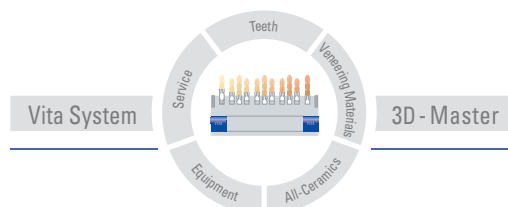
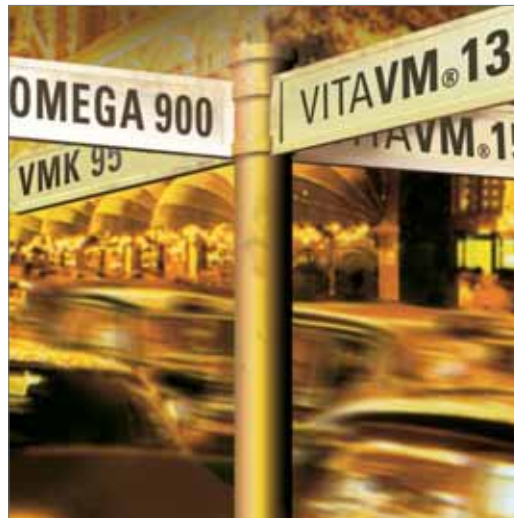


VITA Guide

to metal ceramic
framework design



VITA

VITA metal guide

The development of alloys for metal ceramics, a survey

Gold-platinum alloys

The first alloys for large-scale fabrication of metal ceramic dentures were simple gold-platinum alloys with the addition of a few other components.

Mechanical properties

The mechanical properties had not been matched perfectly and dental technicians first had to get used to processing the new alloys and porcelains. Gradually, however, improved alloys were introduced allowing veneers that featured considerable reliability and aesthetics. These alloys were not only suitable for the production of single crowns but also small and large bridges.

Cobalt-chromium-based alloys

For some years cobalt-chromium alloys have been setting the trend for precious metal-free ceramic bonding alloys. These alloys represent a good alternative if a cobalt-based alloy is used because of the similarity of materials with model casting alloys or any other dental indication.

TEC

In the early stages of development it was unknown that the TEC of the ceramic had to be matched with the alloy. It took quite some time until controlled cooling of the ceramic was recognized as a means to match the two materials.

Reduced gold content alloys

In the beginning of the 80s reduced gold content alloys were developed. After the introduction of these alloys with a gold content of approximately 50 %, palladium alloys were offered which contained only minor quantities of gold or no gold at all. Numerous processing methods had to be developed for these alloys and introduced in the laboratories.

Titanium

For some years titanium has also been used as a basic material for ceramically veneered restorations. The low, specific gravity and the favourable price of titanium render it a very attractive material for dental use. The comprehensive processing method of titanium, however, is responsible for the fact that this material has mainly been used in special laboratories. (see also VITA Titankeramik, directions for use, no. 858 D/E).

Palladium-alloys

Over many years palladium alloys were by far the most common ceramic alloys used in Germany. These alloys, which produce fine results, are still used in many countries today.

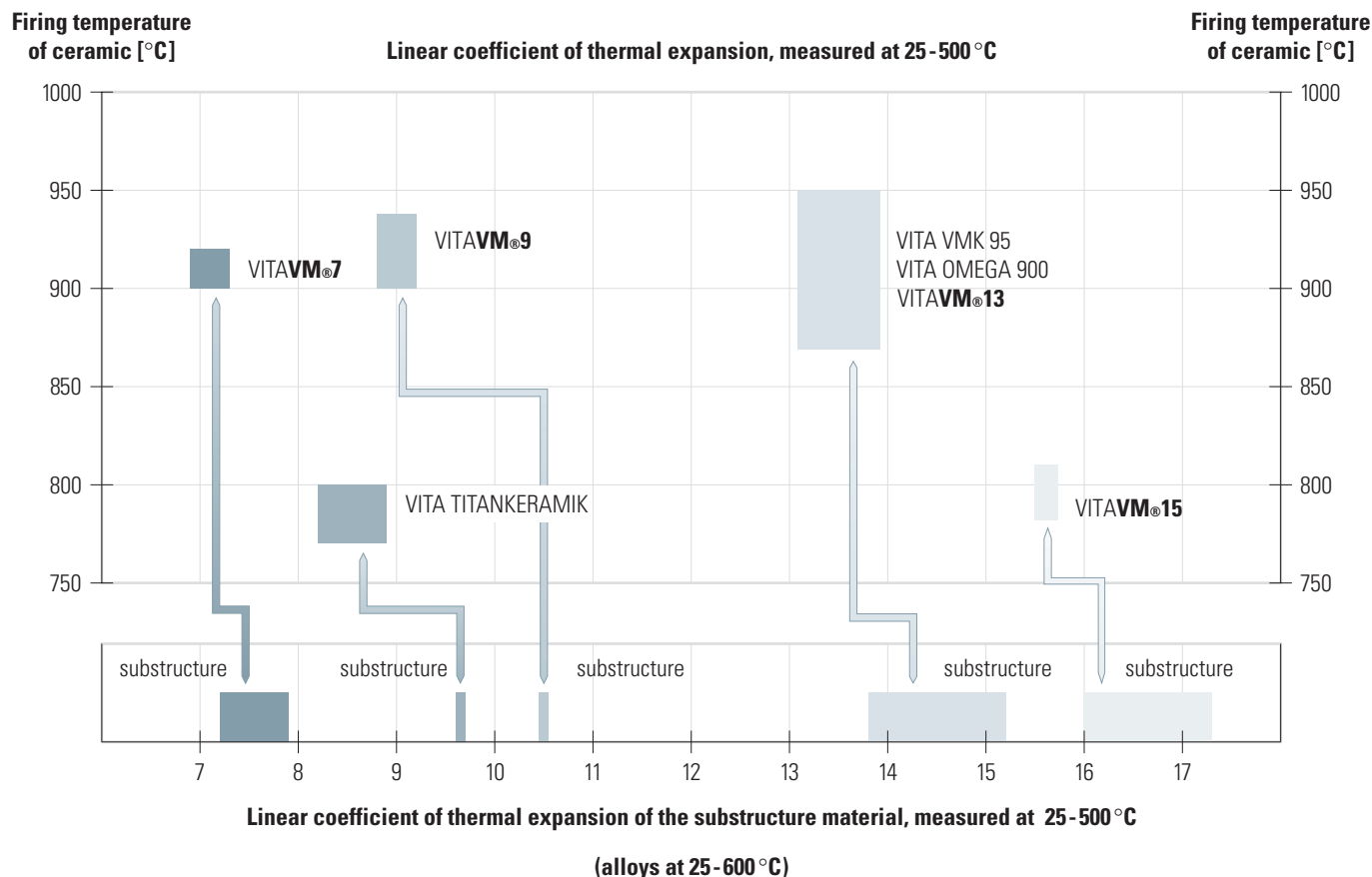
Nickel-based alloys

Low-cost ceramic bonding alloys based on non-precious metals, in particular nickel and cobalt, were also developed. First, only nickel-based alloys were available. Later on materials suitable for veneering could also be produced from the more resistant cobalt. Simple nickel-based alloys are sold worldwide as a favourably-priced basis for metal ceramic work.

Bio alloys

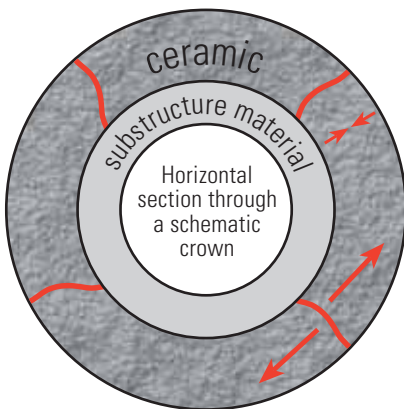
As a result of discussions about the biological compatibility of palladium alloys, more and more alloys were developed under the aspect of optimized biocompatibility in the 90s.

TEC ranges of VITA Veneering Ceramics in relation to the respective suitable framework materials

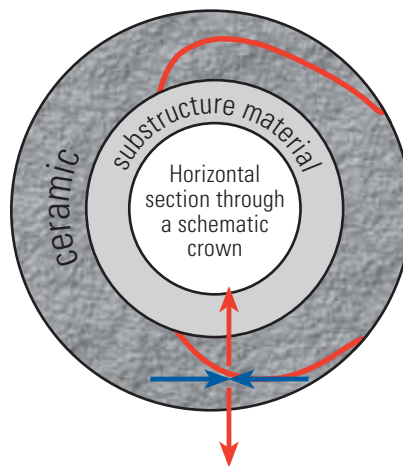


<p>VITAVM®7 CTE (25-500 °C), $6.9-7.3 \cdot 10^{-6} K^{-1}$</p>	<p>VITA In-Ceram ALUMINA, CTE (25 -500°C) $7.2 - 7.6 \cdot 10^{-6} \cdot K^{-1}$ VITA In-Ceram SPINELL, CTE (25 -500°C) $7.5 - 7.9 \cdot 10^{-6} \cdot K^{-1}$ VITA In-Ceram ZIRCONIA, CTE (25 -500°C) $7.6 - 7.8 \cdot 10^{-6} \cdot K^{-1}$ VITA In-Ceram AL, CTE (25 -500°C) approx. $7,3 \cdot 10^{-6} \cdot K^{-1}$</p>
<p>VITA TITANIUM CERAMIC CTE (25-500 °C), $8.2-8.9 \cdot 10^{-6} K^{-1}$</p>	<p>TITANIUM CTE (25-500 °C), $9.6 \cdot 10^{-6} K^{-1}$</p>
<p>VITAVM®9 CTE (25-500 °C), $8.8-9.2 \cdot 10^{-6} K^{-1}$</p>	<p>VITA In-Ceram YZ CUBES for CEREC CTE (25-500 °C), approx. $10.5 \cdot 10^{-6} K^{-1}$</p>
<p>VITA VMK 95, CTE (25-500 °C), $13.3-13.7 \cdot 10^{-6} K^{-1}$ VITA OMEGA 900, CTE (25-500 °C), $13.4-13.9 \cdot 10^{-6} K^{-1}$ VITAVM®13 CTE (25 -500°C) $13.1 - 13.6 \cdot 10^{-6} K^{-1}$</p>	<p>High gold content, reduced precious metal content, palladium based and precious metal-free alloys CTE (25-600 °C), $13.8-15.2 \cdot 10^{-6} K^{-1}$</p>
<p>VITAVM®15 CTE (25 -500°C) $15.5 - 15.7 \cdot 10^{-6} K^{-1}$</p>	<p>Multi-indication alloys CTE (25-600 °C), $16.0-17.3 \cdot 10^{-6} K^{-1}$</p>

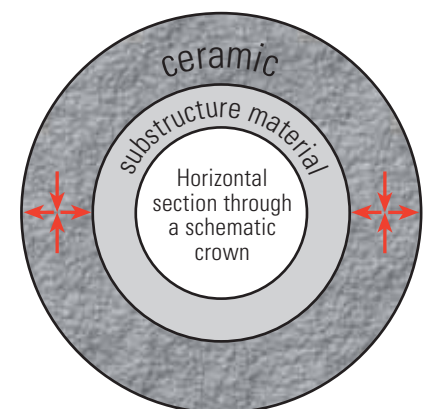
Facts worth knowing about the CTE



If the CTE of the substructure material is **considerably lower** than the CTE of the veneering ceramic, tangential tensile stress will increase and form cracks that run to the outside. This may result in late cracks.



If the CTE of the substructure material is **considerably higher** than the CTE of the veneering ceramic, tangential compressive stress will increase and form cracks that run almost parallel to the substructure. This may result in flaking.



The ideal tangential and radial tensile stress is ensured if the CTE of the ceramic has been optimally matched with the CTE of the substructure material. This way crack formation is avoided due to precise matching of CTEs.

Optimal preconditions are given if the veneering ceramic features a somewhat lower CTE value than the substructure material. Due to the adhesive bonding, the ceramic must follow the thermal behavior of the substructure material. If cooled down, the ceramic is exposed to slight tangential compressive stress. Cracks that are beginning to form and crack propagation will be stopped.

If a substructure material is veneered with ceramic, the thickness of the veneer is a decisive factor in addition to the CTE value. Accordingly, differences in strain (radial tensile stress) are obtained, which will grow in case of increasing layer thickness.

Framework design Modellation



Metal frameworks to be veneered with porcelain must always be designed in a reduced anatomical tooth shape. In this way controlled absorption and distribution of acting compressive and tensile forces will be ensured.

General facts:

- missing die substance must always be compensated for with metal
- transition zones in the area of metal/ceramic must be outside the contact zones towards the antagonist
- sharp transition zones, angled edges and undercuts must be avoided
- the total framework design should be marked by smooth transition zones.



Adequate stability of the framework mainly serves for correct absorption of the acting forces. Additionally, stable design avoids any deformation during firing and contributes to the retention of dimensional stability.



Design of the interdental connectors

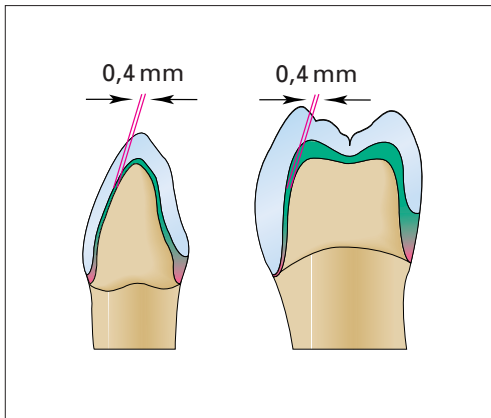
- Sufficiently stable modellation of the interdental connecting areas must be ensured. A design featuring adequate depth is to be prepared that takes periodontal-hygienical aspects into consideration. Large-span bridges can be stabilized with a thin metal collar or at least



with inlay-like proximal reinforcements. Such reinforcements do not only support stability but also serve to control cooling during the firing process. The cooling behaviour of a ceramic bridge is more constant and thermal stress is avoided.

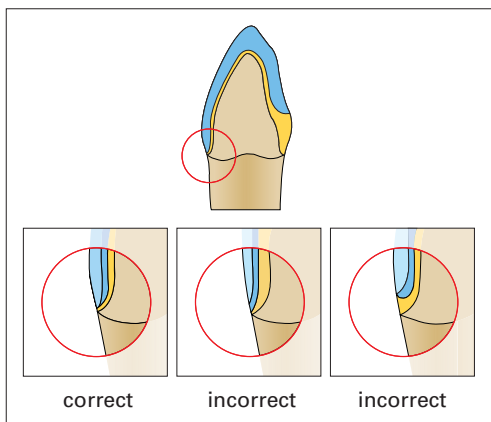


When modelling, sharp edges, undercuts and deep grooves must be avoided. Every effort must be made to achieve smooth transition zones.



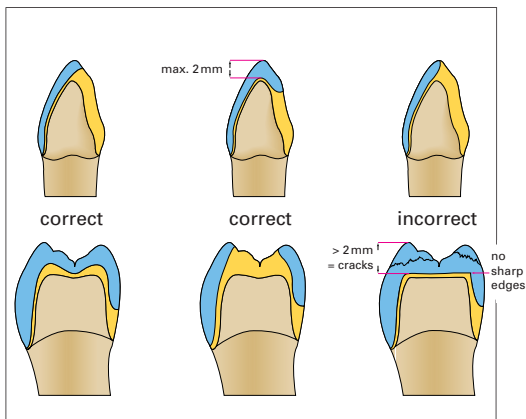
Heraeus Kulzer

- Correct wall thickness of the model.



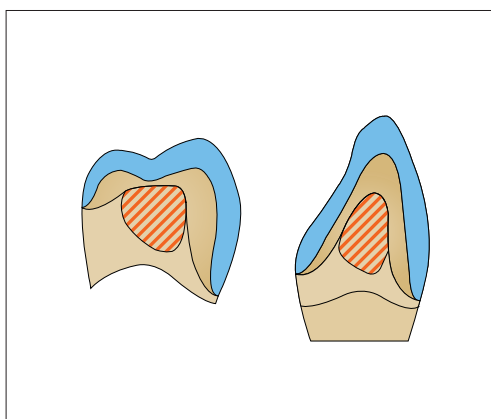
Heraeus Kulzer

- Correct and incorrect modelling of the metal/ceramic transition zone.



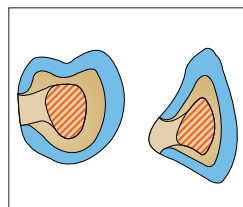
Heraeus Kulzer

- Lateral view of correct and incorrect modelling.



Heraeus Kulzer

- Modelling of the interidental connections.



Heraeus Kulzer

- Modelling of pontics.



Design of the marginal areas

- Use a special wax with suitable characteristics in order to model the cervical marginal areas. Model resins are very common for framework design due to their enhanced stability properties. Since these resins tend to swell considerably during the preheating cycle of the muffle, a thin wax coating is required.

Please adhere to the information provided by the manufacturer to avoid errors and imprecise modelling.



Thickness of the framework

- A thickness of the framework of at least 0,3 mm is required for ceramic veneering. Accordingly, the thickness of the wax-up must be at least 0,35-0,4 mm.



Waxing-up

- Single crown - precious metal alloy at least 0,35 mm
- Abutment crown - precious metal alloy at least 0,45-0,5 mm
- Single crown - precious metal-free alloy at least 0,2 mm
- Abutment crown - precious metal-free alloy at least 0,35 mm

Attaching the sprues



BEGO

- There are very different concepts about attaching the sprues; therefore this chapter is restricted to the description of general, approved basic rules. The type and design of the sprue system depends on the casting method and must be carried out precisely according to the manufacturer's instructions.



BEGO

General principles for attaching the sprues to castings

- the sprue is attached to the thickest point/area
- the molten metal flows from thick to thin parts
- the sprue is placed at an angle of 45° towards the occlusal surface
- the casting lies outside the center of the heat
- all sprues are smoothly coated with wax and lead to the casting without any edges to avoid entraining of investment material particles



- Since massive pontics require more metal than the remaining bridge units, the bar must be reinforced in this area so that it features at least the same volume as the pontic.



- **Tip:** Waxing-up of the bridge elements after the contraction of the wax results in clearly reduced stress in the framework.

Investing



BEGO

For mixing ratios and mixing times for the investment material, please read the instructions provided by the manufacturer.

The following applies to all investment materials (except of speed investment materials):

- The longer the mixing time, the smoother the surface of the casting
- Only small quantities of wetting agent should be used since they influence the investment material.
- Wetting agents must not be applied to model resins, respectively prefabricated plastic elements.



BEGO

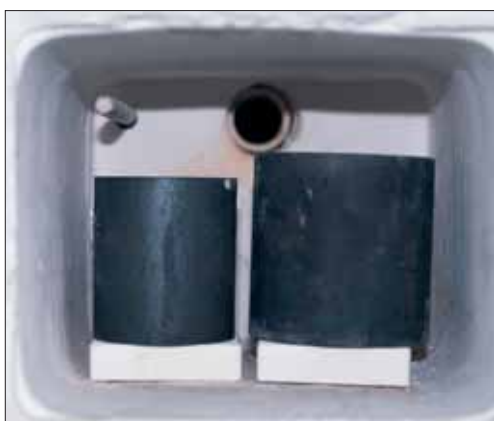
- The investment must be poured in thinly from a height of approximately 20 to 30 cm.



- To avoid bubbles inside the crown, investment material is filled into the crown pattern using a brush or a probe.



- Floating of the wax pattern in the investment material reduces surface tension, removes small bubbles and provides the casting with a smoother surface.
- The investment material is filled up to the upper rim of the ring and the surface is ground in accordance with the respective instructions of the manufacturer (with plaster trimmer or plaster knife).



- When placing therings in the preheating furnace ensure that the muffles do not come into contact with each other and the furnace wall. Elimination of the wax from the rings must also be ensured.

Placement of sprues for crowns and bridges

Golden rules of the sprue system

After opening the crucible, the molten metal flows into the muffle and immediately fills all sprues. Then the entire ring cavity is instantly filled with the hot molten metal through the use of compressed air. The object is to rigidify first and needs to be supplied with liquid molten metal through the reservoir of the sprues. For this purpose the following rules must be observed:

Rule 1: Casting from thick to thin parts

Distribution bar must be sufficiently large; on each side it must be approx. 2-3 cm longer than the bridge and has more volume than the object. In the area of the massive pontics the bar always needs to be reinforced towards the center of the muffle.

Rule 2: Indirect casting

Attach distribution channel to bridges and a small "stick" to single crowns. The molten metal should not flow directly into the object but fill the distribution channel or the "stick" first.

Rule 3: Casting from the inside to the outside

The distance from the object to the bottom of the muffle and from the object to the wall of the muffle must be small. Bridges must be placed in a circle at the muffle wall. Single crowns with "stick" should be tilted towards the wall. Fill investment material only 3-5 cm above the crown margin into the muffle.

Rule 4: No vents

During condensing the compressed air is not directed correctly through vents.

Rule 5: No casting button

Generally, casting buttons are not required. The material quantity to be used is obtained by multiplying the weight of the wax pattern by the density of the alloy (see manufacturer's instructions).

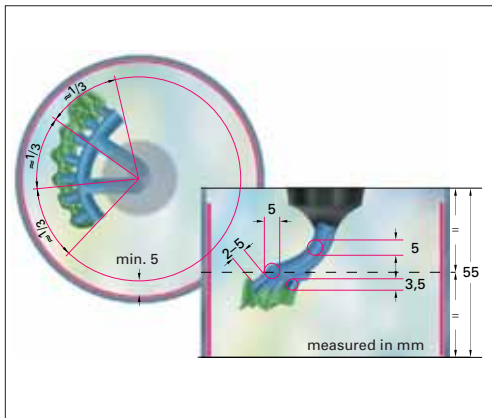
Rule 6: Observe sprue dimensions

Sprues for all alloys with high palladium content and for all precious metal-free alloys require larger dimensions.

Rule 7: Use original sprue former base

The additional and product-specific instructions of manufacturers of investment materials, preheating furnaces, alloys and casting machines must be strictly adhered to.

Casting method



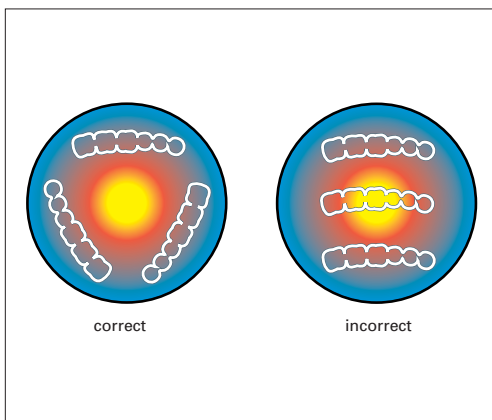
Heraeus Kulzer

- Schematic illustration of bar casting, dimensions for ceramic bonding alloys.



Heraeus Kulzer

- Schematic illustration of the single sprueing, dimensions for ceramic bonding alloys.



Heraeus Kulzer

- Correct and incorrect position of several bridges in the casting mould for centrifugal casting.



- The crowns are close to the wall of the muffle outside the center of the heat and are able to cool first. On each side the distribution channel (bar) should be approximately 2 cm longer than the bridge.

Vacuum pressure casting

- The dimensions of the sprue system must ensure that the cavity is filled quickly and entirely. Additionally, it must be ensured that controlled rigidification of the molten metal removes all shrinkage cavities and porosities from the casting. The sprue is always connected to the thickest point of the pattern.

Direct sprueing of single crowns

- Direct supply through a sprue with a diameter of 4-5 mm depending on the mass of the object.
- The length is approx. 10-15 mm and leads out of the center of heat.
- The connecting point is not tapered. Sprueing with "ost head".
- Distance to the object is approx. 1,5 cm.
- Sprue design for bar casting: head diameter approx. 6 mm or larger. For casting of bridges bar casting is recommended.
- Connecting sprues of 2-5 mm in length and a diameter of 3,5 mm, placed palatally or lingually, are connected to each unit of the wax pattern at an angle of 45°.
- Each bridge unit has a separate sprue.
- It is recommended to have two sprues for large molars.
- All feeding sprues are connected with a bar featuring a diameter of 5 mm.
- The bar runs parallel to the casting.
- Two sprues proceeding from the sprue base former end between the first and second resp. second and third third.
- These sprues have the same diameter as the bar.

Certifugal casting

Centrifugal casting unit for flame melting

- Place casting cylinders or ingots closely to each other in the **preheated crucible**. Move the flame in circles at a distance of 7 cm. As soon as the cylinders or ingots have melted, start the centrifugal casting unit immediately.

High frequency induction centrifugal casting unit

- Place casting ingots into the **preheated crucible** and melt swiftly using the power level given for the respective alloy. The casting cylinders or cubes flow into each other and form a uniform smelt. When this smelt has a uniform bright appearance and the glow shade has disappeared, casting is started.

Trouble-shooting, casting

- It is known that the quality of a dental ceramic veneer depends directly on the quality of the casting. Frequently, sources of errors of the bond can be attributed to low quality of the casting and incorrect processing of materials.
- If old metal is used, the mixing ratio is max. 50% of old metal to at least 50% of new metal.
- Only new metal must be used for precious metal-free alloys.
- Old metal is cleaned through sandblasting and rinsing with water.
- It must be ensured that no graphite particles of the crucible reach the alloy.
- Each alloy requires a separate marked crucible.
- The casting equipment must ensure reliable temperature control and - if possible - automatic monitoring.
- Above all, when melting with the open flame, uniform and careful heating must be ensured. During this melting process there is a particularly high risk of overheating the casting alloy.

Devesting and cleaning of the casting



After casting, the muffle cools down to room temperature and devesting can be carried out subsequently.

- A devesting unit is recommended if a metal ring is used.
- Soak the muffle shortly to reduce dust and cut investment material into pieces using plaster pliers.
- This way investment material can be removed from the casting without the formation of dust.



- Devesting with plaster pliers.



- To avoid any deformation, do not use a hammer for devesting.





Sandblasting

- Investment material residues remaining at the casting can be removed in the sandblasting unit. Generally, only clean disposable corundum (110µm-125µm) for precious metal alloys and 250µm for precious metal-free alloys should be used to clean surfaces to be veneered with ceramic.



- To avoid the penetration of corundum particles into the surface, sandblasting must be carried out at an obtuse angle.
- The correct blasting pressure is ensured by regularly checking the quality of the blasting nozzle.
- Low-quality corundum is not suitable.
- The repeated use of abrasives must be avoided.



- The max. working pressure must be selected in a way that the sensitive margins will not be damaged. Impacting of precious corundum into the surface may result in serious errors during firing.

Recommended working pressure for precious metal alloys: 2-3 bar; precious metal-free alloys: 4-6 bar.



Pickling of precious metal alloys

The surface can be cleaned through the additional use of a suitable pickling agent. Pickling agents are ready for use and the manufacturer's instructions must be strictly adhered to when using them.

- Each alloy requires a specific pickling process to avoid contamination of the surface to be veneered by pickling agent residues of different alloys.
- To ensure correct concentration, the pickling agent must be changed regularly.
- The pickling time must be calculated exactly and must not be estimated.

Separating and finishing



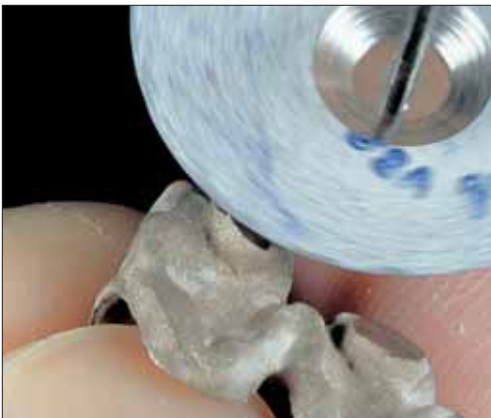
- The casting is separated with ceramic bonded discs mounted in the handpiece ...



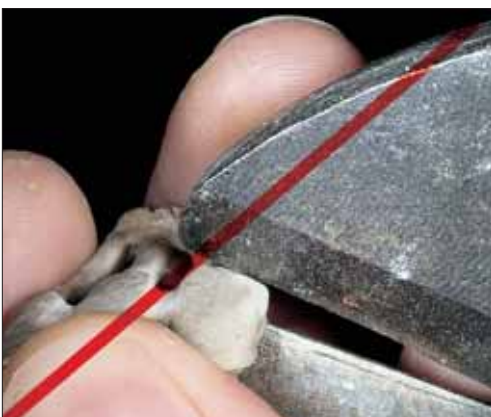
... or the rapid grinder.

Important:

Always wear safety goggles, work behind a protective screen and switch on the dust extraction system. During grinding, gold dust is collected by special filters.



- Ceramic bonded discs are used for coarse grinding of the sprues.
- Adequate stability of the mandrel and correct concentric running must be ensured.
- Sharpen the grinding discs with a whetstone prior to grinding.



- Never use a bolt cutter to cut off the casting.



Finishing

- Finishing of surfaces to be veneered with ceramics is subject to strict requirements. Fine bonding values can be achieved only if the surfaces are prepared correctly. Tungsten carbide burs are perfectly suitable for finishing. Controlled working is ensured due to cutting removal.



Removal with the help of diamond grinding tools or ceramic bonded stones is possible but includes various sources of errors that affect a reliable bond:

- Framework porosities are sealed and riveted.
- Residues of the ceramic binders on the surface are hard to remove. The contaminated surface causes the formation of pores and gas in the ceramic.
- Diamond grinding tools normally leave metallic contaminations on the surface of the framework.



- Tungsten carbide burs should exclusively be used for processing a single material to ensure that no foreign alloy components can penetrate into the sensitive surface.
- When shaping the object, the bur should be moved in one direction using uniform movements.
- The burs must regularly be cleaned with the steam jet or in the ultrasonic unit.

Summary of correct surface processing



- Investment residues are removed with disposable corundum in the fine sandblasting unit at a pressure of 2-3 bar for precious metal alloys and 4-6 bar for precious metal-free alloys.
- Pickling is carried out strictly according to the manufacturer's instructions.
- Fine-cut tungsten carbide burs are used for coarse finishing.
- Finishing and final shaping is carried out using diamond-coated tungsten carbide burs.
- A reliable metal-ceramic bond requires sandblasting of the framework surface with precious corundum, grain size 125µm, at a pressure of 2 bar for precious metal alloys resp. grain size 250µm at a pressure of 4-5 bar for precious metal-free alloys.
- After sandblasting, the surface must not be contaminated with grease or similar material.
- The framework is cleaned with the steam-jet unit or boiled in distilled water.
- After cleaning, the framework may only be touched with tweezers or a similar tool.
- When fitting on the framework, a fine auxiliary material that burns out without any residues (lipstick, Occluspray) is used.
- Contact spots and premature contacts are removed under the stereomicroscope using suitable burs.
- If the primary fit is satisfactory, the framework is finished.



- The cross-cut tungsten carbide bur ensures perfect removal of material.

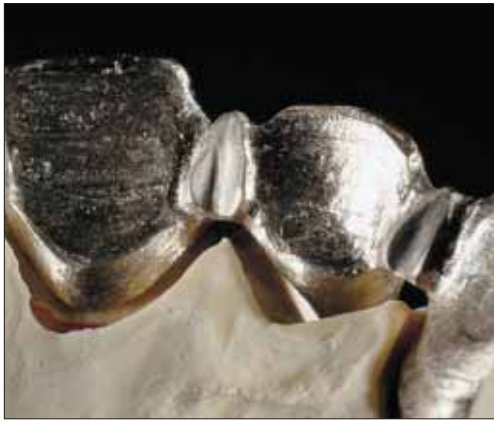


- The perfect basis of an optimal metal-ceramic bond is provided by finishing with diamond-coated tungsten carbide burs featuring bevelling cut.



Detailed views of a correctly prepared framework.





- Completed metal framework with inlay-like reinforcement ...



- ... or small collar.



- Perfect preparation of the metal margins is carried out at the end of the finishing process.



Cast-on auxiliary elements

- Cast-on elements are frequently used especially in the field of implants and combined techniques. These materials do not form any bonding oxides which are required to form a bond with the ceramic.

Accordingly, an adequate wax quantity must be used when shaping the framework.

Cervical ceramic shoulder



The cervical ceramic shoulder allows perfect, aesthetic integration of the restoration in the cosmetically relevant area.

Preconditions:

- Preparation of chamfer or shoulder.
- Accurate presentation of the preparation margin.



- Uniform reduction of the crown framework is required.



- Reduction is carried out as mentioned before using rotary instruments along the marking.



Completed reduction.

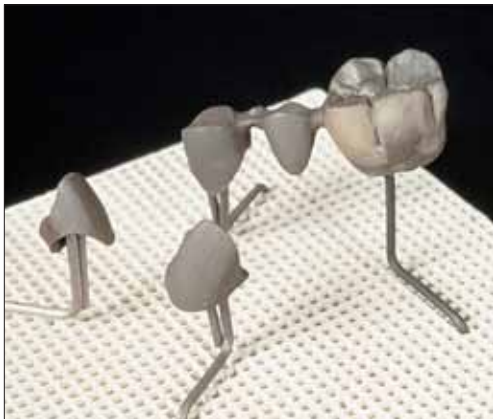
- Make sure that uniform support of the ceramic shoulder material is provided by the metal framework. Layering of the cervical ceramic shoulder, see page 27.

Sandblasting and oxide firing

- If precious metal alloys are used, the surface to be veneered must be cleaned with the blasting nozzle at a pressure of 2-3 bar (grain size 110 μm - 125 μm). Precious metal-free alloys are sandblasted with aluminium oxide, grain size 250 μm , at a pressure of 4-6 bar.
- After sandblasting, the framework must be cleaned under running water or with the steam jet unit.
- Do not touch the framework with your fingers to avoid contamination with grease.
- Each metal surface must become subject to thermal treatment prior to applying the opaque. Oxide baking is carried out between 900-980 °C (precious metal alloys). The temperatures of the alloys have been matched individually and the manufacturer's instructions must be observed.

Targets of oxidizing:

- Non-precious alloy components oxidize at the surface and serve as retention elements of the metal ceramic bond.
- Contaminations and porosities can be seen on the surface and can be removed.



- Optimum support during the firing processes avoids possible thermal deformation.
- Stain-free and uniform oxide colour is required.
- The framework must be supported adequately and uniformly to avoid thermal distortion.
- A moderate heating rate is required to avoid exceeding the final temperature (55°C-75°C/min).
- Uniform heating ensures perfect fit of the framework.
- Slow cooling avoids stress in the framework.

Pickling



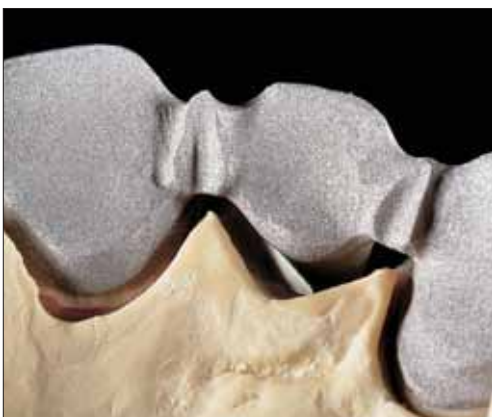
Some alloys require a further pickling process after oxide baking. Precise working according to the instructions is required to avoid possible interactions with the opaque material. Then acid residues must be thoroughly removed from the framework using the steam jet unit.



- Detailed views of the framework after pickled oxide firing.



- Some alloy types require sandblasting. Follow manufacturer's instructions.



Golden wash opaque material



By applying the golden-yellow wash opaque a particular warm-shaded basis is obtained.

Applying the opaque

- To cover the dark shades of the framework colour, opaque is applied. The opaque is the decisive element in the system of processing steps. It determines the quality of the bond and is also used to obtain the colour-bearing basis of our cosmetic efforts. The material can be applied in different ways:

Applying paste opaque

The paste material that is supplied in cups is gently brushed onto the framework surface using the special brush. It must be ensured that the paste opaque is mixed in the cup with a plastic instrument prior to the application. Even after extended storage the correct consistency can be obtained again by mixing with a specific quantity of Paste Opaque Liquid.



Information:

- Solid opaque material readily deposits at the bottom of the cup after extended storage.
- Uniform material consistency must be ensured for materials that are used less frequently.

Applying powder opaque

The opaque material is mixed with the glass spatula and Opaque Liquid. A creamy consistency of the opaque should be obtained. Then the material should be applied with the brush or the glass probe in lightly gyrating movements.



Disadvantage of powder opaque

- Small puddles can be formed in interdental spaces or marginal areas.
- Frequently, coating of the framework is insufficient and causes a grey bloom that makes correct reproduction of the shade impossible.



Applying according to the VITA SPRAY-ON method

- The opaque can be applied in a particularly reliable way if the VITA SPRAY-ON method is used. The opaque material is mixed in the glass vessel with VITA SPRAY-ON LIQUID and sprayed on. Extremely thin and non-transparent layers can be applied.



Due to the enormous grain density an enhanced bond can be achieved for all-ceramic systems.



- If the opaque is placed into the VITASONIC II unit for approx. 30 seconds prior to the use, a particularly uniform and fine consistency is obtained.



Whatever method you decide to use, the material is always applied in two steps:

1. Opaque firing as wash bake

- Organic components are burned out through the base material.
- The opaque material sinters on the bonding oxides of the metal surface and provides the bond.
- Additional bonding oxides are formed on the surface.

2. Opaque firing

- Masking coat of material is applied.
- To avoid the penetration of opaque material into the interior of the crown, spraying is carried out on to the working model.



Firing behaviour:

- The correct surface of the fired opaque must demonstrate an "egg-shell lustre". Insufficiently fired opaque features a non-homogeneous and porous material structure. Frequently an opaque surface that is too lustrous does not provide adequate retention for sintering onto the ceramic and may also cause bonding problems.



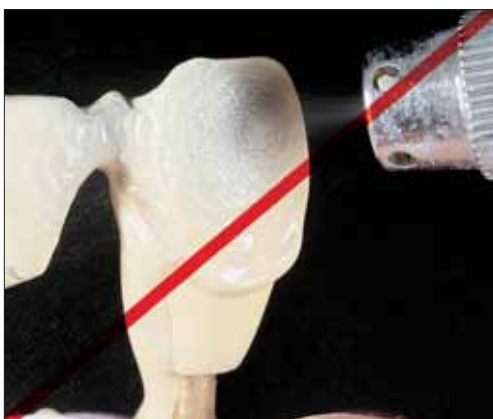
- Brushes and other auxiliary instruments which do not ensure complete removal of material residues should only be used for their respective ceramic.
- Opaque must never be processed with metal instruments. Metal abrasion of the instruments may result in serious contamination and weaken the bond. Therefore only glass, agate and plastic instruments should be used.
- Prior to preparing used opaque material, any residual liquid must be removed and replaced by fresh VITA SPRAY-ON LIQUID and the materials must be mixed with a spatula again.



- Due to material residues in the gun, a separate gun should be used for each ceramic system.



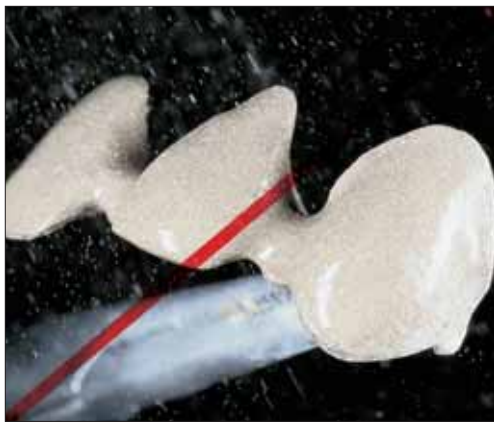
- Damage to the fine needle tip may result in incorrect application behaviour.



- Material that is too wet when applied will not coat the object sufficiently.
- Excessive working pressure and distance that is too small will result in processing errors.



- Opaque material that is too dry may cause air to be trapped.



- Firing temperatures that are too high may result in chipping since the very smooth surface of the opaque will not form a bond with the opaque dentine or dentine that are applied subsequently.



- Bubbles due to contaminated framework surface.



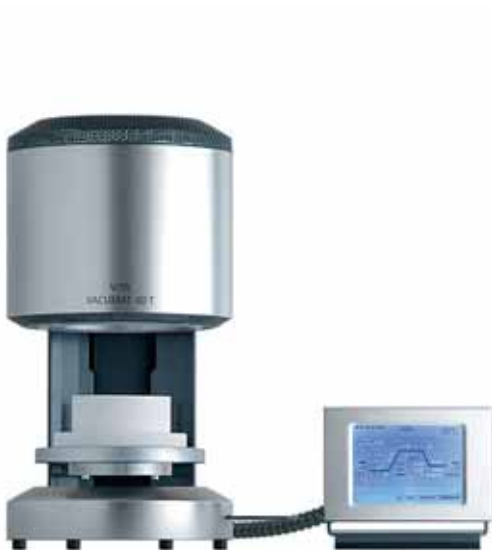
Arbitrary change of the firing temperature

the following must be avoided

- Predrying temperature too high
- Drying time too short
- Heating too quickly



- To ensure constantly reproducible firing temperatures, the same type of firing trays should always be used. Support pins must not be damaged or shortened.



The demands made on a modern dental ceramic system are very high. In this regard VITA Zahnfabrik has succeeded again and again in meeting the desires and expectations of their customers. Modern ceramic systems, however, require accurate adhering to the specific processing parameters to fully develop all their properties and features. Accordingly, thorough testing of the ceramic furnace represents the most important precondition to successful firing of frameworks.

Therefore the following aspects must be observed:

- Ceramic furnaces in which different alloys are fired must be cleaned regularly (once a week).
- Cleaning is carried out in several firing processes at maximum power (1100 °C, 10 min).
- Considerable oxide deposits may cause weakening of the bond and discolouration of the ceramic (a clear evidence is the discolouration of the fireclay base)
- Furnaces with large temperature fluctuations are unsuitable.
- Damaged fireclay bases and contaminated lining material of the furnace must be exchanged before firing.
- Complete function of all filament resp. quartz windings must always be ensured.



Determination of the correct firing temperature

Tip:

Apply translucent material onto an opaque-coated framework. If the edges are already broken after firing, the firing temperature is too high. If the ceramic is too milky and non-homogeneous, the temperature is too low. Approach the average temperature in steps of 5°C. A slight lustre of the porcelain surface confirms correct firing.

Layering of the cervical ceramic shoulder



Prior to applying the shoulder material, the plaster die is prepared in the usual way:

- Harden the plaster
- Apply plaster insulating agent.



- Friction-free fitting of the opaque-coated framework on the die must be possible.



- Application of the shoulder material (MARGIN) for first firing process. The MARGIN material is mixed with MODELLING FLUID and heated to be hardened. It is recommended to stabilize the shoulder material with a hair-dryer or with radiated heat at the furnace opening.



- The plasticized shoulder materials ensure a maximum degree of stability and reliability. Simple lifting off is also ensured.



- After first firing, fired shoulder exhibits ...



... excellent fit.



- Completion for the second shoulder material firing process is carried out in the usual way.



- Perfect marginal seal after corrective firing of the shoulder.





- It is absolutely required to insulate the plaster model to ensure uniform content of moisture of the ceramic during layering.



Tip:

Due to the plasticized shoulder materials, base portions can be prepared at the pontic and fired during the second shoulder material firing process.



- Result after firing.



- Initial situation prior to layering the body.



- Different dentines and ...



... luminaries provide a thin coat across the entire labial surface.



- This allows very precise and accurate control of the brightness value from the depth.



- Check with silicone key.



- Applying dentine featuring different brightness to build up the tooth shape.



- Different chroma, translucent and transparent porcelains are added.



- After slight, central reduction of dentine ...



... an opaque "belt" is prepared.

- Additional individualization by applying Interno porcelains.



Slow cooling:

Slow cooling is required from the first dentine firing onwards in the case of alloys with a thermal expansion coefficient of $>14.4 \cdot 10^{-6} \text{ K}^{-1}$ (max. $15.2 \cdot 10^{-6} \text{ K}^{-1}$).

In the case of alloys with with higher thermal expansion coefficient, cooling down from 900°C - 700°C must not taken less than 3 minutes.

- Result after first firing.



- For further characterization, stain fixation firing can be carried out.



- Enamel and translucent porcelains are added to the tooth shape.



- Result after first corrective firing.



- Shape and surface texture of the restoration can be compared with the natural teeth on the plaster model by using silver powder, and - if required - adjusted.



- Prior to glaze firing, all residues of the silver powder must be removed by steamblasting.



- Detailed views of the completed work.



- **Pickling after firing**

Oxide deposits on the fired ceramic bridge may cause serious irritations of the soft and hard tissues. To achieve a maximum degree of safety for the patient, the fired object must be pickled.

Detailed information on standard layering, individual layering and firing temperatures are included in the directions for use for VITA VM13, VITA VM15, VITA OMEGA 900, VITA VMK 95 and VITA TITANKERAMIK.

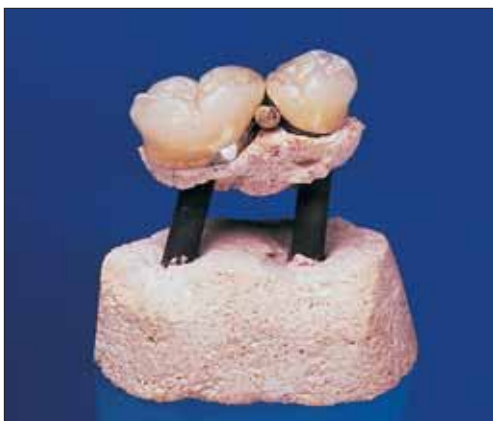
Furnace soldering



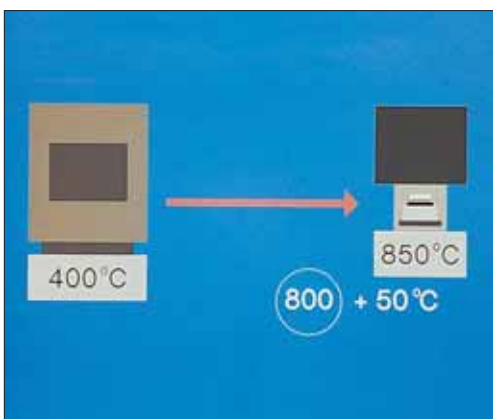
- The crowns are fixed on the model using adhesive wax. The soldering gap should be approx. 0,05 - 0,2 mm.
- Prior to fixing with adhesive wax, the soldering gap should be filled up with **casting wax** to enhance boiling out resp. Burning out behaviour. For reasons of stability it is recommended to connect the crowns with a stable wire and adhesive wax.
- The entire ceramic surface is now coated with pink base wax to avoid contact of ceramic and solder investment material.



- To keep the soldering block as small as possible, the crowns are filled up with a small quantity of solder investment material and then fixed with firing pins G in the actual soldering block as a remote center of heat.
- Then the connection and the wax layer are boiled off.



- A small quantity of flux is added into the soldering gap without wetting the ceramic. The **solder** is shaped into a ball, dipped into flux and attached to the soldering object.



- Preheat object in the preheating furnace with flux and solder for 15-20 min at 400°C.
Working temperature of the respective solder + 50°C.
Predrying: 5 min
Heating: 5 min
Hold the temperature: 4 min
- For solderings after ceramic firing the same cooling rate must be adhered to as for ceramic firing. After cooling, the investment material is removed and the object is cleaned under running water. Flux residues and oxides are removed with a clean pickling agent. Then the material is finished once more and polished.

Supplement:**Soldering and laseing**

Soldering as well as laseing of frameworks is a very complex and difficult process which strongly depends on the experience of the dental technician. If a strict processing routine is not followed, the technician may endanger successful completion of the ceramic veneer.

Trouble-Shooting / Soldering and laseing

- To ensure precision of fit, the framework must not be overheated.
- Fluxes and soldering pastes must be completely removed with pickling agent.
- Soldering after ceramic firing must always be carried out in the ceramic furnace.
- Surface contamination by carbon must be thoroughly removed with burs and sandblasting.
- Ceramically veneered surfaces must not be coated with solder across large areas.

Laser welding with cospecific additional materials ensures a maximum degree of biocompatibility. Laser welding can be carried out prior to firing if adequate preparation of the framework is ensured even after firing.

Working steps:

Clean the point/area of fracture and bevel. If necessary, prepare and insert a complementary element from the same alloy. Sandblast with Kronox® 110. Small cross-sections require depth welding with additional material (spot size Ø 0,3 - 0,4 mm). Larger cross-sections must be connected with a circular tube welding and additional material (spot size Ø 0,8 mm).

For successful and safe laser welding please observe the following:

- Sufficient amount of argon floats around the weld seam - distance approx. 1 cm.
- Discolouration of welding spots is evidence of excess energy combination or insufficient argon floating.
- Formation of cracks in the welding spot indicate excessive energy or too much exposure to the laser beam.
- In case of repair work it may be necessary to model parts to be replaced (e.g. crown margin).
- Compressed or overstretched framework parts must not be reused.

SUMMARY

"Small things matter most"

The previous pages provide a guide to correct framework design. You may have recognized that we have put special emphasis on the possible sources of errors. It is the small things which sometimes make life difficult in our already hectic daily life. When we continued our search for the "small things" we noticed that it was necessary to take a separate look at differences among the groups of alloys in order to meet the highly specific requirements of different dental alloys.

For dental-technical use four types of alloys can be mentioned; they reveal considerable differences in their composition.

Cobalt-chromium alloys

- Very high stability and hardness
- Compared to AuPt alloys, the E-modulus is approximately twice as high
- High heat resistance due to high solidus point
- Low ductility (brittle)
- No cold-forming possible

Attaching the sprues

- It may be necessary to attach pressure compensation channels

Casting

- Perfectly suitable for flame or high frequency centrifugal casting
- Use only ceramic crucibles with special melting powder or protective gas

Oxidizing

- Not applicable!

Long-term cooling

- Long-term cooling with slightly opened furnace chamber down to 450°C (5-7 min)

Peculiarities:

High gold content alloys (palladium-/copper-free)

Biocompatibility

- Resistant
- Corrosion-resistant
- Neutral taste, can be combined with existing restorations without causing adverse reactions
- Plaque-resistant

Casting

- The casting temperature is approximately 1300 °C.
- Graphite is the preferable material for the crucible.

Oxidizing

- 10 min at 950°C with vacuum
- #### Cooling behavior
- Long-term cooling must be carried out from a TEC of the alloy of $> 14.4 \cdot 10^{-6} \text{ K}^{-1}$. (max. $15.2 \cdot 10^{-6} \text{ K}^{-1}$)

Firing

- Low heat resistance
- During ceramic veneering (across the entire temperature range) safe and stable support of the frameworks on the firing tray must be ensured

Palladium-based alloys

- Palladium-based alloys reveal a tendency to absorb carbon and hydrogen
- There is a risk of formation of bubbles since carbon reduces the bonding oxides
- CO forms gas bubbles
- Silver component may have a considerable effect on the reproduction of shade

Casting

- The casting temperature is approximately 1400°C.
- Use melting powder or protective gas (only small quantities)
- Melting with the open flame may result in the undesired absorption of carbon
- Ceramic crucibles must be used: each alloy requires a separate crucible!
- Do not use graphite crucibles

Reduced gold content alloys

- Reduced gold content alloys have a higher palladium content
 - This fact may have a negative effect on the shade
 - Increased silver content may result in contamination of the firing chamber
 - Small tendency towards two-phase separation.
- #### Oxidizing
- Uniform oxidation firing
 - Bright oxide colour
- #### Firing
- Possibility of slight contamination of the firing chamber due to non-precious alloy components
 - Greenish discolouration possible if other ceramic systems are used

Oxidizing

- 10 min at approx. 900°C to 950°C
- Major oxide discolourations must be removed by sandblasting

Pickling

- Commercially available pickling agents
Use separate acid bath!

Cooling behaviour

- Long-term cooling must be carried out from a TEC of the alloy of $> 14.4 \cdot 10^{-6} \text{ K}^{-1}$. (max. $15.2 \cdot 10^{-6} \text{ K}^{-1}$)

Additional information

- Grease-free surfaces must be ensured since carbon residues affect the bond
- Large oxide deposits after firing can be removed by sandblasting at low pressure.

The following products are subject to obligatory labeling:

VITA VM OPAQUE FLUID / VITA OPAQUE FLUID



Corrosive

Causes severe burns.
Store under lock and key.
Do not eat and drink while working.
In case of eye contact rinse immediately and thoroughly with water and consult physician.
Wear appropriate protective clothing.
Wear protective gloves and protective goggles/face mask.

VITA SPRAY-ON LIQUID



Flammable

Keep container tightly closed and store in a well-ventilated place.
Do not inhale vapors/aerosol.
In case of insufficient ventilation wear respiratory protection.
In case of accident or unwellness consult physician (if possible show this label).
Avoid exposure – obtain specific directions before use.

VITA SPRAY-ON INDICATOR LIQUID



Toxic, Flammable

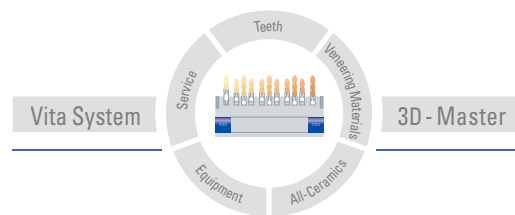
Keep container tightly closed and store in a well-ventilated place.
Do not inhale vapors/aerosol.
In case of insufficient ventilation wear respiratory protection.
In case of accident or unwellness consult physician (if possible show this label).
Avoid exposure – obtain specific directions before use.
This product and its container must be disposed of according to the regulations for hazardous waste.

For more details please see Material Safety Data Sheets!

Wear suitable protective goggles/face mask,
protective gloves and protective clothing when working.



We would like to express our gratitude to Mr Carsten Fischer and Mr Markus Zierz of Zahntechnik Hamburg GmbH for the photodocumentary design and their cooperation with regard to the content of this brochure as well the companies Bego Bremer Goldschlägerei Wilh. Herbst GmbH & Co. and Heraeus Kulzer Dental GmbH & Co. KG for their support and contributions.



US 5498157 A
AU 659964 B2
EP 0591958 B1

Please note: 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 materials 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 legally permissible, is limited to the invoiced value of the goods supplied excluding turnover tax. In particular, as far as legally 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 (fault in making the contract, breach of contract, unlawful acts, etc.) can only be made in the case of intent or gross negligence.
Date of issue of these instructions for use: 07-07

VITA Zahnfabrik has been certified according to the Guideline for Medical Device Directive and the following products bear the CE mark:  0124

VITAVM®7
VITA TITANKERAMIK
VITAVM®9
VITA VMK 95
VITA OMEGA 900
VITAVM®13
VITAVM®15

VITA

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