VITA All-Ceramics

VITA In-Ceram®

Guide for all-ceramic restorations in the dental practice by Prof. Dr. med. dent. Lothar Pröbster and Dr. med. dent Martin Groten

Date of issue: 03-06
Lothar Pröbster, born in 1958, was an assistant in a practice after completing his dental examination in 1983; from 1985 to 1997 he worked as a scientific staff member for Professor Dr. E. Körber and Professor Dr. H. Weber and the policlinics for Dental Prosthodontics of the University of Tübingen. During his time at the university he was preclinic director, one of the project managers of the special research field of implantology and clinical senior dentist. He habilitated in 1995 and in 1997 he was appointed specialist for prosthodontics of the German Association of Prosthodontics and Dental Materials. Since 1997 he has been co-owner of a dental practice in Wiesbaden. In 2001 he was appointed associate professor by the University of Tübingen.

His fields of activities include adhesive and implant restorations, material science and, above all, all-ceramic restoration systems. Up until today he has been dealing closely with all-ceramic procedures, which in 2001 resulted in the co-authorship of the scientific statement of the German Society of Dental Oral and Craniomandibular Sciences on the scientific recognition of all-ceramic crowns and bridges. So far his clinical-scientific activities comprise more than 100 publications, a book and approx. 300 speeches, seminars and workshops. Prof. Pröbster is a member in some professional associations and works as an expert/advisor for Deutsche Forschungsgemeinschaft (German Research Foundation) and for dental magazines.
Dr. med. dent. Martin Groten

Martin Groten, born in 1965, is senior dentist at the policlincs for Dental Prosthodontics and the Department of Medical Materials and Technology (Medical Director: Prof. Dr. Heiner Weber) at the Center for Dental, Oral and Maxillofacial Medicine of the University of Tübingen. His main activities at the clinic include the areas of fixed, combined and implant-supported restorations, all-ceramic restorations and the use of minimally invasive and adhesive techniques in prosthodontics. Additionally, he provides scientific and photographic documentation of clinical treatment procedures.

As clinical examiner in charge, he has been dealing with planning, design, performance and evaluation of clinical studies and the rules of clinical tests of medical products. As assistant director of the Steinbeis-Transferzentrum Dental Products/Clinical Testing/Certification (STZ-DCZC) he has been supervising its accreditation as medical institute for clinical testing of medical products according to the Directive 93/42/EWG for Medical Devices (MDD), EN ISO 17025 and the ICH E6 guidelines for Good Clinical Practice (GCP). He gives numerous speeches in Germany and in foreign countries and is the author or co-author on a series of publications and a manual on clinical testing of medical devices in English. Since 1993 he has been training students and involved in the development of modern teaching concepts. He has been in charge of preclinical education of dental students at the University of Tübingen since 1999.
Preface

Currently, the fabrication of all-ceramic restorations reflects the strongest trend in restorative dentistry. Based on procedural and material-scientific innovations, inlays, crowns, bridges, primary telescopes, implant suprastructures and even implants can be produced exclusively from ceramic, that is without any metal affecting aesthetics or biocompatibility. These materials allow to restore “white esthetics” of teeth true to nature.

VITA Zahnfabrik has gathered experience with all-ceramic materials over decades and become one of the leading manufacturers worldwide.

With this brochure we intend to provide a description of the wide application range of the VITA In-Ceram product range and show the application possibilities for the daily practice.

We wish all readers success in working with the highly aesthetic and proven VITA In-Ceram materials.

Wiesbaden and Tübingen, June 2006

Prof. Dr. Lothar Pröbster
Schöne Aussicht 18
65193 Wiesbaden

Dr. Martin Groten
Universitätsklinikum
Zentrum für Zahn-, Mund- und Kieferheilkunde
Osianderstraße 2-8
72076 Tübingen
Acknowledgement

The authors would like to use the publication of the new VITA In-Ceram brochure to thank the numerous persons who have contributed to our results with the VITA In-Ceram system over the years.

First of all we would like to thank the active and former dental technicians at the Center for Dental, Oral and Maxillofacial Medicine of the University of Tübingen for numerous years of cooperation and the fabrication of the VITA In-Ceram restorations: Bettina Vogel, Susanne Deiser, Karina Schmidt, Jochen Diel, Volker Scheer and Ekkehardt Kröverath.

We would also like to thank our dental assistants for their dependability and help and especially for their patience during the production of the clinical photos: Patricia Scholze, Ziza Ghaxeri and Silke Saile.

We would like to thank Sonja Ganz and Kurt Reichel, Reichel Zahntechnik in Hermeskeil, for the fabrication of the VITA In-Ceram YZ restorations and for providing the photos illustrating the respective dental-technical steps.

We also owe our thanks to all staff members and colleagues whose clinical and scientific commitment was an indispensable contribution to the collection of our clinical data, documentation and experience. Among these persons were Dr. Stephan Girthofer, Dr. Steffen Obergfell and Dr. Corinna Walter.

Last not least we would like to thank all manufacturers and companies who have supported us or provided illustrated material about their systems: VITA Zahnfabrik, Sirona Dental Systems GmbH, Mikrona Technologie AG, Straumann GmbH, DCS Dental AG, C. Hafner GmbH & Co. KG, Amann-Girrbach Dental GmbH and TeamZiereis GmbH.
VITA All-Ceramics

**VITA In-Ceram®**

Guide for all-ceramic restorations in the dental practice

**Table of contents**

- Material properties of all-ceramics 8
- All-ceramic restorations made from VITA In-Ceram 9
  - Characteristics of all-ceramic systems 11
- All-ceramics versus metal ceramics 12
- Materials science and characteristics 14
- Fabrication - VITA In-Ceram 19
  - Initial clinical situation 19
  - Slip techniques 20
    - VITA In-Ceram 20
    - VITA In-Ceram sprint 28
    - WOL-CERAM 28
    - CeHa White ECS 29
  - Milling techniques 30
    - Copy milling 30
      - CELAY 30
    - CAD/CAM techniques 32
      - CEREC/inLab 32
      - DCS PRECIDENT 33
      - Digident 33
    - Special application 34
      - synOcta In-Ceram blank 34
- Fabrication - VITA In-Ceram 36
  - VITA In-Ceram YZ 36
  - VITA In-Ceram AL 39
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indications for the VITA In-Ceram system</td>
<td>40</td>
</tr>
<tr>
<td>VITA In-Ceram ALUMINA</td>
<td>40</td>
</tr>
<tr>
<td>VITA In-Ceram SPINELL</td>
<td>41</td>
</tr>
<tr>
<td>VITA In-Ceram ZIRCONIA</td>
<td>41</td>
</tr>
<tr>
<td>VITA In-Ceram YZ</td>
<td>42</td>
</tr>
<tr>
<td>VITA In-Ceram AL</td>
<td>42</td>
</tr>
<tr>
<td>Indications with experimental character</td>
<td>43</td>
</tr>
<tr>
<td>Clinical preparation techniques</td>
<td>45</td>
</tr>
<tr>
<td>Fundamentals</td>
<td>45</td>
</tr>
<tr>
<td>Preparation depths</td>
<td>47</td>
</tr>
<tr>
<td>Preparation types</td>
<td>48</td>
</tr>
<tr>
<td>Cementing VITA In-Ceram restorations</td>
<td>56</td>
</tr>
<tr>
<td>Conventional cementing</td>
<td>56</td>
</tr>
<tr>
<td>Adhesive cementing</td>
<td>57</td>
</tr>
<tr>
<td>Clinical experience with VITA In-Ceram restorinations</td>
<td>64</td>
</tr>
<tr>
<td>VITA In-Ceram ALUMINA Crowns</td>
<td>67</td>
</tr>
<tr>
<td>VITA In-Ceram ALUMINA Bridges</td>
<td>67</td>
</tr>
<tr>
<td>VITA In-Ceram SPINELL Crowns</td>
<td>67</td>
</tr>
<tr>
<td>VITA In-Ceram ZIRCONIA Restorations</td>
<td>68</td>
</tr>
<tr>
<td>Own clinical experience with VITA In-Ceram</td>
<td>68</td>
</tr>
<tr>
<td>Clinical documentations</td>
<td>74</td>
</tr>
<tr>
<td>Literature</td>
<td>83</td>
</tr>
</tbody>
</table>
What’s behind all-ceramics?

Ceramics comprise a large family of inorganic materials within the group of non-metals. They are divided into three subcategories: silicate ceramic, oxide ceramic and non-oxide ceramic materials. The silicate ceramic materials have the same base materials in common: quartz and feldspar, naturally occurring minerals resulting in a material which consists of silicates (fig. 1):

![SEM-photo of an etched VITA VM 7 surface Magnification x 5000](image)

Fig. 1 Micrograph of a ceramic veneer made from a silicate ceramic material. Translucency and refraction behavior are determined by the crystals embedded in the silicate glass matrix (SiO₂) and resemble the properties of natural enamel.

Silicate ceramic materials, however, can also be synthesized from inorganic pure substances (lithium disilicate ceramic Empress 2 / IPS by Ivoclar Vivadent AG). The term oxide ceramics is used for ceramic materials consisting of simple oxides such as aluminium oxide and zirconium oxide and for complex oxides such as spinels. In the narrower sense oxide ceramics are polycrystalline materials based only on the respective oxides. Glass-infiltrated ceramics such as VITA In-Ceram with high oxide content but also glass content due to the infiltration process (fig. 2) take an intermediate position between silicate ceramics and polycrystalline oxide ceramics.

![Coping made from VITA In-Ceram ALUMINA immediately after glass infiltration firing and prior to removal of excess glass](image)

Fig. 2 Coping made from VITA In-Ceram ALUMINA immediately after glass infiltration firing and prior to removal of excess glass. The pores and cavities between the ALUMINA particles (aluminium oxide) connected with sintered bridges are filled with a lanthanum glass. This glass matrix accounts for only a very small part of the structure, however, it dominates with its optical properties so that the coping is translucent.

Non-oxide ceramics (“special ceramics”) are compounds such as nitrides and carbides which do not play a significant role as restorative materials but are used for “tungsten carbide burs” and polishing agents for the daily dental and dental-technical use. The dental ceramic materials themselves are just a small group within the entire range of ceramics. Owing to the different indications of the individual ceramics, however, a basic understanding of materials science of ceramics is indispensable for dentists in order to ensure correct classification of a dental ceramic system and to be able to use it successfully.
All-ceramic restorations made from VITA In-Ceram

Already in 1989 VITA launched the first type of materials of the all-ceramic system VITA In-Ceram - VITA In-Ceram ALUMINA - into the market. Since then the dental company has repeatedly developed new, innovative variations of this material. Today dental technicians and dentists can select between five material variations in various states of aggregation for different processing methods - from the powder for the slip technique to blocks for CAD/CAM manufacturing of all-ceramic restorations. Accordingly, users can choose the best possible framework material of this well-proven system for any individual indication.
Beauty, natural appearance and biocompatibility - these are characteristics associated with all-ceramic restorations. Ceramics allow to reproduce the hard tooth substance almost perfectly. Current materials and clinical techniques eliminate any concern that all-ceramic restorations may not provide sufficient durability. Decisive factors are the knowledge of the correct material-specific indication of the materials used and the correct clinical technique to achieve excellent long-term results.

Fig. 1 Crowns on teeth 11 and 21 made from VITA In-Ceram Classic SPINELL can hardly be distinguished from natural teeth and reveal perfect periodontal integration.

Fig. 2-4 For more than 100 years dental ceramics have been repeatedly improved and developed further to adapt the properties of natural enamel. Since 1930 VITA Zahnfabrik has produced materials for all-ceramic dental restorations, from the historical VITA LUMIN and VITADUR ceramics to the VITA In-Ceram materials of the third millennium. VITA has become a synonym for all-ceramic materials in dentistry. VITA In-Ceram has proven its reliability as crown and bridge material in innumerous cases worldwide since 1989.

With this guide we intend to provide you with precise and reliable information how to safely and successfully use VITA In-Ceram ceramic materials for all-ceramic restorations in the dental practice.

Fig. 5 All-ceramic restorations with sintered zirconium oxide frameworks represent the best possible solution: they combine extremely high resistance to mechanical and chemical influences with the aesthetic qualities of tooth-like color and translucency. As shown in this example of a four-unit free end bridge with a pontic in the upper jaw (23-25/26), they open new indications for all-ceramic materials.
Characteristics of all-ceramic systems

All-ceramic substructures are characterized by the fact that a metal substructure is omitted and the restoration is exclusively made from ceramic material. Consequently, an opaque metal framework does not have to be masked and therefore a more natural reconstruction of the tooth is possible. The all-ceramic restoration systems available today can be classified according to several aspects. They can be distinguished on the basis of the material-scientific composition, the manufacturing method, the clinical use or the cementation technique. Some of the fabrication systems available also allow processing of various ceramic materials for different clinical applications.

The optical and physical properties are essential for dentistry. Ceramics with a high oxide content (aluminium oxide, zirconium oxide) exhibit very high values of strength but are also less translucent or partly entirely opaque so that these materials (e.g. glass infiltrated oxide ceramic and polycrystalline oxide ceramic) can only be used as core materials which need to be veneered with silicate ceramic materials to achieve the desired aesthetic result.

Silicate ceramic materials in turn feature excellent optical properties to achieve unsurpassed aesthetic results. Due to their lower strength, however, they require adhesive cementation to provide sufficient stability as a tooth-restoration bonding system. Additionally, they are used as veneering material for all-ceramic and metal frameworks.
All-ceramics versus metal ceramics

Fig. 1 Metal ceramic crowns exhibit aesthetic deficiencies compared to all-ceramic restorations: the metal paragingival margin of crown on tooth 11 impairs the total appearance of the restorations.

Fig. 2 Condition of the abutment teeth after removal of the old metal ceramic crowns and careful paragingival repreparation (chamfer).

Fig. 3 VITA In-Ceram ALUMINA crowns, produced using the WOL-CERAM technique, approx. 3 weeks after definitive cementing with a translucent cement (RelyX Unicem, 3M ESPE Dental AG). The crown margins are perfectly integrated in the marginal periodontium.

Direct comparison of the influence of the framework material on the penetration of light through the restored tooth:

Fig. 4a Metal ceramic crown on tooth 22, penetrated by light from the oral direction: the opacity of the metal framework affects the penetration of light mainly in the gingival third of the tooth.

Fig. 4b Crown made from VITA In-Ceram SPINELL on the same tooth: the translucent SPINELL framework allows considerably higher penetration of light.
Fig. 5 Margin of the bridge anchor 13 of a Metal ceramic bridge (teeth 13-15) visible along the paragingival line. Although the veneering material extends up to the margin of the restoration, it does not cover the opaque metal framework.

Fig. 6 Circular chamfer preparations of teeth 13 and 15 after removal of the metal ceramic bridge.

Fig. 7 VITA In-Ceram ZIRCONIA bridge (teeth 13-15) - viewed from the basal surfaces. The opaque ZIRCONIA framework can be easily recognized and reveals a tooth-like color.

Fig. 8 VITA In-Ceram ZIRCONIA bridge approx. 1 year after integration. The paragingival margins were perfectly integrated into the marginal periodontium and can not be seen despite the opaque framework material.

Fig. 9 Dental alloys may corrode under the conditions in the oral cavity. This may contribute essentially to aesthetic inadequacies and result in inflammatory and local toxic reactions. Moreover they may contribute to the development of hypersensitivities (allergies). The use of ceramics excludes the risk of corrosion.
VITA In-Ceram® – Materials science and characteristics

In the VITA In-Ceram product family two different types of ceramics must be distinguished:

- **glass infiltrated oxide ceramics:**
  VITA In-Ceram SPINELL, VITA In-Ceram ALUMINA and VITA In-Ceram ZIRCONIA: oxide reinforced.

- **polycrystalline oxide ceramics:**
  VITA In-Ceram YZ and VITA In-Ceram AL.

The VITA In-Ceram framework can be fabricated in two ways: in the first method the framework of the crown or bridge is molded on a special plaster die using a powder-liquid suspension, the so-called slip, and porously sintered subsequently. In the second method the framework material is industrially prefabricated by compacting the oxide ceramic powder under pressure and presintering it to obtain porous blanks. The frameworks are produced from the blocks through profile grinding (copy grinding or using CAD/CAM systems). In this condition the framework material is porous (fig. 1) and does not exhibit a high strength so that it can be easily processed with rotary tools.

This framework consisting of oxide ceramic microparticles (magnesium aluminium oxide for SPINELL, aluminium oxide for ALUMINA, aluminium oxide and zirconium oxide for ZIRCONIA) is infiltrated with a special, lanthanium-containing glass in a second step to obtain the final VITA In-Ceram ceramic framework (fig. 2), which is practically pore-free. Densification of the particles and the sintered bridges between the oxide ceramic particles results in efficient inhibition of crack formation and growth and thus in very high flexural strength and flexural toughness.

Strength increases in the order of VITA In-Ceram SPINELL - ALUMINA - ZIRCONIA (fig. 3), whereas translucency decreases (see fig. 4, next page). This reciprocal connection leads to the fact that the aesthetically most attractive material variation, VITA In-Ceram SPINELL is particularly suited for crowns in the anterior area in which masticatory forces are very low. The combination of high strength and medium translucency in VITA In-Ceram is perfect for crowns in the anterior and posterior area and bridges in the anterior area, whereas VITA In-Ceram ZIRCONIA is the preferable material for crowns and bridges in...
the posterior area due to lower translucency (high masking capacity) at very high strength.

VITA In-Ceram YZ is a polycrystalline oxide ceramic, i.e. the ceramic exclusively consists of crystalline metal oxides and does not exhibit a glass phase (see page 16, fig. 6). It is composed of at least 91% zirconium oxide (ZrO\textsubscript{2}), 5% yttrium oxide (Y\textsubscript{2}O\textsubscript{3}), 3% hafnium oxide (HfO\textsubscript{2}) and small amounts (< 1%) aluminium oxide (Al\textsubscript{2}O\textsubscript{3}) and silicon oxide (SiO\textsubscript{2}). The task of the cubic yttrium oxide is to retain and stabilize the small-volume, tetragonal crystal structure of zirconium oxide at very high temperatures, when cooling it down to room temperature. The yttrium oxide in the zirconium oxide avoids phase transformation into the crystal structure normally achieved at room temperature, i.e. into the monoclinic structure which exhibits a larger volume. This phase transformation is accompanied by a local increase in volume of 3-5%. The resulting compressive stress in the environment of the crack inhibits crack propagation (see page 16, fig. 7). This "crack-inhibition function" is responsible for the high initial strength and fracture toughness as well as for the fatigue strength of zirconium oxide. Adding small amounts of Al\textsubscript{2}O\textsubscript{3} results in considerably increased fatigue strength, which is why almost all zirconium oxide ceramic materials available are referred to as Y-TZP-A (Yttria stabilized Tetragonal Zirconia Polycrystal-Alumina).

The initial flexural strength of the yttrium stabilized zirconium oxide ceramics is approx. 1000 MPa, the fatigue strength after numerous years of alternating stress in the wet environment decreases to approx. 500 MPa so that even after a long time of wearing sufficient strength is also ensured for multi-unit bridge structures. Due to the coefficient of thermal expansion (CTE) of 10,5 ·10\textsuperscript{-6} ·K\textsuperscript{-1}, frameworks made from VITA In-Ceram YZ are veneered with VITA VM 9.

Clinical try-in of glass infiltrated VITA In-Ceram frameworks:
Fig. 5a Crowns (25, 26) made from VITA In-Ceram
ALUMINA - moderately translucent
Fig. 5b Crowns (11, 21) made from VITA In-Ceram
SPINELL - translucent
Fig. 5c Bridge (15-13) made from VITA In-Ceram
ZIRCONIA - opaque
Recently, presintered VITA In-Ceram AL blocks, consisting of pure, polycrystalline aluminium oxide (Al₂O₃, 100%), have been introduced and are used for the CAD/CAM technology (inLab, Sirona Dental Systems GmbH). Pure, densely sintered aluminium oxide also exhibits high strength (initial flexural strength > 500 MPa). When applied in thin layers, as required for crown and bridge frameworks, its color and translucency are even more similar to those of natural dentine than polycrystalline zirconium oxide. Accordingly, VITA In-Ceram AL are especially suited for crowns in the aesthetically demanding area (see page 40, chapter **Indications for the VITA In-Ceram System**). The CTE value of approx. 7.3 • 10⁻⁶ • K⁻¹ lies within the range of VITA In-Ceram. Restorations made from VITA In-Ceram AL are veneered with VITA VM 7.

Densely sintered, polycrystalline ceramics reveal extreme hardness (Mohs hardness 9) and are therefore difficult to process. In industrial serial production they are used for hip joint prostheses, valves, clutches and other highly stressable motor components. For the production of single items, as it is mandatory in dental techniques, these ceramics could not be used since they were almost impossible to process. It was the method of shaping them with the help of CAD/CAM systems (e.g. inLab) in the so-called "white" condition which permitted the use of these high-strength ceramics in dentistry. In this condition, the blank has not been densely sintered yet and is still porous so that it can be easily milled. The blank is porous, i.e. it features "vents" within the block which extend up to the surface (open porosity). During sintering, material is transported along the grain boundaries until the "vents" are filled with the ceramic solid. As a consequence, the grains (particles) also grow. Since the quantity of the ceramic material, however, has not increased (conservation of mass!) and the air has escaped from the block, the entire block will also inevitably become smaller. The blank will be densely sintered. During this process considerable sintering shrinkage of 20-25% occurs. When fabricating crowns and bridge frameworks, an enlarged framework is produced on the basis of accurate precalculation and subsequent control of the sintering shrinkage. When this framework is densely sintered, it shrinks to the desired, anatomically correct size.
Due to the densely sintered zirconium oxide VITA In-Ceram YZ and aluminium oxide VITA In-Ceram AL particles translucency increases so that ceramic restorations made from VITA In-Ceram YZ and VITA In-Ceram AL blocks - with a required wall thickness of approx. 0.5 mm - feature high translucency.

Materials science of the VITA In-Ceram ceramics

<table>
<thead>
<tr>
<th>Material</th>
<th>Glass infiltrated oxide ceramic</th>
<th>Polycrystalline oxide ceramic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VITA In-Ceram SPINELL</td>
<td>VITA In-Ceram ALUMINA</td>
</tr>
<tr>
<td>CTE (25-500°C)</td>
<td>$10^{-6}$</td>
<td>7.7</td>
</tr>
<tr>
<td>Initial flexural strength</td>
<td>MPa</td>
<td>400</td>
</tr>
<tr>
<td>Fracture toughness</td>
<td>MPa·m$^{1/2}$</td>
<td>2.7</td>
</tr>
<tr>
<td>Modulus of elasticity</td>
<td>GPa</td>
<td>185</td>
</tr>
<tr>
<td>Average particle size</td>
<td>μm</td>
<td>ca. 4.0</td>
</tr>
<tr>
<td>Composition</td>
<td>wt.%</td>
<td>Powder: 100% MgAl$_2$O$_4$</td>
</tr>
<tr>
<td></td>
<td>Structure: 78% MgAl$_2$O$_4$, 22% infiltration glass</td>
<td>Structure: 75% Al$_2$O$_3$, 25% infiltration glass</td>
</tr>
<tr>
<td>Chemical solubility</td>
<td>μg/cm$^2$</td>
<td>1025</td>
</tr>
</tbody>
</table>

*after sintering
Material structure of the VITA In-Ceram blocks

**VITA In-Ceram SPINELL**
- Fig. 1 Structure of the porous VITA In-Ceram SPINELL blocks
  - Magnification x 10,000
- Fig. 2 Glass infiltrated structure
  - Magnification x 10,000

**VITA In-Ceram ALUMINA**
- Fig. 3 Structure of the porous VITA In-Ceram ALUMINA blocks
  - Magnification x 10,000
- Fig. 4 Glass infiltrated structure
  - Magnification x 10,000

**VITA In-Ceram ZIRCONIA**
- Fig. 5 Structure of the porous VITA In-Ceram ZIRCONIA blocks
  - Magnification x 10,000
- Fig. 6 Glass infiltrated structure
  - Magnification x 10,000

**VITA In-Ceram AL**
- Fig. 7 Structure of the porous VITA In-Ceram AL
  - Magnification x 20,000
- Fig. 8 Densely sintered structure
  - Magnification x 20,000

**VITA In-Ceram YZ**
- Fig. 9 Structure of the porous VITA In-Ceram YZ
  - Magnification x 20,000
- Fig. 10 Densely sintered structure
  - Magnification x 20,000
Initial clinical situation

Restorations made from VITA In-Ceram represent an alternative to metal-ceramic crown and bridge restorations and provide superior aesthetics and technical perfection.

Today a variety of VITA In-Ceram materials with specific properties and processing methods is available. Accordingly, VITA In-Ceram covers a wide indication range.

Adequate preparation is the essential precondition for high-quality dental-technical fabrication of restorations.

Fig. 1a Initial clinical situation of a patient needing comprehensive restoration.

Fig. 1b Initial clinical situation of a female patient: Secondary caries at crown margin (tooth 46)

Fig. 2a Preparation of teeth 21 and 22: Shoulder preparation / distinctive chamfer with paragingival line

Fig. 2b Classic shoulder subgingival shoulder preparation with rounded inner angle at tooth 46.
Slip casting techniques

VITA In-Ceram Infiltration ceramics

The original VITA In-Ceram technique, the slip technique, has been used for more than 16 years. The individual dental steps of the slip casting technique include:

- **Fabrication of the framework**
  - Preparation of the model
  - Duplicating the model dies
  - Applying slip to the frameworks
  - Sinter firing
- **Glass infiltration**
- **Veneering**

Preparation of the sintering frameworks

Frameworks made from VITA In-Ceram consist of fine oxide ceramic particles connected with each other via sintered bridges. The arrangement of particles in these sintered bridges results in light scattering which provides them with a certain level of opacity depending on the thickness of the framework. These sintered bridges do not yet exhibit the high final strength of the glass infiltrated VITA In-Ceram material and allow convenient processing with rotary tools in the dry condition.

Fig. 1 Sawcut models of lower and upper jaw in the articulator. The die varnish ensures a sufficiently large cement gap. It is not applied in the area of shoulder or chamfers along the preparation margins.

Fig. 2 For the slip casting technique the varnish-coated master model dies are duplicated and fireproof duplicate dies are produced from the VITA In-Ceram special plaster.

Fig. 3 The VITA In-Ceram slip is applied to the fireproof duplicate dies using a brush. After the slip material has dried, the coping margins are scraped back precisely up to the preparation border using a sharp instrument. Atmospheric sinter firing on the duplicate dies is carried out in the VITA INCERAMAT. For VITA In-Ceram SPINELL and ZIRCONiA a second sinter firing process is subsequently carried out on firing pad.
Fig. 4a  After sinter firing the VITA In-Ceram copings are smoothed using rotary tools and finished to obtain a uniform wall thickness of 0.5 mm. Silicone grinding tools are perfectly suitable for this purpose.

Fig. 4b  A chamfer can be prepared with diamond burs in the area of the coping to reduce the marginal height of the framework to approx. 0.5 mm and to obtain more space for the aesthetic veneer.

Fig. 4c  Crown framework made from VITA In-Ceram ALUMINA for a tooth (46) on the master model.

Fig. 4d  For bridge frameworks adequate dimensions of the connectors must be ensured.
Glass infiltration of the VITA In-Ceram frameworks

During the glass infiltration process the pores between the sintered particles of the VITA In-Ceram framework are filled with a lanthanum glass. This way high mechanical final strength and aesthetic properties are added to the material. These properties include a tooth shade that can be selected and - in particular for VITA In-Ceram SPINELL - translucency.

Fig. 5a Mixing the infiltration glass to be selected according to the tooth shade with distilled water.

Fig. 5b The infiltration glass material is taken up with a brush.

Fig. 5c A uniform coat is applied to the outer surfaces of the framework. The inner surfaces must not be coated.

Fig. 5d An area of approx. 1 mm of the margin should not be coated to prevent liquid glass from flowing onto the inner surfaces. For glass infiltration firing the restorations are placed on platinum rods or on stands wrapped with aluminium foil (see figure).
Fig. 6a  Crown coping after infiltration firing. The infiltration glass penetrated the sintered framework entirely. Excess glass remains on the outer surface.

Fig. 6b  The crown frameworks can also be placed on platinum foil to perform infiltration firing. This is a mandatory requirement to ensure reliable glass infiltration of bridge frameworks because of the thicker pontics.

Fig. 7a & b  Coarse excess glass is removed with corundum tools or coarse-grained diamond wheels.

Fig. 7c  Then the surfaces are sandblasted with Al₂O₃ powder to remove any residual glass.
Fig. 7d The glass infiltrated VITA In-Ceram frameworks exhibit very high mechanical strength. Finally, at least one glass control firing process is carried out during which any excess glass on the surface can be removed after cooling as described above.

Fig. 8a During glass infiltration of bridge frameworks it must be ensured that the incisal edge or occlusal surface of the bridge unit is not coated to allow complete penetration of the liquid glass into the pores of the VITA In-Ceram framework. If complete infiltration is not achieved after first firing, additional glass material is applied and the infiltration process must be repeated.

Fig. 8b The infiltration level must be carefully checked in the area of the connectors. Lighter, chalk-like areas indicate that complete infiltration has not been achieved.

Fig. 8c Clinical try-in of the glass infiltrated frameworks.
Veneering the glass infiltrated VITA In-Ceram frameworks

Already in this condition frameworks made from VITA In-Ceram exhibit the basic optical properties of the natural tooth: basic shade and - especially for VITA In-Ceram SPINELL - translucency. They are turned into almost perfect copies of natural teeth by individual fusing (firing) highly aesthetic fine-structure veneering ceramics to the frameworks. For this purpose the veneering systems VITA VM 7 (VITA In-Ceram SPINELL, ALUMINA, ZIRCONIA and VITA In-Ceram AL) and VITA VM 9 for VITA In-Ceram YZ were developed. **Natural shade effect and enamel-like abrasion behavior** offered by both systems are clearly superior to those of the proven VITADUR Alpha porcelains*.

Fig. 9a - d  Veneering the VITA In-Ceram framework with fine-structure ceramic using the layering technique.

* replaced with VITA VM 7 since 2003 and no longer available
**VITA In-Ceram® – The fabrication - Infiltration ceramics**

Fig. 10a  Finishing with rotary diamond instruments

Fig. 10b  Individual correction by applying additional material

Fig. 10c  Characterization of the shade of the veneer

Fig. 10d  Completed VITA In-Ceram ALUMINA restoration: crown (tooth 46)

Fig. 10e  Completed crown (tooth 12) and bridge (11-22) made from VITA In-Ceram ALUMINA
Clinical integration

Thanks to their high final strength, VITA In-Ceram restorations can be cemented in the conventional way. Adhesive cementation is possible but not required in most cases (see page 56, chapter Cementing VITA In-Ceram restorations).

Fig. 11a Restorations made from VITA In-Ceram ALUMINA in situ: buccal view of crown on tooth 46

Fig. 11b Occlusal view of crown on tooth 46

Fig. 11c Labial view of anterior crowns and bridge (11-22)

Fig. 11d Occlusal view of posterior crowns

Fig. 11e Occlusal view of cuspid and premolar crowns
**VITA In-Ceram®** – The fabrication - Infiltration ceramics

---

**VITA In-Ceram sprint**

The VITA In-Ceram sprint technique allows the fabrication of individual posterior and anterior crowns made from VITA In-Ceram ALUMINA and VITA In-Ceram ZIRCONIA in a conventional vacuum furnace at reduced process times. Based on this technique, the fabrication of VITA In-Ceram ALUMINA and VITA In-Ceram ZIRCONIA frameworks takes only a third of the time required for the conventional slip technique.

In contrast to the classic slip technique, the duplicate dies are manufactured from VITA In-Ceram special plaster and the slip-coated crown copings are heated in the furnace at 130° and 160° for 20 min. before sinter firing. After cooling, the coping can be removed and sintered without the plaster die. This will reduce the time for sinter firing up to approx. 70%.

Glass infiltration and ceramic veneering are performed in the same way as in the conventional slip technique.

---

**WOL-CERAM**

The WOL-CERAM technique (TEAMZIEREIS GmbH) involves depositing the VITA In-Ceram slip directly onto the model die by electrophoresis methods (fig. 1). This way particularly dense and homogeneous layering of the ceramic particles is achieved. The stability of the copings is sufficient for processing them with rotary tools and sintering them without the model die. It is not necessary to produce duplicate dies.

Electrophoretic depositing involves high precision so that the frameworks exhibit high accuracy of fit (fig. 2). VITA In-Ceram ALUMINA and ZIRCONIA slip can be processed using the WOL-CERAM technique. The indications for restorations fabricated in the WOL-CERAM technique mainly include crown frameworks but also individual implant abutments and three-unit bridge frameworks.
CeHa White ECS

The CeHa White ECS system (C. Hafner GmbH & Co. KG) uses the method of electrophoretic depositing (EPD). Similar to the galvanoplating technique, electrophoresis involves the migration of charged particles in a liquid and a highly homogeneous, electrical field. Electrophoretic depositing includes two different partial processes:

1. The electrophoretic migration of charged particles in the electrical field, which are dispersed in a liquid and
2. the deposition of the particles on a membrane (membrane deposition).

When using the CeHa White ECS system, VITA In-Ceram ALUMINA and ZIRCONIA slip is deposited electrophoretically on a duplicate model. Compared to the manual application of the slip, very high density and homogeneity of the ALUMINA and ZIRCONIA particles is achieved. After electrophoretic depositing, the framework features high precision of fit and is sintered porously (shrinkage-free) and subsequently infiltrated with the special glass in accordance with the VITA In-Ceram technique.

The indications for the CeHa White ECS system are identical with those for crowns and bridges made from VITA In-Ceram ALUMINA and VITA In-Ceram ZIRCONIA.

Fig. 2 - 3 Sectional views of crowns with frameworks made from VITA In-Ceram ALUMINA using the CeHa White ECS system.
Milling techniques

Restorations made from VITA In-Ceram can be also be fabricated from industrially sintered VITA In-Ceram blocks using several different milling systems. Sintered blocks produced under technically optimized and standardized conditions exhibit high density and homogeneity of the sintered framework and the number of irregularities in the structure, microcracks and other sinter defects, which can hardly be avoided in the conventional manufacturing process of dental ceramics, can be reduced considerably. Therefore industrially prefabricated ceramics feature clearly higher material quality and superior mechanical properties.

Copy milling

CELAY

The CELAY copy milling system (Mikrona Technologie AG) (fig. 1) was the first milling system which used the advantages of industrially fabricated sintered blocks (VITA In-Ceram for CELAY) (fig. 3). In this technique the frameworks are milled with diamond grinding tools from the sintered blocks.

Crown copings or bridge frameworks are modeled (fig. 5) on the master model using light-curing resin (CELAY-TECH) (fig. 4) corresponding to the size of the respective VITA In-Ceram slip frameworks.
These “pre restorations” (fig. 6) are mounted in the copy milling system and, based on a manual scanning process, an exact copy (fig. 7 and 8) is milled in the milling chamber from a VITA In-Ceram for CELAY (scale 1:1).

Further processing is carried out analogously to the slip technique and involves finishing, glass infiltration and ceramic veneering (fig. 10). The glass infiltration process, however, is much shorter than in the slip technique since capillary forces are much stronger when the blocks are used.

VITA In-Ceram SPINELL, ALUMINA and ZIRCONIA blocks are available for the fabrication of single tooth crowns, individual implant abutments and bridge structures with the CELAY system.
Restorations from VITA In-Ceram (fig. 1 and 2) could already be produced with the CEREC 2 system (Sirona Dental Systems GmbH) which was introduced in 1994.

CEREC 3 (fig. 3) and inLab (fig. 4) cover the entire VITA In-Ceram indication range. All material variations, including the high-strength zirconium oxide VITA In-Ceram YZ, and the aluminium oxide VITA In-Ceram AL can be processed (fig. 5) (see chapter “The fabrication - sintering ceramics” (on page 36 and following).

The VITA In-Ceram frameworks are designed virtually on the computer (CAD) and then milled fully automatically from the VITA In-Ceram blocks (CAM) (fig. 6 and 7).

After taking an impression, intraoral photos of the prepared abutments or photos of the model can be taken and digitized. As an alternative to the CAD process, frameworks can also be waxed up on the master model. The special wax allows scanning the model in the inLab scanning/grinding device or in the inEos scanner.

This way very individual constructions and framework geometries can be produced from VITA In-Ceram all-ceramic materials, especially from zirconium oxide: VITA In-Ceram YZ for inLab (fig. 8).

The entire VITA In-Ceram range of materials can also be processed in the infiniDent processing center of Sirona. In this case dental technicians transmit the design data gathered in the inLab or inEos system to the processing center in Bensheim, which will then send back the milled or glass infiltrated or densely sintered VITA In-Ceram frameworks.
**DCS PRECIDENT**

VITA In-Ceram blocks and VITA In-Ceram ZIRCONIA blocks are available for the DCS PRECIDENT system (DCS Dental AG) which was introduced in 1989 and comprises a scanner and a milling unit (fig. 1). The indication range includes crown and three-unit bridge frameworks. Perfect processing of the block is ensured thanks to a recognition system for blanks.

Fig. 3 shows the DCS Dentform software displaying a section of a crowns and a scanned wax-up on the monitor.

---

**Digident®**

Another CAD/CAM system for processing VITA In-Ceram materials is the Digident system (Digident GmbH) (fig. 1). A stripe light scanner scans the preparations based on a master model and digitalizes them (fig. 2).

The CAD/CAM reconstructions (fig. 3) cover the indications of anterior and posterior crowns and three-unit bridges with VITA In-Ceram ALUMINA blocks and VITA In-Ceram ZIRCONIA blocks (fig. 4).
Special application

synOcta In-Ceram blank

The synOcta In-Ceram blank (fig. 1) for the fabrication of customized all-ceramic implant suprastructures for the synOcta implant system by Straumann (Waldenbuch, Switzerland).

Fig. 2 Distomesial reduction of the blank to place it on the analog.

The presintered VITA In-Ceram blanks can be easily processed with rotary tools to obtain the perfect shape required for the abutment and are glass infiltrated subsequently. The interface is already glass-infiltrated by the manufacturer to ensure its integrity.

Fig. 3 Completely ground suprastructure element in reduced tooth shape prior to infiltration and veneering

Fig. 4 Completed restoration in situ prior to closure of the screw channel
## Table: Systems and techniques for the fabrication of VITA In-Ceram restorations

<table>
<thead>
<tr>
<th>Manual slip technique</th>
<th>Electrophoresis</th>
<th>Milling and CAD/CAM techniques</th>
<th>DCS PRECEDENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>VITA In-Ceram</td>
<td>WOL-CERAM CeHa White ECS</td>
<td>CEREC/ inLab</td>
<td>Digident</td>
</tr>
<tr>
<td>SPINELL, ALUMINA, ZIRCONIA</td>
<td>ALUMINA, ZIRCONIA</td>
<td>SPINELL, ALUMINA, ZIRCONIA</td>
<td>ALUMINA, ZIRCONIA</td>
</tr>
</tbody>
</table>

### Model fabrication
- Sinter firing
- Optical impression
- Model scan

### Duplicating the models
- Not required
- Not required
- Optical impression
- Model scan

### Fabrication of the framework
- Applying the slip
- Electrophoresis
- Modelling
- CAD process or scan
- CAD process

### Glass infiltration
- Copy milling
- CAM milling
- CAM milling

### Ceramic veneering

---

1) Also possible in the VITA In-Ceram sprint technique
2) Additional systems for the use: etkon, Hint-Els Denta CAD, Cynovad Neo (Dentaurum)
VITA In-Ceram® sintering ceramics
VITA In-Ceram YZ for inLab

VITA In-Ceram YZ for inLab (fig. 1) are presintered zirconium oxide blocks partially stabilized with yttrium oxide. The presintered zirconium oxide can be perfectly processed with rotary tools and shaped to obtain a framework for all-ceramic crown and bridge structures. During subsequent sinter firing the framework shrinks to approximately 25% of its original size (fig. 2). When planning and preparing the ceramic models, sinter shrinkage must be accounted for. Accordingly, CAD/CAM technology is used for processing VITA In-Ceram YZ.

Prior to grinding (milling) the CAD/CAM system calculates the framework geometry of the VITA In-Ceram YZ blocks to ensure that the CAM framework to be milled exhibits the required enlarged size. The necessary information is included in a barcode printed on every YZ block and can be scanned by the system.

Currently, the inLab system by Sirona Dental Systems GmbH is the only approved CAD/CAM system for processing VITA In-Ceram YZ.

The guidelines for the fabrication of frameworks from the YZ blocks in the inLab system are based on those for VITA In-Ceram ZIRCONIA. Two methods can be employed:

• Waxing up the framework on the master model and subsequent scanning and digitalizing the framework model (see page 36-37, fig. 3-5).

• CAD construction of the framework after optical impression or scanning for digitalizing the master model die (see fig. 5).

The attachment-supported bridge in this example (see page 35, fig.4 to page 38, fig. 14) describes an experimental indication.

Fig. 5 Scanning the models allows to fabricate individual constructions and framework geometries. Their purely CAD-based creation could only be done using complex software.
Fig. 6 Completely milled crown with attached patrix made from VITA In-Ceram YZ for inLab.

Fig. 7 If required, the milled frameworks made from VITA In-Ceram can be colored (entirely or partly) using COLORING liquid prior to sinter firing. The COLORING LIQUID is available in the five lightness levels (LL1 - LL5) of VITA SYSTEM 3D-MASTER.

Fig. 8 After sinter firing in the VITA ZYrcomat or Thermo-Star high-temperature furnaces at 1530° C the VITA In-Ceram YZ frameworks exhibit tooth-shaped translucent properties and very high strength of > 900 MPa.

Fig. 9 Checking the fit of the frameworks on the master model.

Fig. 10 Only minor contour corrections should be made and must be performed with fine-grain diamond tools whilst cooling with water.
Fig. 11 - 13 The frameworks made from VITA In-Ceram YZ for inLab are veneered with VITA VM 9 - the veneering material of the VITA VM system which was developed especially for zirconium oxide frameworks in the CTE range of approx. 10.5.

Fig. 14 Restorations made from VITA In-Ceram YZ blocks are suitable for conventional and for adhesive cementation as well (bridges 14-17, 45-48).
**VITA In-Ceram AL for inLab**

VITA In-Ceram AL for inLab are presintered blocks consisting of pure aluminium oxide. They are milled with the inLab system and dense sintered just like VITA In-Ceram YZ for inLab in the VITA ZYrcomat or Thermo-Star high-temperature furnaces. The resulting polycrystalline Al₂O₃ framework is somewhat more translucent than VITA In-Ceram YZ and its color is more similar to natural dentine.

Just like VITA In-Ceram infiltration ceramics, the frameworks made from VITA In-Ceram AL are veneered with VITA VM 7 in accordance with the CTE value of aluminium oxide.

Frameworks made from VITA In-Ceram AL are suitable for conventional cementation. If required, adhesive cementing is also possible.

**Fig. 15** Teeth prepared for restorations made from VITA In-Ceram AL and YZ.

**Fig. 16** Situation on the model. The anteriors were restored with frameworks made from VITA In-Ceram AL, teeth 14-17 with frameworks made from VITA In-Ceram YZ. Teeth 23-27 with non-precious metal framework on implant healing caps for subsequent integration of a long-term restoration.

Fig. 15 and 16: Kimmel Zahntechnik GmbH, Koblenz
Indications for the VITA In-Ceram system

Restorations made from VITA In-Ceram account for the majority of standard prosthetic indications for crowns and bridges. Preconditions for their long-term clinical success are

- putting the preparation guidelines into practice and adhering to them and
- selecting the suitable materials of the VITA In-Ceram system in accordance with the aesthetic and functional requirements.

In situations considered to be difficult from the prosthetic point of view, e.g. insufficient space in patients with short clinical crowns or high functional stress in bruxists, the indication must be considered very carefully, especially for all-ceramic bridges.

VITA In-Ceram ALUMINA

Fig. 1 - 2 Crowns made from VITA In-Ceram ALUMINA can be successfully integrated in all jaw regions, in particular also in the region of anterior teeth. Precondition for successful integration is the adequate size of the abutment teeth.

Fig. 3 Crowns made from VITA In-Ceram ALUMINA can also be used for implant prosthetics as shown in this example of a customized implant suprastructure (CeraOne, Branemark system) for a single tooth gap, regio 24

Fig. 4 Three-unit abutment bridges in the anterior area are the indication for bridges made from VITA In-Ceram ALUMINA.
VITA In-Ceram® – Indications for the VITA In-Ceram system

VITA In-Ceram SPINELL

Fig. 5 - 6 Thanks to the translucency of the SPINELL material crowns made from VITA In-Ceram SPINELL are particularly suitable for aesthetically demanding anterior restorations. The level of discoloration of the abutment tooth or the dentine must be taken into consideration. For opaque abutments or abutments exhibiting dark discoloration or restored with metal post systems, VITA In-Ceram ALUMINA is more suitable. Crowns made from VITA In-Ceram SPINELL can also be placed on molars or premolars* of patients without functional anomalies. In the molar area, however, the stronger frameworks made from VITA In-Ceram ALUMINA, VITA In-Ceram ZIRCONIA or VITA In-Ceram YZ resp. AL for inLab should be preferred.

VITA In-Ceram ZIRCONIA

Fig. 7 Crowns made from VITA In-Ceram ZIRCONIA can be integrated in all jaw regions (including anterior teeth) despite the less favorable aesthetic properties of the ceramic compared to ALUMINA and SPINELL. VITA In-Ceram ZIRCONIA is the In-Ceram material variation with the highest opacity and can therefore be used preferably in clinical situations in which high masking capacity (so-called masking power) for coating severely discolored abutments is required.

Fig. 8 - 10 Thanks to the increased strength of VITA In-Ceram ZIRCONIA this material is suited for three-unit bridges in the anterior and molar region. However, little experience has been gathered on this subject so far. It is not recommended to use VITA In-Ceram ZIRCONIA for the fabrication of bridges with more than three units.

* Bindl & Mörmann 2002 report about the success of crowns made from VITA In-Ceram SPINELL on molars (see table on page 66).
**VITA In-Ceram® – Indications for the VITA In-Ceram system**

**VITA In-Ceram YZ for inLab**

Fig. 11 There are no indication limitations for restorations of teeth with crowns made from the high-strength zirconium oxide VITA In-Ceram YZ as long as the preparation guidelines are adhered to.

Fig. 12 - 13 Thanks to the high strength and excellent aesthetic properties VITA In-Ceram YZ blocks represent an ideal ceramic material for anterior and posterior metal-free bridges. Since currently some promising results but only a limited number of long-term studies with zirconium oxide bridges are available, there is still some uncertainty concerning the indication for bridges including more than 2 connected bridge units.

**VITA In-Ceram AL for inLab**

VITA In-Ceram AL blocks are available in sizes of 20 and 40 mm. They are used to fabricate single tooth crowns in the anterior and posterior area and three-unit bridges. VITA In-Ceram AL can also be used for primary crowns in the telescopic technique.

Fig. 14 Model with anterior crowns made from VITA In-Ceram AL for inLab, veneered with VITA VM 7. Teeth 34-37 were restored with VITA In-Ceram YZ for inLab and veneered with VITA VM 9. Composite veneered temporary bridge (45 - 47) on implant healing caps.

Fig. 15 Situation in situ

Fig. 14 und 15: Kimmel Zahntechnik GmbH, Koblenz
Indications for VITA In-Ceram with experimental character - perspectives

For quite some time the use of restorations made from VITA In-Ceram has also covered numerous additional indications. This is reasonable from the clinical-scientific point of view and also necessary for the further development of therapeutic possibilities of dentistry. Part of the indications which are still subject to clinical testing and therapeutic studies is described in the following examples. Reliable predictions on permanent success of such reconstructions, however, can not be made yet.

Fig. 16 - 17 This four-unit bridge made from VITA In-Ceram ZIRCONIA on teeth 23 and 26 was integrated two years ago. From today’s point of view the clearly stronger VITA In-Ceram YZ should be preferred for such indications (fig. 15 shows the bridge of fig. 13 in situ).

Fig. 18 - 19 Three-unit cantilever bridge made from VITA In-Ceram ZIRCONIA (see page 69, chapter Clinical experience); cantilever bridges represent an exceptional indication with highly experimental character. This applies also to cantilever bridges made from VITA In-Ceram YZ (example shown: four-unit bridge). Such reconstructions can not yet be recommended for the dental practice.

Fig. 20 Separated bridges shown in this figure and bridges with reduced anchor elements represent the furthest step towards the potential future of all-ceramic restorations: inlay / partial crown bridges, adhesive bridges. Currently, they are only fabricated in clinical and experimental studies. A question which still needs to be answered in practice is to what extent ceramics - also pure zirconium oxide - are able to fulfill the extreme mechanical requirements made on such constructions under the conditions in the oral cavity.
When looking at the development of the two last decades which brought continuous further development of all-ceramic restoration techniques and the VITA In-Ceram system, additional indications for VITA In-Ceram and all-ceramic reconstructions can be assumed.

### Table: Use of material variations for the standard indications of the VITA In-Ceram system for conventional cementing (single crowns, fixed partial dentures)*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VITA In-Ceram</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPINELL</td>
<td>+++</td>
<td>+</td>
<td>o</td>
<td>-</td>
</tr>
<tr>
<td>ALUMINA</td>
<td>+++</td>
<td>+++</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>ZIRCONIA</td>
<td>+</td>
<td>+++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>VITA In-Ceram</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPINELL</td>
<td>+++</td>
<td>++</td>
<td>+1)</td>
<td>-</td>
</tr>
<tr>
<td>ALUMINA</td>
<td>+++</td>
<td>+++</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>ZIRCONIA</td>
<td>+</td>
<td>+++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>VITA In-Ceram</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AL</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>YZ</td>
<td>+++</td>
<td>+++</td>
<td>++</td>
<td>+++</td>
</tr>
</tbody>
</table>

**Incisals** | **Canine teeth (cuspids)** | **Molars** | **Premolars**
+++ preferable indication | ++ recommended indication | + possible indication | o not recommended | - no indication

*) Cantilever bridges (3-4-unit) with an attached unit [width of a premolar] are sometimes fabricated; experience, however, is too limited for clinical recommendation/evaluation. All in all, there is only little experience with bridges including more than three units.

1) if adhesive cementation is possible
2) up to a framework span width of approx. 28 mm (CELAY, inLab, Digident)
3) up to a framework span width of approx. 33 mm (CELAY, inLab) or 40 mm (Digident)
4) up to a framework span width of approx. 33 mm (inLab)
5) up to a framework span width of approx. 40 mm - corresponds to a length of the blank (YZ) of 55 mm (inLab)
Clinical tooth preparation

Fundamentals

Clinical preparation for prosthetic treatment with restorations made from VITA In-Ceram is based on the main principle of dental tooth preparation:

As much as necessary - as little as possible

Each preparation should offer

- a form of retention and stability for the restoration and
- a form of resistance for the abutment tooth

but also ensure

- sufficient space for functional design and structural durability of the restoration
- whilst ensuring removal of substance in accordance with proper axial alignment and the anatomical tooth shape and
- reveal a clearly defined preparation margin.

The axial preparation angle should be 5 to 10°. Owing to the sensitivity of the ceramic to any tensile forces friction on the prepared abutment is renounced for all-ceramic crowns (in the non-cemented condition).
Additionally, adequate cooling during the preparation must be ensured. The nozzles of the hand piece / turbine should spray at least 50 ml water per minute onto the rotary instrument. In case of para- and subgingival preparation the marginal periodontium should be "displaced" using a retraction cord to protect it against any damage caused by contact with rotary instruments. Even minor damage entails the risk of gingival recession due to tissue contraction during healing and thus the risk of exposure of the preparation margin.

Fig. 1a Preparing always requires adequate cooling with water. Cooling is only efficient if the cooling water reaches the abrasive tool from all sides.

Fig. 1b By placing a retraction cord, the gingival margin can be protected against damage caused by the grinding instrument.

Suitable preparation instruments are tools with parallel walls (or slightly conical) with coarse (grain size: approx. 80 to 120 μm) and fine (grain size: 50 μm) diamond coating.

Fig. 2a Rotary instruments recommended for crown preparations; from left to right: coarse diamond-coated torpedo for coarse preparation, fine round head cylinder for chamfer preparations or flat heat cylinder with rounded edges to prepare a 90° shoulder; coarse diamond-coated bud for palatal or occlusal preparation using a corresponding finisher.

Fig. 2b Additional abrasive tools which are frequently very useful for preparatory work or the preparation; from left to right: separation diamond, finishing instruments, ball-headed diamond preparation instruments, tungsten carbide instrument for cutting metal restorations or frameworks to be removed.
Preparation depths

For the required preparation depth the minimum wall thickness of 0.5 mm for the ceramic substructure (coping) made from VITA In-Ceram must be adhered to in order to avoid the risk of fracture when exposing the restoration to masticatory load.

Depending on the functional situation, aesthetic requirements and location of the clinical tooth crown, additional space of 0.5 to 1.0 mm must be created for veneering with feldspar ceramic. Accordingly, an axial preparation depth of 1 to 1.5 mm (removal of tooth substance) is obtained. In the occlusal or incisal area substance equal to 1.5 to 2 mm must be removed. These preparation depths are very similar to those required for metal ceramic restorations.

Fig. 3 Checking the preparation depth for the preparation of a central upper incisor for a VITA In-Ceram YZ bridge with a silicone key and a PA probe. In the labial area slightly more space should be created (previously 1.0 mm) during finishing. It is not necessarily required to achieve a preparation depth of 1.5 mm due to the natural dentine color and translucency of the VITA In-Ceram YZ framework. An incisal preparation depth of approx. 2 mm is already sufficient.

Any necessary reduction of the recommended cutting depths must not affect the thickness of the framework (coping) wall. The VITA In-Ceram framework, however, must not be exposed. It should be at least coated with a layer of glaze material1.

1) This requirement applies only to frameworks made from VITA In-Ceram SPINELL, ALUMINA and ZIRCONIA.
Preparation types

The classic preparation type for restorations made from VITA In-Ceram is still based on the traditional recommendation for all-ceramic crowns (Conod 1937, originally intended for crowns made from sinter ceramic):

Preparation of a para- to slightly subgingivally placed circular shoulder with a depth of approx. 1 mm and an angle of approx. 90° towards the longitudinal tooth axis with a rounded inner angle of the shoulder.

This way reliable support of the crowns at axial load is ensured so that shear stress can be avoided and masticatory forces mainly create compressive stress which all ceramics are capable to withstand. For materials of lower strength the circular shoulder is recommended.

Fig. 4 Schematic diagram of the classic preparation type with a circular shoulder of a depth of 1 mm, which is also recommended for VITA In-Ceram crowns. The flat-head cylinder with round edges is the suitable preparation instrument.

Fig. 5 Clinical example of subgingival circular shoulder preparation of tooth 46. An axial preparation angle of 6 to 10° guarantees good bonding of the cemented restoration to the abutment tooth. Suitable preparation instruments are flat-head cylinders with rounded edges (top left) or corresponding instruments with a slightly conical working section (top right).

Fig. 6 Occlusal view of the prepared shoulder with a depth of 1 mm at tooth 46. This view illustrates how invasive this classic preparation type is for the tooth.

Fig. 7 Circular shoulder preparation with a depth of approx. 1 mm is not unproblematic since it involves high requirements on the preparation technique and hardly allows any errors. Especially smaller teeth are weakened considerably (often the vitality of the tooth pulp is compromised). Moreover the sharp inner angle of the shoulder is an area of higher fracture risk.
Chamfer preparations, in particular pronounced chamfers, also provide good mechanical support. However, they also reduce the disadvantages of the classic shoulder preparation: the preparation depth in the critical area of the inner angle of the shoulder is reduced when preparing a shoulder; rounding avoids the formation of an additional point of fracture.

Fig. 8 At the same preparation depth, pronounced chamfer design of the preparation reduces critical preparation in the cervical area compared to the classic shoulder.

Fig. 9 Chamfer preparations of 25 and 26 to receive crowns made from VITA In-Ceram ALUMINA blocks. Particularly suitable are round-head cylinders or corresponding diamond abrasive tools with a slightly conical shank.

Fig. 10 Pronounced chamfer prepared for a bridge made from VITA In-Ceram ZIRCONIA (13 to 11). When using this material, sufficient thickness of the veneering material in the area of the margin of the restoration needs to be achieved since the framework is opaque and less aesthetically appealing than other material variations of VITA In-Ceram infiltration ceramics.

From today’s point of view these pronounced preparation types can be modified in certain situations. Under favorable aesthetic conditions (especially in cases in which an almost natural dentine color is maintained) and, above all, when using translucent framework materials (VITA In-Ceram SPINELL, VITA In-Ceram AL or YZ), the veneering material can be layered somewhat more thinly so that lower axial preparation depth is required. Conservative chamfer preparation may be sufficient also because of the high strength of zirconium oxide (VITA In-Ceram YZ) [see page 47, fig. 3].

Fig. 11 Comparison of removal of substance between pronounced (dotted line) and conservative / flat chamfer preparation. A flat chamfer reduces the entire axial preparation work.
Fig. 12 Clinical example of flat chamfer preparation of teeth 11 and 21 to receive crowns made from VITA In-Ceram ALUMINA with the WOL-CERAM procedure.

Fig. 13 Preparation of moderate or flat chamfers of teeth 23 and 25. The teeth were restored with a bridge made from VITA In-Ceram YZ for inLab and a cantilever element (tooth 26) (see page 51-53, fig. 16-31; page 43, fig. 19; page 10, fig. 5 and page 63, fig. 20-22)

Fig. 14 In special cases the layer of the veneer can be reduced to a thin layer of glaze material to avoid exposure of the VITA In-Ceram infiltration ceramics framework. This method, however, should be limited to cases and surfaces (palatal as shown in the figure) for which aesthetic appearance plays a minor role.

Fig. 15 Schematic overlap of the preparation types described to compare the resulting preparation depths (the length of a yellow-black line is 1 mm).
Clinical case

Fig. 16 Buccal view of the initial situation prior to preparation of 23 and 25 to be restored with a cantilever bridge made from VITA In-Ceram YZ for inLab with a cantilever element (tooth 26).

Fig. 17 View of the planned abutment teeth from the occlusal direction.

Fig. 18 Separation of approximal surface of the adjacent tooth using a separation diamond.

Fig. 19 Preparation of orientation grooves to mark the direction of the tooth axis and the required minimum preparation depth with a coarse diamond-coated torpedo (Ø 1mm, approx. 3/4 lowered in the area of the buccal equator). The adjacent teeth provide additional orientation.

Fig. 20 Illustration of the gingival and incisal/occlusal preparation axes in their relation to the tooth axis.
Fig. 21 Axial preparation of teeth 25 and 23 using the coarse diamond-coated torpedo under consideration of the tooth axes and the common path of insertion.

Fig. 22 The tip of the torpedo always remains in the supra- or paramarginal area in order not to damage the marginal periodontium which is additionally displaced with a retraction cord.

Fig. 23 Preparation of tooth 23 in the incisal third: following the previous surface contour the preparation axis is clearly more angled to the tooth axis.

Fig. 24 Marking the required reduction in the area of the incisal edge of tooth 23.

Fig. 25 Removal of substance from the palatal surface of tooth 23 with a shape-congruent abrasive instrument (coarse diamond-coated bud). It is also suitable for the preparation of occlusal surfaces.

Fig. 26 Initial preparation of the occlusal surface of tooth 25 with the torpedo. The preparation depends on the cuspal inclination and the fissure relief; however, there is a tendency towards leveling the structures and flattening the original cusp inclination.

Fig. 27 Initial preparation is completed by grinding the outer occlusal surfaces, in this example the palatal cusp edge of 25.
Fig. 28 Condition of the initially prepared teeth 23 and 25.

Fig. 29 Finishing the preparation serves to smoothen the prepared surfaces and to achieve the desired preparation depth and for final contouring and positioning of the preparation margin. In this example: paragingival and - after removing the cord - slightly subgingival circular chamfer resulting from the geometry of the round head cylinder.

Fig. 30 Completion of preparation of 23 and 25 from the buccal direction: paragingival to slightly subgingival chamfer preparations.

Fig. 31 View of preparations of 23 and 25 from the palatal direction.
Avoiding unsuitable preparations

Clinical preparations must always be based on the oral conditions of the patient.

Some preparation types or typical preparation errors, however, should be avoided or corrected:

**Fig. 32 45° shoulder:** this preparation type is unsuitable due to low resistance of ceramics to tensile stress since it does not sufficiently counteract shear forces caused by axial load.

*Avoidance:* do not use correspondingly shaped preparation instruments.

*Correction:* reparation with a diamond finisher along the preparation margin to prepare a shoulder (flat head cylinder) or chamfer (round head cylinder).

**Fig. 33 „Gutters“:** they are mostly formed during the preparation with a round head cylinder which reveals a diameter that is too small in relation to the cervical preparation depth.

*Avoidance:* select a preparation diamond with an adequate diameter; ideally: diameter = 2 x preparation depth, Cervical.

*Attention:* damage to gingiva -> retraction cords and grinding the adjacent tooth.

*Correction:* lowering and leveling the outer edge using a flat head finishing instrument.

**Fig. 34 „Tangential preparation“:** it is the result of low preparation depths, pointed preparation instruments or is obtained if the head of the instrument does not have contact with the preparation area. Just like for the reasons mentioned for 45° shoulder it is unsuitable for ceramic restorations (see above). Additionally, thin ceramic margins entail a high risk of fracture.

*Avoidance:* select the suitable geometry of the preparation instrument. Adherence to the correct minimum preparation depth and the preparation axes is essential.

*Correction:* reparation using a round head cylinder and ensuring the correct preparation angle until the required preparation depth is achieved.
**Fig. 35 Bevels**: bevels result from grinding preparation edges at an angle of less than 90° and more than 45°. Since - morphologically - they correspond to tangential preparation, they also entail increased risk of fracture of the preparation margins.

*Avoidance*: do not create a bevel.

*Correction*: moving the preparation margin to the border of the bevel or (accidental) bevel-shaped ground area.
Cementing VITA In-Ceram restorations

Conventional cementing

Thanks to their high strength all restorations made from VITA In-Ceram are suitable for conventional cementing. The general rules and preconditions for cementing fixed restorations apply:

- no incompatibility with the cementing material
- high accuracy
- clearly defined fit
- preparation according to the principle of retention and stability
- relative drying

Recommended luting cements


- Glass ionomer cements (e.g. Ketac-Cem, 3M ESPE Dental AG) (Sorensen et al. 2002)

Hybrid ionomer cements (e.g. Protec Cem, Ivoclar Vivadent AG) or compomer cements are used (Jokstad 2004, McLaren & White 2000, Segal 2001). However, laboratory results are available which indicate that these cements may swell in the mouth (Leevaloj et al. 1998, Sindel et al. 1999). The clinical relevance, however, still needs to be clarified (Jokstad 2004). More data are required for reliable clinical assessment.

The authors have preferred zinc oxide phosphate cement (Harvard) for cementing crowns and bridges made from VITA In-Ceram - for anteriors they also used glass ionomer cement - since it has proved its clinical reliability as a luting material over numerous years for VITA In-Ceram as well (Groten et al. 2002, Jokstad 2004, Olsson et al. 2003, Sadoun 1996, Vult van Steyen et al. 2001). Its high opacity, however, may be a disadvantage.
Other cementation materials (McLaren & White) should be selected for crowns made from VITA In-Ceram SPINELL since they feature translucent properties or are available as translucent material variations (see table on page 58).

**Adhesive luting**

The number of supporters of adhesive luting is increasing steadily (Burke et al. 2002). This must be mainly attributed to the positive experience gained with luting of ceramic inlays and veneers but also to reports on reduced failure rates of single tooth crowns made from feldspar ceramics when adhesive cementing with composite material was performed instead of conventional cementing (Malament & Socransky 2001).

According to the results of laboratory studies the main reason is the positive bond between the restoration and the prepared tooth which results in considerably enhanced fracture toughness of the ceramic (Burke et al. 2002, Groten & Pröbster 1997). The precondition to achieve this effect in the clinical use is firm adhesion of the luting composite to the ceramic and the tooth (enamel or dentine).

While sufficient bonding to enamel and dentine can obviously be ensured with modern adhesive luting systems, bonding to high-strength ceramic materials (oxide ceramics) is more complex and problematic since, unlike feldspar / glass ceramics, they can not simply be etched with hydrofluoric acid (HF-gels). The microretentive surface structure must be achieved using a different method (e.g. by sandblasting). But apparently successful roughening of the surface with or without silanizing depends on the respective structural ceramic material. From the clinical point of view, however, control of subgingival preparation margins and the presence of different substrate materials (sclerosed or carious dentine and various build-up materials) is a significant problem so that some restorations can not be luted. Moreover drying and removal of excess material are much more difficult.

The respective suitable luting method can be taken from the table on the next page:
VITA In-Ceram® – VITA All-Ceramics

VITA In-Ceram®
– Cementing VITA In-Ceram® restorations

Note:
In case of insufficient retention adhesive cementing is recommended:

Frameworks made from VITA In-Ceram ALUMINA and VITA In-Ceram AL for inLab (Isidor et al. 1995, Kern & Strub 1998, Blatz et al. 2003 & 2004):

- Silicatization (e.g. Rocatec, 3M ESPE Dental AG), silanization (e.g. ESPE-Sil, 3M ESPE Dental AG), self- or dual-curing Bis-GMA composite (e.g. Variolink II, Ivoclar Vivadent AG).
- Sandblasting, phosphate monomer-containing composite (e.g. PANAVIA F2.0, Kuraray Europe GmbH, RelyX Unicem, 3M ESPE Dental AG).

Since VITA In-Ceram SPINELL and ZIRCONIA are variations of the pure VITA In-Ceram ALUMINA material, the same recommendations apply to these two materials.


- Only the inner surfaces are sandblasted (to avoid the risk of phase transformation), use phosphate monomer-containing composite (e.g. PANAVIA F2.0, Kuraray Europe GmbH; RelyX Unicem, 3M ESPE Dental AG) (with metal-zirconium primers).

<table>
<thead>
<tr>
<th>Material variations</th>
<th>ZnO-phosphate cements</th>
<th>Glass ionomer cements</th>
<th>Hybrid ionomer / compomer cements</th>
<th>Bis-GMA-composite systems*</th>
<th>Phosphate monomer-containing composite systems*</th>
</tr>
</thead>
<tbody>
<tr>
<td>VITA In-Ceram ALUMINA</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+(++)</td>
<td>(++ )</td>
</tr>
<tr>
<td>ZIRCONIA</td>
<td>+++</td>
<td>++</td>
<td>+</td>
<td>+(++)</td>
<td>(++ )</td>
</tr>
<tr>
<td>AL</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+(++)</td>
<td>(++ )</td>
</tr>
<tr>
<td>YZ</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+(++)</td>
<td>(++ )</td>
</tr>
</tbody>
</table>

+++ preferable indication
++ recommended indication
+ possible indication
* so far only documented by laboratory tests. No data are available on clinical long-term reliability.
The question when to use conventional cementing and when to use adhesive cementing can be answered in the following way:

**Conventional cementing if possible - adhesive cementing if necessary**

Please note:

- Opaque cements are suitable for translucent frameworks (VITA In-Ceram SPINELL, ALUMINA and VITA In-Ceram YZ and AL) only to a limited degree since they reduce the aesthetic benefits of translucency.

- On the other hand, even opaque cements do not provide sufficient capability to cover unaesthetic discoloration or dark metal shades (Schmid 2003).
Clinical procedure

Convenient, conventional cementing is possible for all restorations made from VITA In-Ceram.

Fig. 1 After cleaning and degreasing the inner surfaces of the crown (alcohol), the conventional cement is applied into the crown (in this example: Ketac-Cem, ESPE DENTAL AG). The prepared tooth is also cleaned and disinfected under relative drying.

Fig. 2 The Ketac Cem glass ionomer cement can be mixed and easily applied thanks to a capsule system (Applicap, 3M ESPE Dental AG).

Fig. 3 The reliable alternative: zinc oxide phosphate cements (e.g. Richter & Hoffmann Harvard Dental GmbH).

Fig. 4 The cement is spread across the entire surface up to the margin of the restoration and a suitable instrument (brush or Heidemann spatula) is used to obtain uniform layer thickness. Excessive application should be avoided.

Fig. 5 Initially, the restoration is positioned slowly by pressing it down with the finger and lowered to the final position in a way to ensure that excess cement can flow off easily. Then the patient is made to bite carefully; afterwards the masticatory pressure is gradually increased to slowly “displace” the remaining excess cement under the increasing masticatory pressure. During this process, the patient may bite on a cotton roll (attention: it must be ensured that the restoration is not moved away from the final position and accurate fit is retained!).

Fig. 6 After hardening completely, all excess cement can be easily removed with a probe or a scaler. This requires thorough probing of the restoration margins and the sulcus to remove the residual cement and takes considerable time - a fact, which is frequently underestimated.

Fig. 7 Complete removal of all residual cement along the sulcus and control of the static and dynamic occlusion result in perfect periodontal and functional integration of the crown made from VITA In-Ceram.
The use of translucent and tooth-colored cements may provide advantages for anteriors or demanding aesthetic situations - e.g. like in this example of paragingival preparation margins:

Fig. 8 Disinfecting and degreasing the cleaned preparations with alcohol.

Fig. 9 If required, deposits or residual temporary cement can be removed with pumice powder or cleaning paste and a rubber cup in a gentle and reliable manner.

Fig. 10 After this preparatory work the dentine surfaces are dried by gently spraying them with air. Relative drying is considered to be sufficient.

Fig. 11 The hybrid cementation material (in this case the adhesive cement RelyX Unicem, 3M ESPE Dental AG) is filled into the degreased and cleaned crowns and spread whilst avoiding excess application. Additional conditioning of the inner surfaces of the crown is not required unless positive adhesive bonding is to be achieved.

Fig. 12 Crowns are lowered whilst slowly increasing the pressure exerted with a finger to "displace" all excess material until the final position is reached. Due to extraaxial stress which results when the patient bites there is a particularly high risk for anterior crowns to become wedged in an incorrect position.
Fig. 13 If the restorations are positioned accurately, the cement margins are polymerized for approx. 3 seconds.

Fig. 14 This level of polymerization allows easy removal of excess material such as residual conventional cement since final hardness and adhesion to the tooth surface have not been achieved yet. The risk of dislocating the crowns no longer exists.

Fig. 15 After removing all excess material polymerization can be completed by curing each side for approx. 20 seconds. The material, however, also hardens automatically (autopolymerizing) within approx. 3 to 4 minutes and is therefore also suitable for opaque frameworks made from VITA In-Ceram.

Fig. 16 Condition of the crowns 11, 21 made from VITA In-Ceram ALUMINA after definitive cementation with RelyX Unicem.

Fig. 17 Adhesive cementation of a bridge (45 - 47) made from VITA In-Ceram ZIRCONIA for CELAY with PANAVIA F due to limited retention to the distal abutment.
Fig. 18 The adhesive resin cement PANAVIA F (Kuraray Europe GmbH) is white-opaque. No aesthetic disadvantages need to be expected in the area where the material is applied and for the opaque framework made from VITA In-Ceram ZIRCONIA. Excess material can be easily recognized and should be removed as far as possible before polymerization is completed.

Fig. 19 Chairside adhesive conditioning of the inner surfaces of the anchors of the crown can be performed with the CoJet system (3M ESPE Dental AG). Alternatively, sandblasting is also possible if PANAVIA F is used.

Fig. 20 Translucent, tooth colored luting materials/cements provide superior comfort in aesthetically sensitive areas. In these situations of paragingival preparations for a bridge made from VITA In-Ceram YZ for inLab (23 - 25) with a cantilever element (26) reliable retention and coverage of the cement joint in the transitional zone of restoration - tooth neck are required.

Fig. 21 Adhesive cementation under relative drying using the translucent variation of RelyX Unicem. All excess cement had been removed before polymerization was completed.

Fig. 22 Aesthetic integration: paragingival transitional zone of the restoration to the natural tooth is almost invisible thanks to the framework made from VITA In-Ceram YZ for inLab and the veneer. The combination of their optical properties creates a result which is almost identical to natural enamel. This effect, however, must not be impaired by the properties of the cement to achieve a perfect aesthetic result.
Clinical experience with VITA In-Ceram® restorations

The table (see page 66) provides a survey on the data on the clinical behavior of VITA In-Ceram® restorations available in literature. The following aspects need to be considered for the interpretation of the data listed in the table:

There is no standardized method based on which clinical long-term studies are generally performed. Additionally, each author places different emphasis on acquisition and evaluation of patient data. As a result all reports of studies differ from each other and no direct comparisons can be made. Yet data must be handled in a way to obtain useful and pragmatic results for the clinical practice since different (or “better” - whatever that means) data are not available.

In our approach the following aspects provided in literature were considered to be factors which contribute essentially to the success of restorations made from VITA In-Ceram:

- Material variation (VITA In-Ceram SPINELL / ALUMINA / ZIRCONIA) and preparation type (shoulder / chamfer).
- Restoration type (crowns / bridges).
- Restored teeth according to occlusal-functional jaw regions (anteriors / premolars / molars).

Additionally, the sample sizes were determined, which is not simple since the information provided is not always complete and sometimes contradictory.

- Number of patients who received VITA In-Ceram® restorations under “observation” (in the broadest sense). The relation of the total number of patients with restorations to patients under “observation” could frequently not be determined.
In the result data on the failure, i.e. failure of a restoration made from VITA In-Ceram, resulting in removal or remake were included:

- Number of restorations / percentage of the total number given.

- Type of failure (fracture / loss of retention / pain after cementation / loss of abutment / secondary caries / necessary endodontic treatment / other reasons)

- Indication of a (mostly cumulative) survival rate in percent which was frequently not included by the authors and had to be estimated as precisely as possible based on failure information published.

Accordingly, the table includes interpretations if the authors did not provide any specific/direct information. These interpretations result in considerable simplification so that a certain degree of arbitrariness could not be avoided. It was attempted to meet the requirements for the dental practice rather than those of science.

At best, any data which extend beyond a clinical follow-up period of 5 years have limited significance. Mostly, follow-up periods of 3-6 years were found in literature. The studies mainly deal with crowns and bridges made from VITA In-Ceram ALUMINA in the classic slip casting technique.

Few data are available on VITA In-Ceram restorations produced from industrially prefabricated VITA In-Ceram blocks (Bindl & Mörmann 2002, for CEREC; Groten et al. 2002, for CELAY). Based on enhanced material properties and characteristic values of industrially prefabricated ceramics, however, it must be assumed that the clinical properties of these restorations can be compared to those of restorations fabricated using the slip casting technique.
### Table: Survey of literature: Clinical data on VITA In-Ceram Classic restorations

<table>
<thead>
<tr>
<th>Author</th>
<th>Material (prep.)</th>
<th>Type</th>
<th>Construction</th>
<th>Follow-up period</th>
<th>Region</th>
<th>Number of rest.</th>
<th>Failure Reason</th>
<th>cum. survival rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hüls 1995</td>
<td>Alu (S)</td>
<td>Crowns</td>
<td>3y (0-6J)</td>
<td>82</td>
<td>A (P)</td>
<td>335</td>
<td>5, C, F, I, E, R</td>
<td>97.3%</td>
</tr>
<tr>
<td>Scotti &amp; Catapano 1995</td>
<td>Alu</td>
<td>Crowns</td>
<td>3y</td>
<td>45</td>
<td>A, P, M</td>
<td>63</td>
<td>1, F</td>
<td>98.4%</td>
</tr>
<tr>
<td>Pröbster 1996</td>
<td>Alu (S)</td>
<td>Crowns</td>
<td>2.5y</td>
<td>18</td>
<td>A</td>
<td>28</td>
<td>0, -</td>
<td>100%</td>
</tr>
<tr>
<td>Pröbster 1997b</td>
<td>Alu (S)</td>
<td>Crowns</td>
<td>3.3y</td>
<td>28</td>
<td>A</td>
<td>46</td>
<td>3, F</td>
<td>97.2% (63.5%)*</td>
</tr>
<tr>
<td>Haselton et al. 2000</td>
<td>Alu</td>
<td>Crowns</td>
<td>4y (?)</td>
<td>41</td>
<td>A, P, M</td>
<td>80</td>
<td>2, F</td>
<td>98%</td>
</tr>
<tr>
<td>McLaren &amp; White 2000</td>
<td>Alu (S, C)</td>
<td>Crowns</td>
<td>3y (0-7y)</td>
<td>53</td>
<td>A</td>
<td>97</td>
<td>2.7%, F</td>
<td>98%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.3%, O</td>
<td>93.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>P, M 89</td>
<td>94%</td>
</tr>
<tr>
<td>Scherrer et al. 2001</td>
<td>Alu</td>
<td>Crowns</td>
<td>5y (?)</td>
<td>(?)</td>
<td>(?)</td>
<td>68</td>
<td>27, F</td>
<td>92%</td>
</tr>
<tr>
<td>Segal 2001</td>
<td>Alu (S)</td>
<td>Crowns</td>
<td>6J</td>
<td>253</td>
<td>I, C</td>
<td>177</td>
<td>2, F</td>
<td>99%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>P, M 369</td>
<td>99%</td>
</tr>
<tr>
<td>Vult von Steyern et al. 2001</td>
<td>Alu (S)</td>
<td>Bridges</td>
<td>3-unit</td>
<td>5y</td>
<td>18</td>
<td>P</td>
<td>11</td>
<td>0, -</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>M 9</td>
<td>2, F</td>
</tr>
<tr>
<td>Bindl &amp; Mörmann 2002</td>
<td>Alu (?)</td>
<td>Crowns</td>
<td>3y</td>
<td>21</td>
<td>P</td>
<td>2</td>
<td>0, -</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Spi (?)</td>
<td>Crowns</td>
<td></td>
<td></td>
<td>P</td>
<td>4</td>
<td>0, -</td>
<td>100%</td>
</tr>
<tr>
<td>Fradeani et al. 2002</td>
<td>Spi (S)</td>
<td>Crowns</td>
<td>4y</td>
<td>13</td>
<td>A</td>
<td>40</td>
<td>1, F</td>
<td>97.5%</td>
</tr>
<tr>
<td>Groten et al. 2002</td>
<td>Alu (S, C)</td>
<td>Crowns</td>
<td>2.5y (0-5y)</td>
<td>30</td>
<td>A-M</td>
<td>58</td>
<td>8, I, P, O</td>
<td>86.5%*</td>
</tr>
<tr>
<td></td>
<td>Spi (S, C)</td>
<td>Crowns</td>
<td>8.5y</td>
<td>25</td>
<td>F</td>
<td>2</td>
<td>0, -</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Zir (S, C)</td>
<td>Bridges</td>
<td></td>
<td>9</td>
<td>A, P, M</td>
<td>1</td>
<td>1, F</td>
<td>89%</td>
</tr>
<tr>
<td>Sorensen et al. 2002</td>
<td>Alu (S)</td>
<td>Bridges</td>
<td>3y</td>
<td>47</td>
<td>A</td>
<td>21</td>
<td>0, -</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3-unit</td>
<td></td>
<td>P</td>
<td>19</td>
<td>2, F</td>
<td>89%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>M</td>
<td>21</td>
<td>5, F</td>
<td>76%</td>
<td></td>
</tr>
<tr>
<td>Olsson et al. 2003</td>
<td>Alu (?)</td>
<td>Bridges &amp; Cantil.</td>
<td>6y</td>
<td>37</td>
<td>A, P, M</td>
<td>42</td>
<td>5, F</td>
<td>88%</td>
</tr>
</tbody>
</table>

**Follow-up period:** average follow-up period. In brackets: maximum observation time span  
**Material:**  
Alu: ALUMINA; Spi: SPINELL; Zir: ZIRCONIA; (S): shoulder preparation; (C): chamfer preparation  
**Reason for failure:**  
F: fracture (at) of the restoration; R: retention; P: pain after cementation; I: inadequate fit;  
C: secondary caries; E: endodontic problems; O: other reasons  
**(*) worst-case assumptions:** all undesired incidents requiring therapy and any loss to follow-up are assumed to be failures  
**Data:** respective data could not be found in the publication  
**Region:**  
A: anterior tooth; I: Incisor; C: Canine; P: Premolar; M: Molar
VITA In-Ceram SPINELL crowns

Crowns made from VITA In-Ceram SPINELL are preferably used in the anterior and premolar area. A uniform high rate of success is published: 97.5 to 100% for a period of 2 to 4 years (Bindl & Mörmann 2002, Fradeani et al. 2002, Groten et al. 2002).

VITA In-Ceram ALUMINA crowns

Crowns made from VITA In-Ceram ALUMINA have proved to be very reliable in the area of anterior teeth. Most authors report success rates of approx. 97 to 100% over average follow-up periods of 3 to 6 years (Bindl & Mörmann 2002, Groten et al. 2002, Haselton & Díaz-Arnold 2000, Hüls 1995, McLaren & White 2000, Pröbster 1997, Sadoun 1996, Scotti & Catapano 1995, Segal 2001, Scherrer et al. 2001). The failure rate in the posterior area is also insignificant; two reports, however, indicate a rate of approx. 7 to 10% (Bindl & Mörmann, McLaren & White 2000).

VITA In-Ceram ALUMINA bridges

Obviously the success of bridges made from VITA In-Ceram ALUMINA mainly depends on the restored jaw region. Average success rates of clearly less than 90% within 3 to 6 years are considerably lower than those of metal-based restorations. The losses - almost exclusively due to fracture of the bridges - are clearly higher in the posterior region: 11% of failures in the premolar area within approx. 3 years and 24% of failures if bridge spans (3-unit) extended up to the molar area. Compared to that, there were no failures/losses of anterior bridges within the same period (Sorensen et al. 2002). A Swedish project team (Olsson et al. 2003) observed 5 failures (12%) in 42 bridges (more than 50% were cantilever bridges) within periods up to 9 years (5-6 years on average). The posterior area was affected more strongly (fracture of 3 cantilever bridges) than the anterior area. Both failures of anterior cantilever bridges were caused by traumatic loss of teeth and do not depend on the restoration type or material. In their 5-year study of 3-unit bridges made from VITA In-Ceram ALUMINA another Swedish team (Vult von Steyern et al. 2001) found similar results as Sorensen and his coauthors: 22% of failures in the posterior area and no failures of anterior bridges. Sadoun, the "inventor" of VITA In-Ceram, also reports a failure rate of approx. 10% in posterior bridges within a period up to 8 years and only 2% in the anterior area (Sadoun 1996).
VITA In-Ceram® – Clinical experience with VITA In-Ceram® restorations

VITA In-Ceram ZIRCONIA Restorations

Hardly any clinical data are available on restorations made from VITA In-Ceram ZIRCONIA (Bohlsen et al. 2004; Groten et al. 2002). Compared to the VITA In-Ceram ALUMINA material, our own clinical experience, however, allows to conclude enhanced prognosis for restorations extending up to the molar area (see below).

Own clinical experience with VITA In-Ceram infiltration ceramics

From 1994 to 2002 30 ambulant patients of the clinic (15 men and 15 women aged between 20 and 65 years) received crowns and bridges made from VITA In-Ceram blocks. All restorations were produced with the CELAY system (copy milling technique). In 43 therapeutic steps - some of these were of experimental nature - 8 dentists and 5 dental technicians fabricated

- 62 crowns made from VITA In-Ceram ALUMINA blocks,
- 5 bridges made from VITA In-Ceram ALUMINA blocks (4 x 3-unit abutment bridges, 1 x 2-unit cantilever bridge),
- 27 crowns made from VITA In-Ceram SPINELL blocks (25 anterior and 2 premolar crowns, fig. 1 and 2) and
- 10 bridges made from VITA In-Ceram ZIRCONIA blocks (9 x 3-unit bridges, fig.3. one of them was a cantilever bridge, fig. 4 and one was an anterior bridge, see page 69, fig. 5)

to restore 110 abutment teeth in 30 patients. The preferred preparation type corresponded to the requirements for all-ceramic crowns and bridge restorations (Conod 1937, Groten & Pröbster 1998, Pröbster et al. 1994) (see page 69, fig. 6 and 7). Since 1999 more and more circular chamfers were prepared as required for metal-ceramic restorations (see page 69 and 70, fig. 8-10).

Fig. 1 Crowns made from VITA In-Ceram SPINELL for CELAY on teeth 11 and 21.

Fig. 2 Crown made from VITA In-Ceram SPINELL for CELAY on tooth 25.
Fig. 3 Bridge made from VITA In-Ceram ZIRCONIA for CELAY from teeth 15 to 17.

Fig. 4 Bridge made from VITA In-Ceram ZIRCONIA for CELAY from teeth 13 to 11 (same female patient).

Fig. 5 Cantilever bridge made from VITA In-Ceram ZIRCONIA for CELAY with abutments 17, 16 to replace tooth 15 (cantilever element).

Fig. 6 Classic preparation type for all-ceramic crowns: circular 90° shoulder with a preparation depth of 1 mm and rounded inner angle (see fig. 5-6, page 48).

Fig. 7 Classic preparation for crown made from VITA In-Ceram ALUMINA on tooth 12 and a bridge made from VITA In-Ceram ALUMINA from tooth 11 to tooth 22. The example of anterior teeth shows that this invasive preparation may be accompanied by weakening of the abutment tooth and damaging the vitality of the pulp (see fig. 7, page 48).

Fig. 8 Currently, chamfer preparations such as those for PFM restorations are preferred to minimize the risks to the integrity of the abutment tooth. In this case a pronounced circular chamfer of teeth 11 and 21 was prepared to receive the crowns made from VITA In-Ceram SPINELL for CELAY (see fig. 1).

Fig. 9 Circular chamfer preparations for a bridge made from VITA In-Ceram ZIRCONIA for CELAY from teeth 13 to 11 (see page 68, fig. 4).

Fig. 10 Moderate circular chamfer preparations to restore teeth 11 and 21 with crowns made from VITA In-Ceram ALUMINA produced using the WOL-CERAM technique (see fig. 3, page 12).

All restorations were cemented conventionally - preferably with phosphate cement (Harvard Cement, fast setting, Richter & Hoffmann Harvard Dental GmbH). Most of the translucent crowns made from VITA In-Ceram SPINELL were fixed with hybrid ionomer cement (Protec Cem, Ivoclar Vivadent AG). Some crowns were integrated using glass ionomer cement (Ketac Cem, 3M ESPE Dental AG). In some cases, the restorations were cemented to be worn temporarily for a limited time or because of planned orthodontic treatment over an extended
Own clinical experience with VITA In-Ceram

<table>
<thead>
<tr>
<th>Start of therapies: Number of pat.</th>
<th>Number Ther.</th>
<th>Number of restorations</th>
<th>Number of teeth</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1994</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>April 2002</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Ther. started</td>
<td>30</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>43</td>
<td>62</td>
<td>63</td>
</tr>
<tr>
<td>2 Ther. discontinued</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Ther. completed</td>
<td>29</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>(1311-12)</td>
<td>42</td>
<td>59</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Contact lost</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Under follow-up</td>
<td>26</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>(1513-14)</td>
<td>39</td>
<td>56</td>
<td>57</td>
</tr>
<tr>
<td>6 Follow-up therapy</td>
<td>9</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>(-repair)</td>
<td>(3)</td>
<td>(2)</td>
<td>(2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(7)</td>
<td>(6)</td>
<td>(6)</td>
</tr>
<tr>
<td>(-failure)</td>
<td>(5)</td>
<td>(4)</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3)</td>
<td>(2)</td>
<td>(2)</td>
</tr>
<tr>
<td>(--retreated)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3)</td>
<td>(4)</td>
<td>(4)</td>
</tr>
<tr>
<td>(--total loss)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 function (worst case = [15-16]/1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(100% (85%)</td>
<td>(85%)</td>
</tr>
<tr>
<td></td>
<td>(87%) (81%)</td>
<td>(85%) (81%)</td>
<td>(85%)</td>
</tr>
<tr>
<td>8 function (best case = [17+4]/1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>38</td>
<td>53</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(100% (85%)</td>
<td>(85%)</td>
</tr>
<tr>
<td></td>
<td>(87%) (88%)</td>
<td>(85%) (81%)</td>
<td>(85%)</td>
</tr>
</tbody>
</table>

k) under follow-up resp. followed until failure occurred

*) “follow-up therapy” describes any undesired impact on a restoration or a restored tooth resulting in clinical intervention (regardless of type and cause).

The sum of the number in the lines and columns of the block “follow-up therapy” do not have to be identical with the total number of follow-up therapies since in some follow-up units repairs were performed and failures resulted.

#) “Repair” is any clinical intervention performed on a restoration or tooth - after an undesired incidence - as long as the restoration is retained.

+) “Failure” is any loss of a restoration regardless of the cause.

+x) “Total loss” is any loss of a restoration (regardless of the cause) which can not be retreated with VITA In-Ceram Classic for CELAY.

†) worst case indicates that all patient contacts/loss to follow-up (14) must be considered “failures” (like 6).

‡) best case indicates that all patient contacts lost/loss to follow-up (14) must be considered “in function” (like 7).

l) is an abbreviation for “line” in the equations

1) borderline / experimental indications (cf. page 72)
Modified Lexis diagram for comparative representation of the clinical process of treatment with crowns and bridges made from VITA In-Ceram for CELYA. One or several bars indicate the patients according to the number of therapeutic phases. The width of each bar is proportional to the number of abutments restored in the respective therapeutic phase. Color coding is used to identify the respective framework material and the occurrence of incidences such as complaints, failure and follow-up treatment according to the legend.

Numerous patients had been treated several times and received complex restorations (restorations made from VITA In-Ceram SPINELL, ALUMINA and ZIRCONIA) and are indicated by several bars and using several colors.

The task of such an apparently "confusing" diagram is to illustrate complex processes and clinical situations in a graphical form.

C) refers to the patient ID in the studies
Within the follow-up period of more than 8 years (January 1994 to April 2002) 3 patients no longer showed up (10% loss to follow-up) so that the condition of 11 abutment elements (10%) resp. 9 restorations (9%); 3 crowns made from VITA In-Ceram ALUMINA for CELAY, 4 crowns made from VITA In-Ceram SPINELL, 2 bridges made from VITA In-Ceram ZIRCONIA) is unknown (see page 71, fig. 11, Groten et al.).

Altogether, 14 of 104 integrated restorations required follow-up therapy or correction (13%). 11 restorations failed completely (11% of failure), 3 crowns made from VITA In-Ceram ALUMINA which could not be integrated (3%) must be added to this number. Failure was found in 7 patients (23%); one of these had repeated failure. This correlates with one failure after 8 therapies (19%). 6 of the failed restorations were replaced by restorations made from VITA In-Ceram for CELAY (5 patients). All restorations made from VITA In-Ceram for CELAY failed in 3 patients (10%).

The average period of wearing until the time when the failures were determined was less than 1.5 years. Fig. 11 on page 71 illustrates that complaints or complications (yellow and red proportions) either occurred or began soon after completion of the therapy or did not occur at all, at least not later than 10 months after the integration.

The individual causes for failure were (in brackets: percentage of respective restorations and patient ID):

Fracture: 1 of 10 bridges made from VITA In-Ceram ZIRCONIA (10%, C 19), 2 of 5 bridges made from VITA In-Ceram ALUMINA (40%, C 02 repeated - experimental indication, bruxist); inadequate fit: 3 of 62 crowns made from VITA In-Ceram ALUMINA prior to the integration (5%, C 30); loss of retention: 1 bridge made from VITA In-Ceram ALUMINA (20%, C 20 - experimental indication, free-end situation), 1 temporarily cemented crown made from VITA In-Ceram ALUMINA (1.5%, C 50); tooth fracture: 2 crowns made from VITA In-Ceram ALUMINA (3%, C 31, C 02); complaints after cementation: 1 bridge made from VITA In-Ceram ALUMINA (20%; C 03); 3 crowns made from VITA In-Ceram ALUMINA (5%, C 03, C15) - glass ionomer cement; new restorations were prepared.
Teeth with chamfer preparation did not reveal higher failure rates than teeth prepared using the classic method. Only one restoration with chamfer preparation failed (bridge made from VITA In-Ceram ZIRCONIA of patient C 19).

So far no failure has occurred among the 27 crowns made from VITA In-Ceram SPINELL which were mostly integrated in the anterior area.

Cumulatively, approx. 15% of the fabricated and 13.5% of the integrated crowns made from VITA In-Ceram ALUMINA failed or needed to be corrected. Loss occurred with all (initial restoration) bridges made from VITA In-Ceram ALUMINA. Only one (follow-up therapy, C 03) was in situ.

So far success could be achieved for 89 of 110 restored teeth under follow-up since 0.5 (see page 68, fig. 2) to approx. 8.5 years (fig. 12) (worst case scenario: loss to follow-up = failure). For 2.5 years (average) a cumulative rate of integrity of 81% of all restored teeth and a success rate of 78% (n=81) of all restorations made from VITA In-Ceram for CELAY (n=194) are obtained. If only restorations are considered which were lost (best case scenario: loss to follow-up = success), 89 of 110 teeth were successfully restored (91%) and 90 of 104 restorations are in function (87%).

Fig. 12 Crowns made from VITA In-Ceram ALUMINA for CELAY on teeth 11 and 21 approx. 8.5 years after integration.

The indications included in the table on page 44 result from the clinical experience described. In the course of further development of the VITA In-Ceram material - from VITA In-Ceram AL (pure Al₂O₃ for high-temperature dense sintering) to the high-strength zirconium oxide VITA In-Ceram AL - these indications could constantly be extended during the past years. Even if multi-unit posterior and cantilever bridges have already been successfully integrated, these indications are still considered to be experimental and should not yet be added to the standard indications for fixed restorations.

Adherence to indication restrictions and design and construction guidelines will result in successful clinical use of restorations made from VITA In-Ceram.
Clinical documentations

Documentation 1
Patient, 33 years
Diagnosis: insufficient crowns and bridges
Therapy: crowns 11, 21 made from VITA In-Ceram SPINELL for CELAY and bridge (13-15) from VITA In-Ceram ZIRCONIA for CELAY
Documentation 2

Female patient, 54 years

**Diagnosis:** insufficient prosthetic restoration of partially edentulous arch with gaps and tooth migration with chronic periodontitis

**Therapy:** preprosthetic, systematic periodontitis therapy, all-ceramic restorations for total rehabilitation to restore the function and for gap closure with bridges made from VITA In-Ceram ZIRCONIA for CELAY (teeth 17-16/15)
VITA In-Ceram® – Clinical documentations

12

13

14
Documentation 3

Female patient, 23 years

**Diagnosis:** missing tooth 22, implantation in regio 22

**Therapy:** adjustment of position of tooth 21 with labial bow to improve gap configuration, crown made from VITA In-Ceram ALUMINA for CELAY on customized implant abutment (CeraOne, Branemark system)
Documentation 4
Female patient, 21 years

Diagnosis: amelogenesis imperfecta with numerous missing teeth and bimaxillary asymmetry with considerably limited possibilities of oral hygiene

Therapy: preprosthetic, orthodontic adjustment of the arches and bimaxillary osteotomy to raise the bite and for repositioning in angle class II relation; functional and aesthetic prosthetic rehabilitation to build up static and dynamic occlusion, tooth alteration and adjustment of proportions and establishment of hygienic capabilities with reduced preparation work with single tooth crowns made from VITA In-Ceram YZ for inLab in the mandible and the maxilla.
VITA In-Ceram® – Clinical documentations

13 14 15

16 17 18

19 20 21

22 23 24

25 26 27
Documentation 5
Female patient, 51 years

**Diagnosis:** insufficient prosthetic restoration of partially edentulous lower and upper arches (good level of oral hygiene) and mostly undamaged tooth structure; divergence of abutments (tooth 47 to 45)

**Therapy:** prosthetic gap closure with 3 four-unit bridges made from VITA In-Ceram YZ for inLab with reduced preparation work: abutment bridge (17-14), cantilever bridge (23-25) with cantilever element (tooth 26) in premolar width: partial bridge, teeth 44-47 (attachment cemented).


Conod H. Étude sur la statique de la couronne jaquette. Schweizer Monatsschrift für Zahnmedizin 47, 485-529 (1937)


With the unique VITA SYSTEM 3D-MASTER
all natural tooth shades are systematically determined
and completely reproduced.

Please note: Our products should be used according to the working instructions. We cannot be held
liable for damages resulting from incorrect handling or usage. The user is furthermore obliged to check
the product before use with regard to its suitability for the intended area of applications. We cannot
accept any liability if the product is used in conjunction with porcelains and equipment from other
manufacturers which are not compatible or not authorized for use with our product. Furthermore, our
liability for the correctness of this information is independent of the legal ground and, in as far as lawfully
permissible, is limited to the invoiced value of the goods supplied excluding turnover tax. In particular, as
far as lawfully permissible, we do not assume any liability for profit loss, for indirect
damages, for consequential damages or for claims of third parties against the purchaser. Claims for
damages based on fault liability (culpa in contrahendo, breach of contract, unlawful acts, etc.) can only
be made in the case of intent or gross negligence. The VITA Modulbox is not necessarily a component
of the product.

Date of issue: 02-05

VITA Zahnfabrik has been certified according to the Medical Device Directive
and the following products bear the CE mark:

VITA In-Ceram® SPINELL, VITA In-Ceram® ALUMINA, VITA In-Ceram® ZIRCONIA,
VITA In-Ceram® YZ for inLab, VITA In-Ceram® AL for inLab

CEREC® and inLab® are registered trademarks of Sirona Dental Systems GmbH, Bensheim, Germany
CelHa WHITE ECS® is a registered trademark of C. Hafner GmbH & Co. KG, Pforzheim, Germany
CELAY® is a registered trademark of Mikrona Technologie AG, Spreitenbach, Switzerland
DCS Precident® is a registered trademark of DCS Dental AG, Afield, Switzerland
Digident® is a registered trademark of Digident GmbH, Pforzheim, Germany
Harvard Cement® is a registered trademark of Richter & Hoffmann Harvard Dental GmbH, Berlin, Germany
Ketac-Cem® and Relix® are registered trademarks of 3M ESPE Dental AG, Seefeld, Germany
PANAVIA® is a registered trademark of Kuraray Europe GmbH, Düsseldorf, Germany
Protoc Cem® is a registered trademark of Iovadent AG, Schaan, Liechtenstein
synOcta® is a registered trademark of Straumann AG, Waldenbuch, Switzerland
WOL-CERAM® is a registered trademark of Teamzirereis GmbH, Engelbrand, Germany