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Range of applications of a CAD/CAM system with translucent and opaque ZrO_2

Knut Miller, Falko Noack

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Abstract
Using the example of a single model the author demonstrates the breadth of possibilities the user has with the Ceramill CAD/CAM system (AmannGirrbach, Koblach, Austria) and how diverse and comprehensive this system can be with Ceramill Zi and Ceramill Zolid materials.

Keywords
Zirconia, translucent zirconia, CAD/CAM, virtual articulator, abutments, crowns, bridges, PMMA crowns, bridge with precision attachment

Range of applications of a CAD/CAM system with translucent and opaque ZrO_2

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Introduction

The composition and mechanical properties of Ceramill Zolid translucent zirconia (AmannGirrbach) are comparable to those of Ceramill Zi blanks, which have been established on the market for many years. In comparison with Ceramill Zi, Ceramill Zolid only has a slightly reduced proportion of Al_2O_3,[6] to optimise the light transmission properties.

Al_2O_3 contributes to the opacity of the material, and it is also necessary for improving the hydrolysis stability and, therefore, for making the material resistant to external influences. This has been achieved in Ceramill Zolid using chemical restructuring, ensuring an adequate diffusion barrier for the yttrium, which is also accompanied by very good aging resistance, i.e. long-term stability.

The sinter temperature has a decisive influence on the physical properties of the material, and therefore is also important for long-term stability. One of the development objectives for Ceramill Zolid was that this material should be sintered at the same temperature as conventional Ceramill Zi – namely at 1,450°C.

Relevant studies confirm the resulting benefits.[4,5] The Al_2O_3 is very homogenously and finely distributed at the grain margins with Ceramill Zolid. This leads to higher light transmission, making the material also suitable for monolithic restorations.

In order to show different indications, the author prepared a model for diverse materials and indications, which will be used to demonstrate the wide spectrum of the Ceramill CAD/CAM system.

The model

The master model can be seen in Fig 1 with its individual segments; the removable gingival mask has been fabricated using denture acrylic. Fig 2 shows the overall view of the model. The prepared tooth 27 (Fig 3) has been fabricated in a grey resin to simulate the problem of a "dark discoloured tooth preparation", which is not aesthetically ideal. The author planned to solve the problem using Ceramill Zi, which is a less translucent material.

Fig 1 There are implants on teeth 17, 16 and 13, the two central incisors have a circumferential deep chamfer preparation, also teeth 24, 26 and 27, residual tooth segment in teeth 18, 12, 22, 23 and 28.

Fig 2 The overall view of the model.

Fig 3 A close-up of the model with "discoloured die".

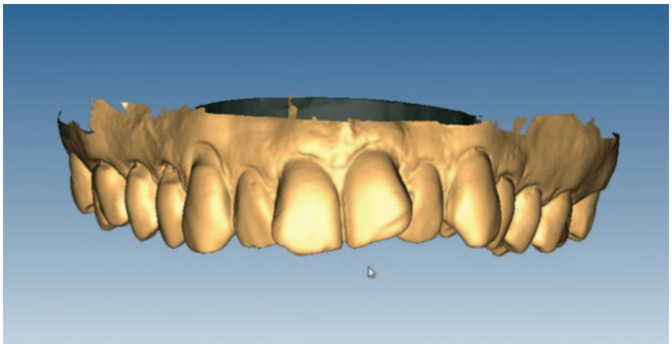

Fig 4 The scanned study model.

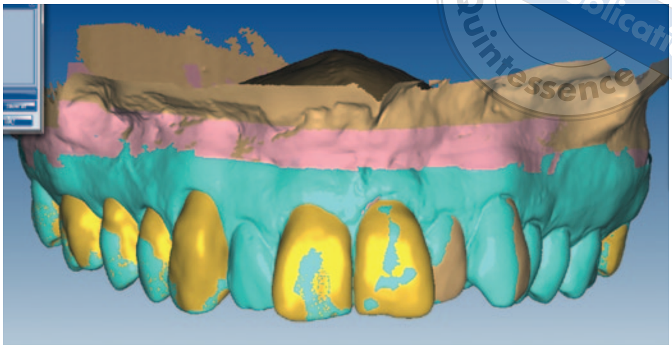

Fig 5 The study model modified using the CAD freeform tool.

Fig 6 The anatomically reduced framework of teeth 11 and 21 with the dynamic guide surfaces on the palatal.

A study model of the original situation (Fig 4) is available as a reference for the planned restoration. This model can be very easily incorporated in the Ceramill Mind CAD software for virtual planning and design (AmannGirrbach). The basis of a study model can then be individually modified in the CAD software (Fig 5) – if required or wished – using the freeform tool. This type of information is very helpful as a guideline to greatly shorten the time required for the design. The two anatomically reduced Ceramill Zolid frameworks for the central incisors can be seen in Fig 6; the labioproximal section was reduced for a ceramic shoulder, and the palatal guide surfaces were precisely and dynamically reconstructed using the virtual Artex CR articulator (AmannGirrbach) and "digital functional prosthetics" (DFP). This simple reconstruction of the functional guide surfaces using the original situation considerably reduces the time required, and the technician can concentrate fully on the shape and aesthetics when veneering. The "DFP" contoured palatal guide surfaces, which in this case are not to be veneered using build-up porcelain, must then only be finely polished to a high lustre using appropriate polishers (Ceramill Polish Lab Kit). It is very important, particularly with monolithic zirconia restorations, to polish contact surfaces to a high lustre after grinding to avoid abrasion on the opposing dentition or adjacent teeth.

Abutments in teeth 13, 16 and 17

During the design process of the abutments in the Ceramill Mind CAD software, the margins of the emergence profile were placed so that the buccal margins were subgingival (Fig 7) and the palatal margins were placed supragingivally (Fig 8).

The simultaneously designed Ceramill Zolid design abutments and bridge superstructure – for teeth 13 and 16 – can then be nested, milled and, if desired, custom

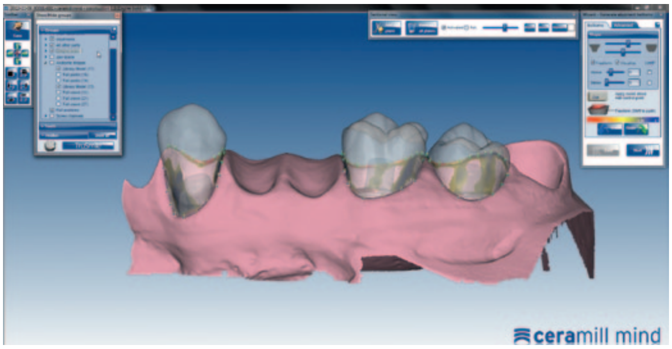

Fig 7 The emergence profile margins were placed slightly subgingivally buccally.

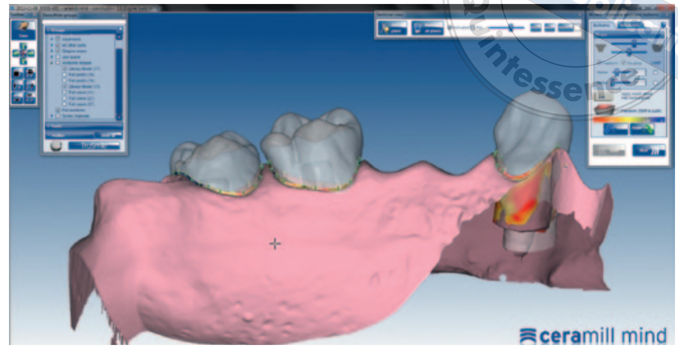

Fig 8 The palatal emergence profile margins are supragingival.

Fig 9 Simultaneously milled primary and secondary frameworks.

Fig 10 Monochromatically stained abutments.

Fig 11 Buccal view with gingivally coloured deep chamfer to support the cervical region of the crown.

Fig 12 Palatally this supragingival marginal region has been retained as a dentine shade to ensure a harmonious transition to the crown.

stained in one stage and can also be sintered together. In the experience of the author, this is a timesaving, efficient working stage (Fig 9). Staining of the Ceramill Zolid abutments in the partially sintered state, i.e. before fully sintering, can be completed using Ceramill Liquids according to individual requirements. For comparison, Fig 10 shows how homogeneous the result looks if the abutments are immersed in dentin-coloured Liquid CL for 2 mins.

In Figs 11 and 12, the author has stained the intra-alveolar gingival region pink and the “core” in a corresponding dentin shade using the brush technique. The abutments have been stained both in the subgingival and mesioproximal to distoproximal regions of the deep chamfer using a gingival-coloured liquid. The reason for this approach is to imitate harmonious shade transition to the dentin for the porcelain shoulder fired on the superstructure with the veneered cervical section of the crown (see Fig 11).

The visible area of the supragingival palatal region of the abutments has been completed in a dentin shade to ensure a matching shade transition to the superstructure (see Fig 12). Figs 13 and 14 show the Ceramill Zolid abutments on the model.


Figs 13 and 14 Buccal and palatal view of the contoured emergence profiles.

Fig 15 Cavity surfaces stained with dentine-coloured and intensive CL Liquid; result after sintering.

All fully anatomical, monolithic Ceramill Zolid crowns in this case study were stained and characterised in the partially sintered state, including internally in the cavity surface (e.g. using the intensive solution CL orange in the occlusal area of the cavity) (Fig 15).

The author uses this intensive liquid highly diluted in a ratio of 25% to 75% (75% is the proportion of distilled water) and it is then regulated according to the number of applications, depending on the intensity required. In this case, the solution was applied two to three times using a brush.

Bridge for teeth 13 to 16

A translucent monolithic zirconia (Ceramill Zolid) bridge was planned and fabricated for teeth 13 to 16. For this, the palatal guide surface on tooth 13 was dynamically contoured quickly and precisely using the Artex Cr® virtual articulator. The rest of the area was then anatomically reduced according to the respective parameters (Fig 16). The framework of tooth 13 was also reduced from the mesiocervical to distocervical in a CAD process in order to fire on a conventional porcelain shoulder.

The two pontics on teeth 14 and 15, which were only reduced buccally, were also veneered. The functional occlusal contour was defined using the virtual articulator. The

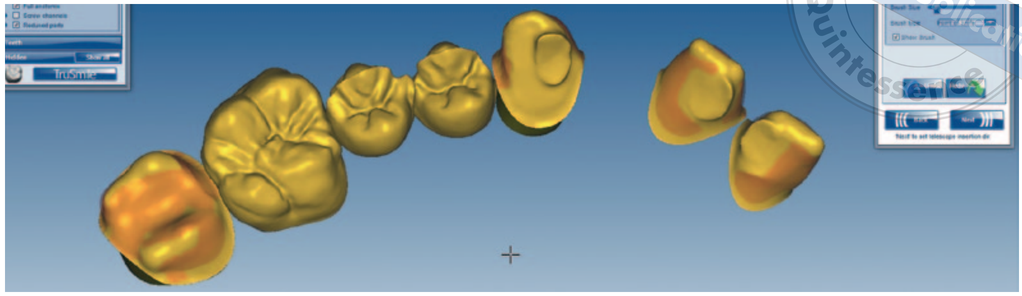

Fig 16 Screenshot of the dynamically designed guide surfaces on the palatal surfaces of teeth 13, 11 and 21 in the Ceramill Mind CAD software.

Fig 17 Buccal view of the bridge on teeth 13 to 16.

Fig 18 Palatal view of the superstructure on teeth 13 to 16.

Fig 19 Step-by-step views of the CrCo abutment on tooth 17 milled from Ceramill Sintron, **a** in the milled state (green body stage), **b** the result immediately after sintering, still untrimmed and **c** with fired opaque, adhesively retained titanium base and polished to a high lustre.

entire occlusal and proximal contact points, which were defined in Ceramill Zolid, had to be polished manually to a high lustre after sintering. Tooth 16 was designed fully anatomically. Figs 17 and 18 show the bridge on the model.

Abutment on tooth 17 with PMMA crown

For tooth 17, the author had planned an abutment based on a material combination consisting of non-precious metal, zirconia and temporary PMMA resin. The abutment was milled from Ceramill Sintron®, a new chromium cobalt (CrCo) sinter metal that has a similar technical process to zirconia (Fig 19), conventional opaque[3] for bonding porcelain was applied after sintering and in the final stage the abutment was then adhesively retained with the titanium base. After sintering, the Ceramill Sintron® CrCo alloy[2], which is dry milled using the Ceramill Motion or Ceramill Motion 2, can be finished and polished much more easily than a cast CrCo framework, as it has a lower Vickers hardness (HV10: 280), the structure is more homogenous and has a much finer grain structure.[1]

The author had also sprinkled a margin powder on the surface of the opaque (Fig 20) and fired it (circumferentially, however, only by approx 1.5 mm towards the abutment

Fig 20 The opaque surface modified with margin powder.

Fig 21 The Ceramill Sintron abutment with the Ceramill Zolid framework and – for better illustration – the fully anatomical Ceramill temporary crown, which is not completely seated.

margin in order to ensure a precise marginal fit of the coping). The idea is to achieve a better retentive surface for the bond with the temporary restoration, which was milled from Ceramill Temp, during cementation, and also to produce better internal light scatter due to an irregular porcelain surface. The anatomically reduced framework was then milled from Ceramill Zolid and stained monochromatically using a dentin-coloured Ceramill Liquid. The fully anatomical crown, which was fabricated using Ceramill Temp (medium blank shade), can also be reduced using the CAD software if the plan is to veneer or characterise the PMMA crown. The design of an anatomical tertiary framework made from composite or high-quality PMMA resin on implant-supported restorations is based on the following consideration (Fig 21): the risk of fracture is considerably higher with implant-supported restorations than with restorations on natural prepared teeth due to the absence of stimulus transfer. It therefore makes sense to incorporate the overload component in the framework, so that important elements such as bone and implant are protected. In this case, the resin veneer (made from PMMA or composite), which has the least strength, functions on an overload component.

One of the advantages of this is the protection of the bone and the inserted implant. Another positive aspect of this approach is also that, in the worst-case scenario, if the veneer fractures as a result of overloading, easy, cost-effective replacement and repair of the veneer are possible and it is also easier to access the screw channel.

Bridge with precision attachment

For the left side of the model (teeth 24 to 27), the author had selected the following indication: teeth 26 and 27 were to be splinted to compensate for the divergence of the path of insertion and also to mask the “discoloured prepared tooth” and take into account the aesthetic requirements. A conical Ceramill Zi primary unit was designed on tooth 27 (Fig 22). Due to its increased opacity (Fig 23), conventional zirconia is ideal for masking the unfavourable shade situation (e.g. discoloured tooth preparation, metal cores, titanium abutments.

The cervical margins of the primary unit were polished to a high lustre using the Ceramill zirconia polishers to create an ideal starting position for gingival adaptation. The superstructure for teeth 26 and 27 (Fig 24) was then designed fully anatomically and

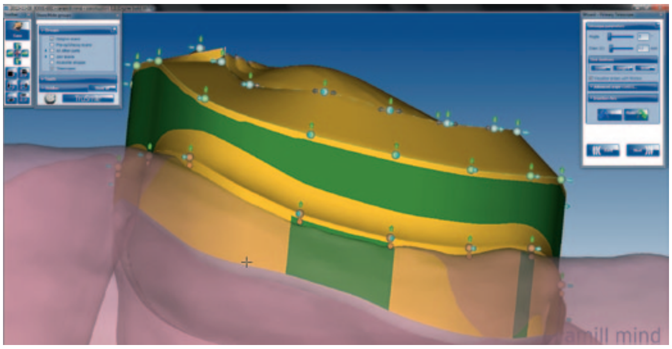

Fig 22 A design section of the inner telescope crown.

Fig 23 A stained and sintered conical primary unit made from Ceramill Zi for tooth 27.

Fig 24 A fully anatomical superstructure in situ, splinted and with a mesial precision attachment.

Fig 25 The restorations with manually produced degree of glaze.

provided with a T-attachment mesially for prospective planning and fabricated using translucent Ceramill Zolid.

After sintering, all anatomical frameworks were further characterised and glazed using the Ceramill Stain & Glaze Kit. The degree of glaze was then customised in the same way as with conventional build-up porcelain using silicone rubber polishers and pumice or diamond paste (Fig 25).

In this case, the tertiary structure on teeth 24 and 25 was contoured fully anatomically reduced circumferentially. The crown framework on tooth 24 was also reduced buccally to create space for a porcelain shoulder.

Conclusion

Because it has been possible to incorporate comparable material properties into Ceramill Zi and Ceramill Zolid, despite their different translucency, they can easily be used together or separately to suit the individual requirements of the patient and enable a much wider range of restoration options to be fabricated using the Ceramill CAD/CAM system, as the author was able to demonstrate using the example of a single model (Figs 26 to 28).

Fig 26 Teeth 24 to 27 with the three frameworks. The cervical region of tooth 24 was reduced buccally for a porcelain shoulder.

Fig 27 A close-up of the three frameworks in teeth 24 to 27.

Fig 28 An overall view of all the frameworks on the model.

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Knut Miller
Falko Noack
Amann Girrbach AG
Herrschaftswiesen 1
6842 Koblach, Austria
E-mail: knut.miller@amanngirrbach.com