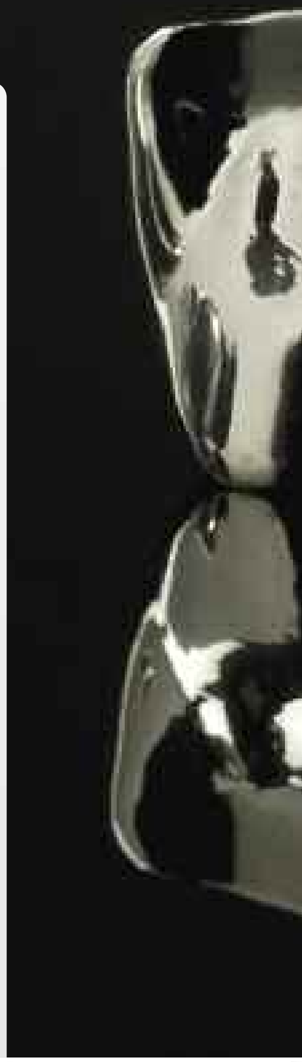
Millable CoCr blanks for in-house manufacture: value creation, control and convenience

CoCr-Revolution

An article by Dipl.-Ing. Falko Noack, Dornbirn/Austria



For a long time CAD/CAM was equated with zirconia. The reason was that in-house manufacture only experienced a boom with the introduction of pre-sintered zirconia. The health reforms and also the reduction in real wages ensured that there was an increase in the demand for non-precious metal alloy restorations. CAD/CAM-supported manufacture is suitable for fabricating non-precious restorations. However, very high demands are placed on the manufacturing unit (coolant delivery, rigidity of the machine etc.), which is why this class of material often had to be ordered from centralised manufacture/manufacturing centres. Amann Girrbach provides the ideal opportunity of fully utilising a CAD/CAM system in-house in the laboratory with Ceramill Sintron CoCr blanks, which can be dry milled in-house and are therefore a very attractive option.

Indices

- CAD/CAM
- CoCr alloy
- Milling process
- Green body
- In-house manufacture
- Sintering

Product idea

Further development in the CAD/CAM sector primarily involved an increasing demand for additional materials. Though ceramic materials and plastics are now readily available for CAD/CAM in-house manufacture, a gap still exists in the application of one of the most successful and widespread classes of dental restoration materials. I refer to NPM* alloys. Special CoCr alloys make up a large proportion of dental restoration materials. Up until now, however, this type of material could only be processed with the support of CAD/CAM in centralised manufacture (laser-melting process) or on large, cost-intensive milling machines (milling from the dense material). The aim of developing Ceramill Sintron was therefore to close this gap and develop a millable blank, including the manufacturing process, which enables cost-effective processing of CoCr in the CAD/CAM in-house sector. The basic product requirements were defined as follows:

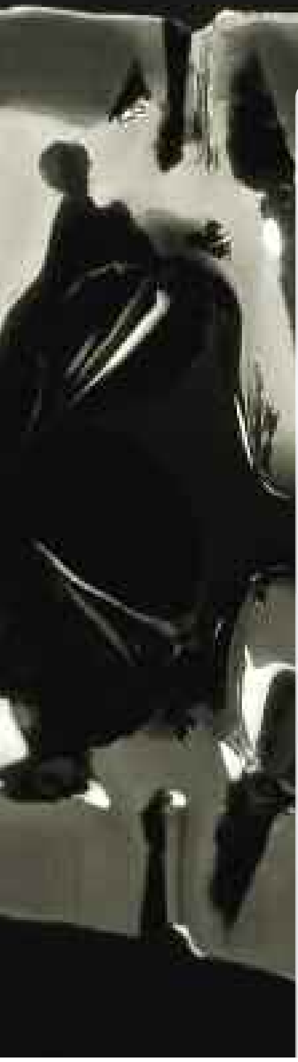
- Milling properties similar to pre-sintered zirconia
- Direct processing of the material without additional casting procedure
- Time-efficient sintering of the material
- Compliance with all material properties relevant in dental technology
- Veneerability of the material using commercially available bonding porcelains
- Cost-effective manufacturing process for CoCr frameworks

Product description

Ceramill Sintron blanks are in the green body state and comprise a CoCrMo alloy held together by an organic binder. The alloy is used for the fabrication of fully anatomical and anatomically reduced crown and bridge frameworks and is suitable for the fabrication of fixed or removable restorations using CAD/CAM systems (Fig. 1) in accordance with DIN EN ISO 22674. Restorations fabricated using this material are fitted in the oral cavity of patients as invasive products for long-term use. It is therefore a Class IIa medical device.

The material is processed in a wax-like state (unsintered metal powder held together by a binder = green body) and then sintered in a high-temperature sinter furnace developed specifically for this material. This sintering process is completed under an argon shielding atmosphere (Argon 4.6) using a preset temperature programme tailored to the alloy and this process reduces the dental framework to its pre-calculated final size. In the sintered state the material has the properties required for a Type 4 alloy (DIN EN ISO 22674), which is comparable with CoCrMo casting alloys that have been used successfully for many years. Further processing/conditioning in the dental laboratory, such as bonding a porcelain veneer or repairing by laser welding, is also possible and comparable with CoCrMo casting alloys. It has therefore been possible to develop a material that combines the properties of two successful and clinically proven materials.

* NPM or non-precious metal alloys are generally chrome-cobalt alloys



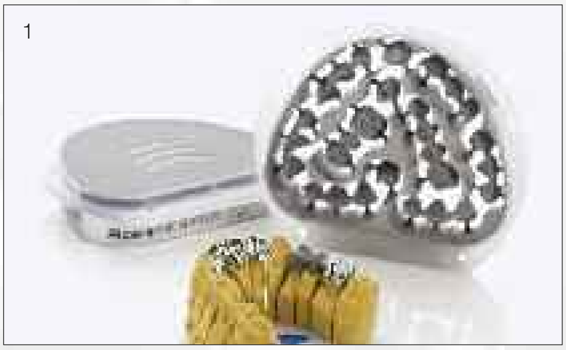


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Fig. 1 Ceramill Sintron blanks comprise a CoCrMo alloy in the green body state and are used for CAD/CAM-supported fabrication of fully anatomical and anatomically reduced crown and bridge frameworks

Mechanical, physical properties after final sintering

Tensile strength (Rm)	830 MPa
0.2 % Proof stress (Rp0,2)	450 MPa
Modulus of elasticity (E)	200 GPa
Elongation at rupture	20 %
Vickers hardness (HV 10)	280
Coefficient of thermal expansion (25-500 °C)	14,5 *10-6/K

Working stages for fabricating a CoCrMo framework

A. Casting procedure	B. CAD/CAM-Sinter process
1. Model fabrication, articulation	1. Model fabrication, articulation
2. Model preparation (hardening, die spacer application)	2. Model scan
3. Wax-up	3. CAD design
4. Spruing	4. CAM (milling of the framework from a CoCrMo blank)
5. Investing	5. Separating and trimming
6. Preheating and casting	6. Sintering
7. Devesting and sandblasting	7. Polishing or preparing for porcelain firing
8. Cutting off the sprues	
9. Trimming	
10. Polishing or preparing for porcelain firing	

The chemical composition, macroscopic appearance, mechanical and biological properties and processing characteristics in the sintered state are identical in practical terms to those of CoCrMo casting alloys that have been clinically proven for many years.

Processing of raw components in a preliminary material stage using CAD/CAM technology and then sintering the zirconia, which is also used as a ceramic framework material for dental restorations, have been familiar processes for some years and are now state-of-the-art technology. As well as having a large number of features in common with casting alloys, Ceramill Sintron also has the following advantages:

- No or only minimal traces of oxidation due to the sinter process under shielding gas
- Use of the material in a highly automated CAD/CAM process ensures increased process reliability
- Improved reproducibility of the final results, as the possibilities of manipulation have been reduced compared with the casting procedure
- Homogeneous and identical alloy composition in the entire reconstruction, as melting of the alloy is no longer required
- No obvious disadvantage compared with casting in terms of material consumption (sprues of cast restorations should also not be reused)
- Time-saving in the fabrication of dental restorations (fewer working stages for the dental technician)
- Lower material costs, as consumable materials required for waxing up and casting (investment, wax etc.) are not required

Manufacturing process

The table contains a list of comparisons (see above) of the process stages for fabricating a CoCrMo framework in the dental laboratory according to the casting procedure and CAD/CAM sinter process. It is clear from the comparison that fewer working stages are required for fabricating a framework in the dental laboratory using the CAD/CAM sinter process.

Technically, the procedure with the Ceramill Sintron manufacturing process has much fewer sources of error than that of the conventional casting procedure. With Ceramill Sintron the material properties, in particular the alloy composition, remain unchanged both during the milling process and subsequent sinter process (solid-phase sintering under shielding gas atmosphere). This is not always guaranteed when casting this type of CoCrMo framework. As a result of complete melting of the alloy during the casting procedure, segregation phenomena may occur in the molten metal due to the concentration gradients. Not all alloy components are uniformly and homogeneously arranged in the structure during the solidification process. Certain areas of the structure then become impoverished while other areas are enriched with alloy components. In addition, excessively high melting temperatures may cause a reduction of the low-fusing alloy components. This alters the composition of the alloy. Also, contamination may be caused by compo-

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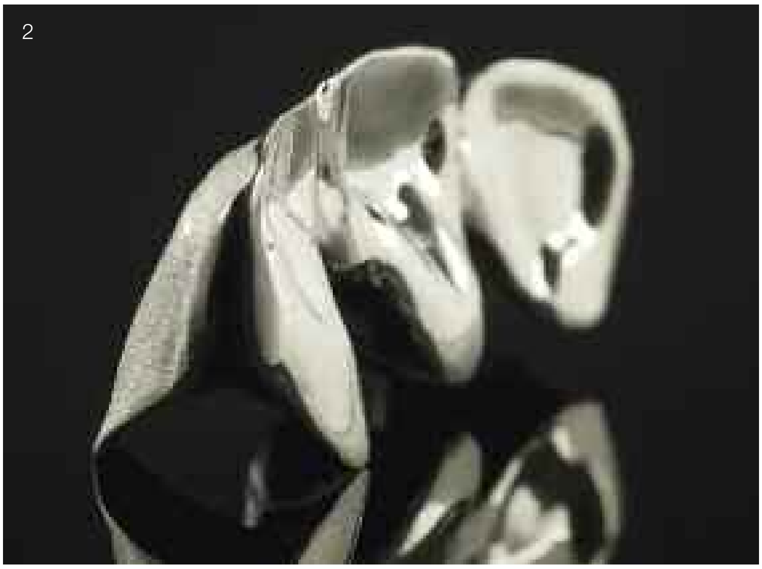

Fig. 2 Ceramill Sintron is indicated, for example for anatomically reduced crowns and bridge frameworks in the anterior and posterior region

nents of the casting mould investment entering the alloy as a result of interactions between the molten metal and investment. It should also be noted that the casting procedure, particularly when casting using an open flame, involves heavy oxidation of the casting. This oxidation layer is removed by sandblasting after devesting of the casting. Sandblasting is an erosive, material-reducing procedure which can negatively affect the accuracy of fit, particularly in the region of the crown margin. Inexact regulation of the investment expansion can cause deformation and other inaccuracies in the fit of the casting. The alloy may also become contaminated due to residual material from the pattern (wax or resin), which can also involve changes in the alloy composition and possibly a change in the mechanical and biological properties.

All of the above risks are avoided by using the Ceramill Sintron manufacturing process. Segregation phenomena are either not possible or only to a very limited degree during the sinter process, as sintering involves diffusion-controlled material transport without the creation of a liquid phase. This is also referred to as solid-phase sintering in this context, as is known from pre-sintered zirconia. Contamination of the alloy from external sources, for example by the investment or residual waxing up materials, is excluded, as neither material is used during the manufacturing process of Ceramill Sintron. Deformation due to thermally induced stresses during the milling process is also excluded, as there are no thermal effects during the milling process of the green body. Surface oxidation is also reduced to a minimum, as sintering is completed under a shielding gas atmosphere. The sandblasting process, which is time-consuming and reduces the accuracy of fit to a certain extent, is therefore no longer required.

For the reasons described above it can be concluded that a sintering process combined with CAD/CAM milling procedures, as is used for Ceramill Sintron, has distinct advantages compared with the conventional casting procedure with regard to process reliability and reproducibility. The manufacturing process is shown in the illustrated sequence (see right).

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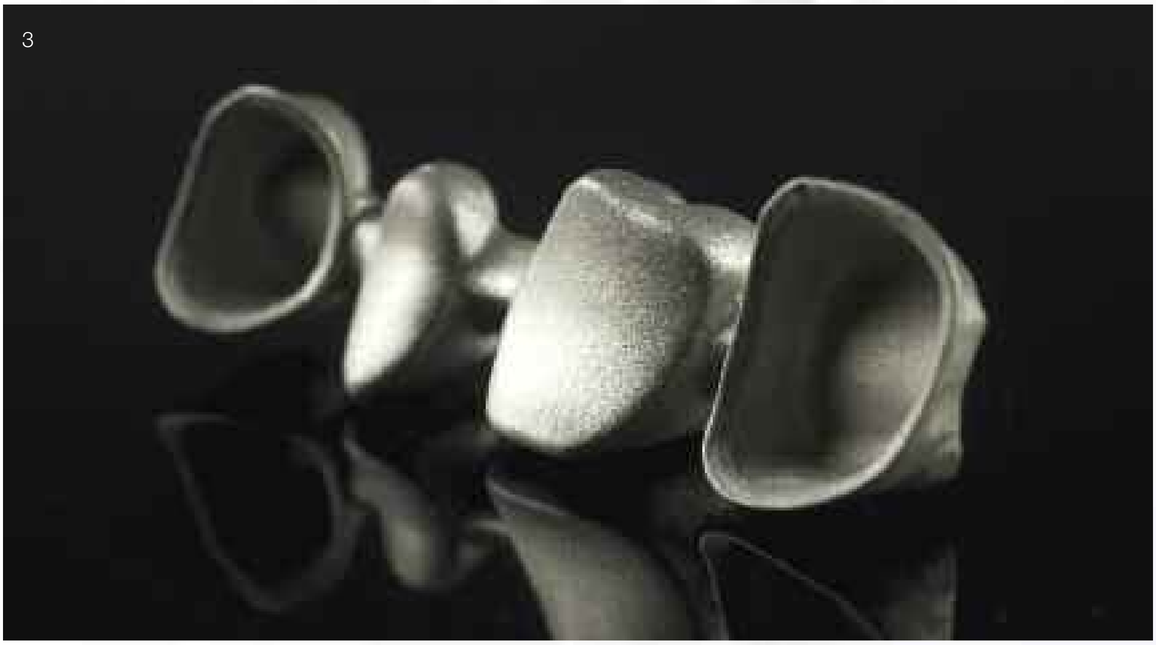
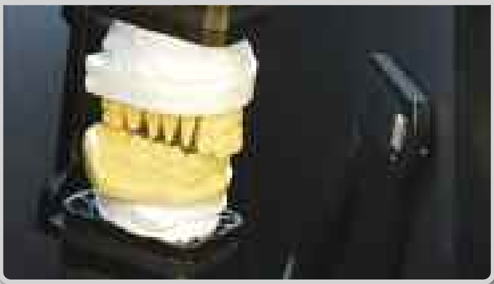


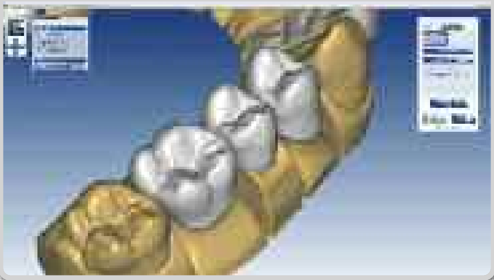
Fig. 3 Bridge frameworks with a maximum of two connected pontics are approved in the anterior and posterior region

Ceramill Sintron Workflow

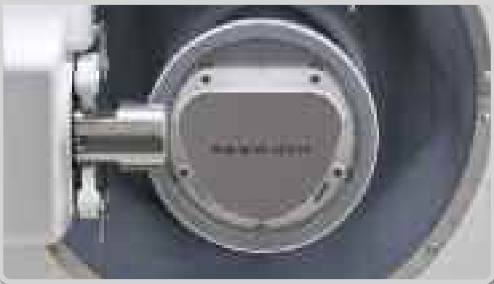
Scanning



CAD

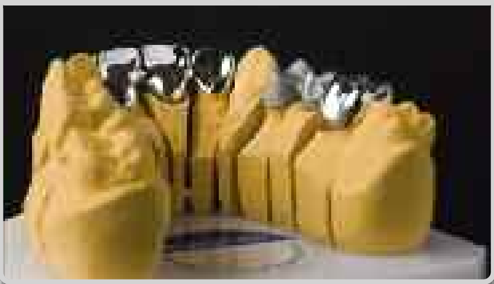


CAM



Sintering

Further processing



Indications

Ceramill Sintron is indicated for the following types of restoration:

- Anatomically reduced crown and bridge frameworks in the anterior and posterior region (Fig. 2)
- Fully anatomical crowns and bridge restorations in the posterior region and anatomically partially reduced anterior restorations
- Bridge frameworks with a maximum of two connected pontics in the anterior region and a maximum of two connected pontics in the posterior region (Fig. 3) and a maximum anatomical length of 50 mm
- Cantilever bridges with a maximum of one pontic (one cantilever unit up to maximum the second premolar)
- Primary telescope crowns

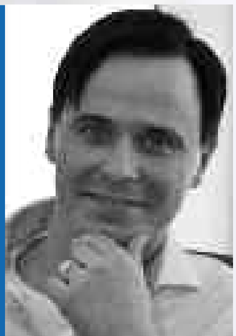
Conclusion

The dry millable Ceramill Sintron CoCr blanks from Amann Girrbach closes the gap that up to now existed between the consequent (full) utilisation of the CAD/CAM technique and central manufacture of CoCr units. The material and accompanying procedure guarantee the user a wide range of indications and alloy characteristics, which comply with the requirements of a Type 4 alloy (DIN EN ISO 22674).
In addition, the advantages provided by CAD/CAM manufacturing can be utilised, whereby the value creation with CoCr restorations can now remain in the owner's laboratory.

Product list

Product	Name	Manufacturer
CAD/CAM software	Ceramill Mind & Match software	Amann Girrbach
CoCr blanks	Ceramill Sintron blanks	Amann Girrbach
Manufacturing unit	Ceramill Motion and/ or Ceramill Motion 2	Amann Girrbach
High-temperature sintering furnace	Ceramill Argotherm	Amann Girrbach
Sinter accessories	Ceramill Argotherm sinter box	Amann Girrbach

About the author



After about eight years working in the dental technology sector (Dental Laboratory Glaser; Boblitz/Brandenburg, Germany), during which he mainly specialised in the fixed/removable technique and implant prosthetics, Falko Noack decided to study at the University of Applied Sciences Osnabrück. After four years at the university he gained the title Dipl.-Ing in Dental Technology. During his study time he worked at the university on various projects in the field of metallography and material testing of dental materials. The topic of his diploma thesis was the development of a process chain for a zirconia pre-sintered blank manufacture. He then applied his practical and technological knowledge in research and development at Amann Girrbach, especially in the field of zirconia production and application technology. Falko Noack is now head of the Research and Development Department at Amann Girrbach.

Contact address

Dipl.-Ing. (FH) Falko Noack • Amann Girrbach AG
Herrschaftswiesen1 • 6842 Koblach/Austria
falko.noack@amanngirrbach.com • www.amanngirrbach.com