et al., 2012). As with single crowns, the technical complications of three-unit tooth-supported bridges appear to be limited to chipping. If measures are taken to reduce the chipping risk (fully contoured framework design and ceramic veneering with long-term cooling), performance levels comparable to those of metal-ceramic bridges can be expected.

Multi-span bridges

The situation for multi-unit and multi-span bridges appears in a somewhat different light. For longer-span designs, framework fracture rates of 9% to 17% within a 5-year period have been reported (Salido et al., 2012; Schmitt et al., 2012; Schmitter et al., 2012). It was shown that the technical complication rates strongly depend on the position and size of the bridge. Anterior bridges were significantly less susceptible to framework or veneer fractures (Schmitter et al., 2012)

The use of multi-span veneered zirconia bridges should therefore be limited to the anterior region for now. Multi-span bridges in the posterior region, on the other hand, should be executed as fully contoured (monolithic) restorations in order to avoid technical complications (framework fractures, chipping).





Clinical performance of Cercon® restorations

Cantilever bridges

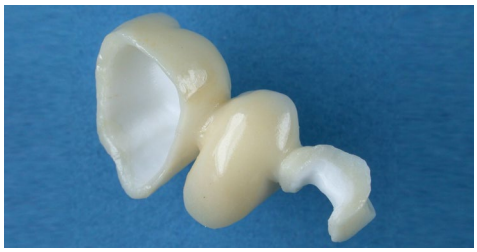
Zirconia bridges with cantilever pontics have been shown to exhibit adequate framework stability in clinical studies with observation periods of 2 to 4 years (Wolfart et al., 2009; Ohlmann et al., 2012). The well-known chipping problem can be alleviated by suitable means as the ceramic veneer is applied.

Adhesive bridges

Zirconia is suitable as framework material for adhesively bonded bridges in combination with a minimally invasive preparation (Sasse et al., 2012). The single-wing adhesive bridge design is a promising alternative to conventional double-wing designs.

Inlay bridges

Zirconia-based inlay bridges show an increased initial risk of complications even with adhesive cementation (Ohlmann et al., 2008), so that their indication must be viewed critically until further data become available. Initial clinical results with a modified preparation design to increase the adhesive surfaces in the area of the inlay anchors have shown a reduced incidence of technical complications (Abou-Tara et al., 2011). Of 23 adhesively bonded inlay bridges with zirconia frameworks, one case of retention loss and two cases of chipping were observed after a mean observation period of 20 months.



Implant abutments

One- and two-piece zirconia abutments can support implant-supported fixed single-tooth restorations in the anterior and posterior regions, as has been shown by clinical studies with observation periods of up to 5 years. Initial results from a retrospective study have also indicated that all-ceramic abutments can be used to support short-span bridges (Kim et al., 2012).

Clinical performance of Cercon® restorations

Anterior superstructures

All-ceramic single crowns on all-ceramic abutments may yield a better esthetic result under clinical conditions than metal-reinforced restorations. All-ceramic crowns have not shown an increased rate of technical complications (framework fractures, chipping) in this indication (Hosseini et al., 2012).

Posterior superstructures

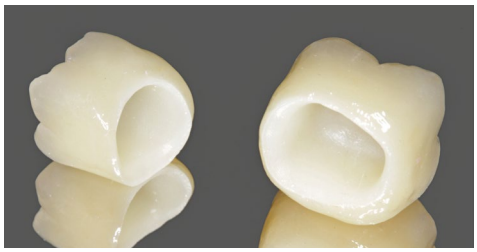
Cemented all-ceramic single crowns with zirconia frameworks exhibited a higher rate of complications in the form of extensive veneering ceramic fractures when used to restore implants with prefabricated abutments in the posterior region (Schwarz et al., 2012). At the same time, a prospective comparative 5-year study showed that all-ceramic single crowns in the posterior region that were cemented to custom all-ceramic abutments exhibited the same clinical performance as metal-ceramic crowns on custom titanium abutments (Zembic et al., 2012).

All-ceramic zirconia superstructures in the posterior region must therefore meet the following requirements:

- Fully contoured abutment design, preferably with ceramics as a material
- Fully contoured design of the crown framework
- Suitable measures to reduce the chipping risk

Bridges

As long as these conditions are met, cemented veneered zirconia crowns can be used as superstructures in the posterior region, if a strict indication exists. A monolithic or partially veneered implant-supported single-tooth restoration might be considered as an alternative. Screw-retained crowns made of zirconia can also be fabricated monolithically or with partial veneering in regions not exposed to functional forces.



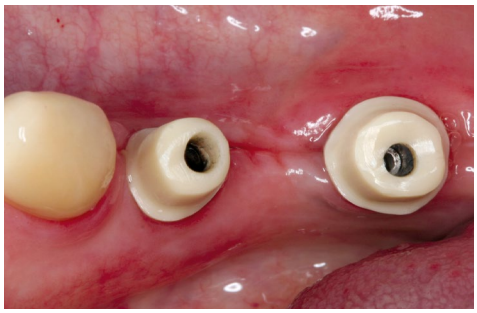
Implant-supported metal-ceramic and all-ceramic bridges are associated with an increased risk of technical complications compared to tooth-supported restorations (Pjetursson et al., 2012; Larsson et al., 2012). It is therefore preferable to use conditionally removable (retrievable) short-span designs (Kim et al., 2012).

Given the very limited clinical data available, the indication for implant-supported bridges should initially be limited to three-unit designs. In the posterior region, bridges should be supported by custom abutments to avoid technical complications. The same recommendations apply here as for all-ceramic single crowns in the posterior region. Especially for restorations in the molar region, a fully contoured (monolithic) design should be considered.

Monolithic restorations

Results of several clinical studies examining monolithic zirconia bridge designs over observation periods of up to 5 years have now become available. Overall, a significant reduction in technical complications was achieved by dispensing with ceramic veneers altogether. If the design is monolithic in nature, multi-unit bridge designs on implants appear to be justified (Bidra et al., 2017).

Vestibular veneering in non-functional regions make for optimized esthetics without increasing the risk of technical complications. This design is particularly recommended for implant-supported multi-unit restorations in the anterior region involving anterior or canine teeth.



Monolithic restorations

Due to the well-known problems associated with veneered restorations, attempts have been made for some time now to minimize the risk of technical complications with so-called monolithic restorations, i.e., restorations made of a single material (Rinke and Fischer, 2012).

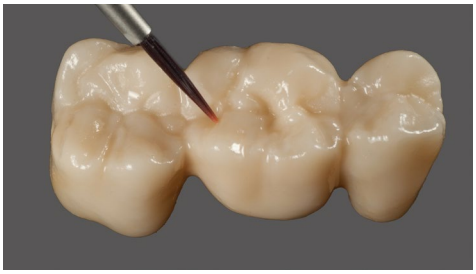
The following potential benefits of these restorations have been reported:

- Avoiding technical complications
- Minimally invasive (conservative) preparation
- Cost reduction by eliminating veneering altogether

Monolithic and partially veneered crowns made of Cercon ht were evaluated in a clinical study for an observation period of 3 years (Bömicke et al., 2017). During the entire period, no technical complications were observed with the 82 monolithic crowns; only one case of minimal (polishable) chipping was seen in the 66 partially veneered Cercon ht crowns. The three-year overall survival rate was 98.5%; any failures that did occur were due to biological complications.

In addition, further clinical studies have shown that even with tooth-supported monolithic bridges, the rates of technical complications were very low at observation periods of up to 3 years.

The use of monolithic or vestibular zirconia restorations veneered in the non-functional regions is thus a clinically validated restorative technique that reduces the rate of technical complications.



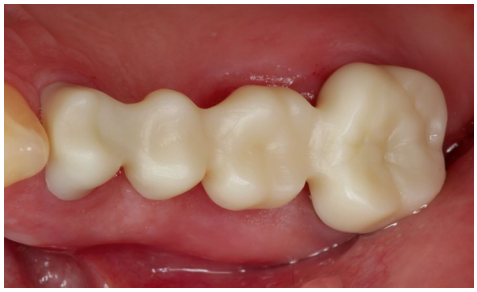
Abrasion behavior

Potential risks during clinical application as well as possible benefits were extensively evaluated in in-vitro studies.

Fully contoured crowns exhibited higher light transmittance and greater fracture resistance than veneered zirconia crowns in in-vitro studies (Beuer et al., 2011). The abrasion behavior of zirconia surfaces is of focal importance for the clinical use of that material. In the initial phases of clinical use, complete coverage of the zirconia framework with veneering ceramic was required, as increased abrasion of antagonists was feared if these were exposed directly to the framework.

A study by Jung et al. (2010), however, showed that polished and also glazed zirconia surfaces show less antagonist abrasion than classic veneering ceramics. These results have since been confirmed by further studies (Preis et al., 2011; Rosentritt et al., 2011; Mitov et al., 2012; Stawarcyk et al., 2013). Accordingly, the clinical deployment of polished or glazed fully contoured restorations is not expected to increase the risk of antagonist abrasion. For the first time, it is now possible to produce conventionally cemented all-ceramic crowns and bridges with preparation depths previously limited to cast-metal restorations. Taking into account the fact that customization in terms of shade is also available based on the intrinsic shade of the framework and on subsequent staining, interesting new fields of application of all-ceramic restorative concerts have arisen. In bridge constructions, a combination of veneered and monolithic units is also possible. In this way, optimal esthetics can be achieved in the anterior region, whereas no veneering is required in the posterior region.

The extra translucent Cercon xt facilitates a further esthetic optimization of monolithic restorations with minimum material-wall-thickness requirements that are less than those for high-strength glass-ceramics due to improved optical properties of Cercon xt.



Product recommendations

For your restorative success, we recommend these complementary products from Dentsply Sirona:

Impression taking	Aquasil Ultra
Veneering	Cercon® ceram Kiss, Cercon® ceram love, Celtra Ceram
Finishing	TwisTec®
Temporary cementation	Integrity Temp Grip
Definitive cementation, conventional	AquaCem®
Definitive cementation, self-adhesive	SmartCem®2, Calibra Universal
Definitive cementation, adhesive	Calibra Ceram + Prime & Bond Active

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Notes

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