kuraray

Noritake

TROUBLESHOOTING HANDBOOK

FOR KATANA™ Zirconia

THE ROUTE TO PERFECTION:
SIMPLE, QUICK AND RELIABLE FOR
HIGHLY AESTHETIC RESTORATIONS

CONTENT TABLE

1. MODERN ZIRCONIA AS A HIGH-END MATERIAL

Modern zirconia has a high potential: the material properties meet virtually every expectation in terms of aesthetics and function. Whether it is used for frameworks, micro layering or monolithic restorations, all applications can now be covered with zirconia. Nevertheless, zirconia is a sensitive material that requires a high level of attention during processing. The saying “The devil is in the details” fits well here. After all, it is often the little things that ultimately have the greatest effect: for the better but also for the worse. In this white paper we have summarized the fundamental rules, “hidden” obstacles, and common sources of error when processing zirconia. This is because we want you to reach your desired result simply, quickly and safely – with high-quality zirconia restorations from KATANA™ Zirconia.

If we take a quick look back, we can see how comparably quickly zirconia established itself as a material for fixed restorations in dentistry.
At the start of the 2000s, zirconia was an opaque, chalky white material that, due to its limited aesthetic properties, was only used to manufacture veneered frameworks. Especially at the beginning, failures (e.g. chipping of veneering ceramics) often occurred, in particular due to processing errors.

These were thoroughly researched and critically discussed. The veneering fractures were largely caused by an incorrect framework design, overly rapid cooling, and insufficiently coordinated coefficient of thermal expansion values between the framework and the veneering ceramics.

Nowadays, there are clear processing criteria based on extensive study and well-executed research in materials engineering. More than twenty years after its introduction in dentistry, zirconia has developed into a highly aesthetic material that ensures success in many situations – with and without veneering (monolithic). Right at the forefront of this is KATANA™ Zirconia from Kuraray Noritake Dental Inc..

COLOUR GRADATION AND GREAT TRANSLUCENCY ...

... AND NATURAL COLOUR APPEARANCE OF RESTORATIONS MADE OF KATANA™ Zirconia.

2. IMPORTANCE OF SELECTING THE MATERIAL

KATANA™ Zirconia AS THE BASIS FOR AESTHETICS, EFFICIENCY AND SIMPLICITY

Users have a large selection of zirconia at their disposal. There are many providers of zirconia and at least as many zirconia products. Science and the dental industry will never get tired of pointing out that not all zirconia are alike. Rather, there are major differences in quality depending on the selected raw materials and industrial processing techniques.

Zirconia differs, among other things, in its optical properties. This may be problematic in everyday laboratory work, e.g. if the zirconia restoration in the A2 shade deviates considerably from the reference stick. This results in clear failures, causing extra work and dissatisfaction.

With the increasing aesthetic potential of zirconia and decreasing thickness of veneering ceramics, this fact is more relevant than ever. Users must be able to rely on the aesthetic potential of zirconia, especially for the manufacturing of monolithic restorations.

The purchase price is not the only factor that determines the efficiency of a material in daily routine; the processing quality and dependability of the results are particularly important.

" The quality of zirconia and thus that of the prosthetic work depends on the quality of the raw material. This has a major impact, e.g. on the optical properties, surface quality, edge stability, and accuracy of fit. Unlike many other manufacturers, Kuraray Noritake Dental Inc. produces all zirconia in-house. From the proprietary powder technology through to disc pressing and pre-sintering, all aspects are meticulously coordinated. The high quality of KATANA™ Zirconia is based on decades of ceramic competence."

Mathias Fernandez Y Lombardi

(EU Scientific Manager for Dental Ceramics & CAD/CAM Materials of Kuraray Noritake Dental)

3. KATANA™ Zirconia LINE-UP

Translucency
45%
High Translucency

Flexural Strength
1,100 MPa
No layers

Translucency
45%
High Translucency

Flexural Strength
1,150 MPa
All layer

Translucency
ENAMEL: **49%** BODY 1: **47%** BODY 2, 3: **45%**
Integrated Translucency Gradient

Flexural Strength
ENAMEL: **750 MPa** BODY 1: **1,000 MPa** BODY 2, 3: **1,100 MPa**
Integrated Strength Gradient

Translucency
49%
Super Translucency

Flexural Strength
750 MPa
All layers

Translucency
51%
Ultra Translucency

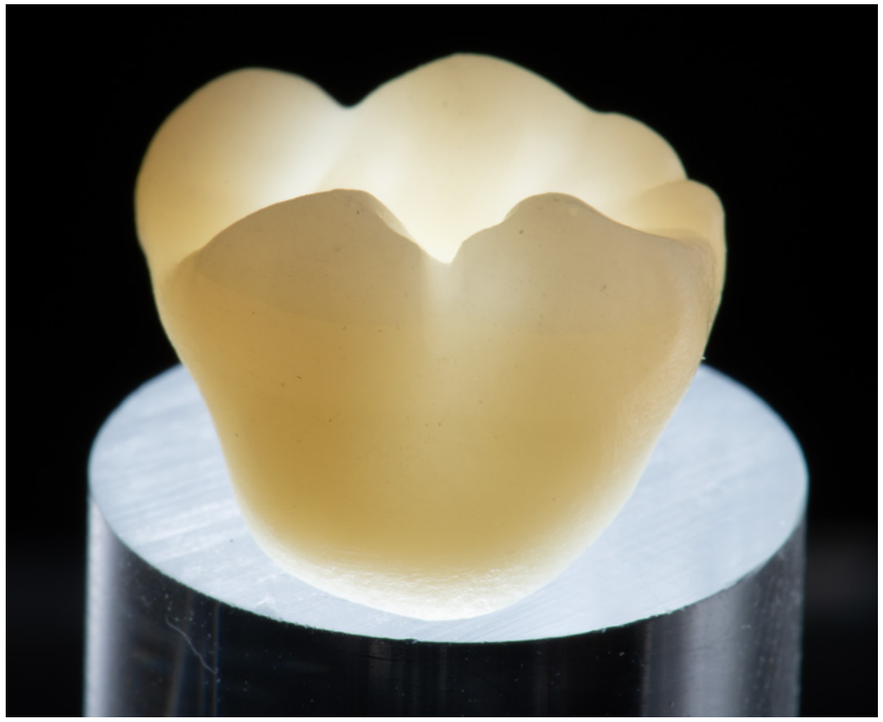
Flexural Strength
550 MPa
All layers

We recommend using framework and veneering materials from one manufacturer, if possible, that are compatible with each other (e.g. KATANA™ Zirconia and CERABIEN™ ZR from Kuraray Noritake Dental Inc.).

4. TROUBLESHOOTING GUIDELINES

FOR MANUFACTURING RESTORATIONS FROM KATANA™ Zirconia

Even when working with the best zirconia, failures may occur. Zirconia is a sensitive material that reacts to the most subtle of changes. Correct processing is based on many factors correlating with each other. If defects occur when manufacturing zirconia restorations, help is needed quickly. In the worst case, incorrect results mean that a new restoration has to be made. This is why causes of errors should be identified quickly and solutions found as soon as possible. Kuraray Noritake Dental Inc. offers extensive assistance, e.g. with a specialist support team of trained material experts. We have created the Troubleshooting Handbook to provide quick help for users.



5. FUNDAMENTAL PROCESSING TIPS

Always follow the manufacturer's specifications (milling, sintering, glazing)

BLANK MANAGEMENT

- Store zirconia blanks in a clean, dry place.

COMPUTER-AIDED DESIGN AND MANUFACTURING

- Consider the correct positioning of the restoration in the blank (nesting) for multi-layered zirconia.
- Use separate milling tools when milling the restoration to prevent the zirconia from being contaminated by residual metallic or glass ceramic chips.

When working with pre-sintered zirconia, wear powder-free gloves.

MANUAL PROCESSING PRIOR TO SINTERING

- Keep manual reworking on the framework to a minimum.
- Make sure you do not contaminate the zirconia restoration before sintering (e.g. from fats on hands).
- Only use rotating tools designed for the processing of high-strength all-ceramics (e.g. zirconia) and observe the manufacturer's specifications regarding rotational speed.
- Remove dust deposits on the restoration using a clean brush and/or oil-free compressed air.
- Do not work on metal surfaces and do not touch the restoration with metal tweezers/tongs.

SINTERING

- Calibrate and clean your sintering furnace regularly.
- Observe the information on long-term cooling when finalizing a restoration (e.g. veneering).
- Change the sintering beads regularly and only use them if needed.
- Remember: KATANA™ Zirconia is happy to be alone in the furnace. Simultaneous sintering with zirconia from other manufacturers may cause foreign deposits of metal oxides, which has a negative impact on the colour effect.
- Reduce the heating and cooling rates for large restorations or voluminous objects.
- If a lid was used for the sintering bowl, remove as soon as you can do it by hand. Otherwise, too much coldness will be projected on the material.

MANUAL PROCESSING AFTER SINTERING

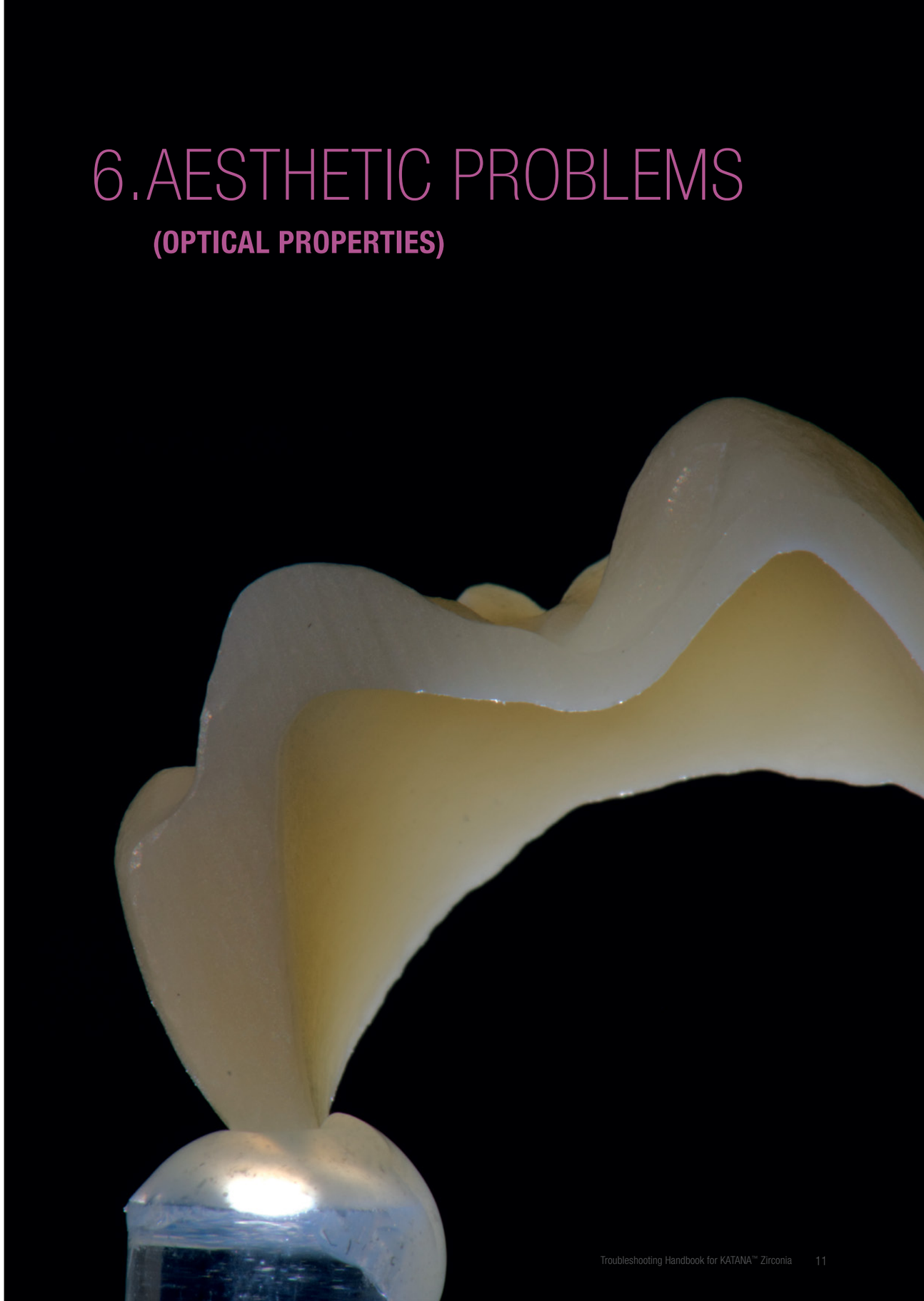
- Make sure you do not overheat the zirconia when preparing the sintered restoration.
  TIP: Low contact pressure, no worn milling tools, if applicable water cooling/laboratory turbine.
- Avoid using the steam jet for cleaning the framework. The ultrasonic bath offers an alternative for gentle cleaning.
- Only use rotating tools designed for the processing of high-strength all-ceramics (e.g. zirconia) and observe the manufacturer's specifications regarding rotational speed.

Avoid pitfalls and hurdles!
We will present the typical sources of error and recurring obstacles in processing zirconia as well as the often very simple solutions.

With its optimally matched formulation, KATANA™ Zirconia is known for its outstanding aesthetic results match the reference sticks precisely. To use the material's full potential, the processing guidelines must be followed for framework design, milling, sintering, and finalizing. If problems occur when manufacturing restorations with KATANA™ Zirconia, the "Troubleshooting" guidelines will show you solutions.

6. AESTHETIC PROBLEMS

(OPTICAL PROPERTIES)



6.1 LACK OF TRANSLUCENCY

The translucent properties of zirconia are the basis for natural-looking optic properties. If the restoration does not have the desired translucency after sintering, this may be due to a number of reasons.

The KATANA™ Zirconia family integrates materials that differ, among other things, in their translucency. Depending on the indication, the desired zirconia can be selected, e.g. KATANA™ Zirconia UTML = highest translucency.

COMPUTER-AIDED DESIGN AND MANUFACTURING

- Check the positioning of the restoration in the blank (nesting). For multi-layered zirconia, the restoration should be correctly positioned within the layers. The correct positioning is in the middle of the block.
- **Dry milling** is preferable for the CAM process. Wet milling – generally indicated for glass ceramic materials – is possible. However when wet milling zirconia, the cooling water may affect the specified translucency value from being reached. If wet milling is used for manufacturing zirconia restorations, make sure the restoration is completely dry before sintering.

MANUAL PROCESSING PRIOR TO SINTERING

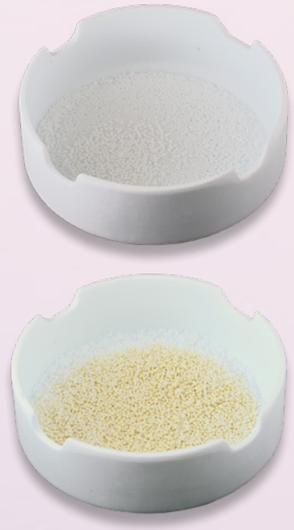
- Avoid sandblasting the restoration surface. Sandblasting can affect the development of translucency.

Zirconia crowns with prominent opacities especially in the typically translucent enamel area.

Correct positioning of a crown and a bridge on sintering beads in a sintering tray.

SINTERING

- Check whether the **sintering parameters** (part of manufacturer's IFUs provided with product) have been observed. If the temperature is too low, the zirconia will not be completely sintered. This results in reduced translucency.
- Make sure **the restoration** is correctly **positioned in the sintering furnace** and use the corresponding sintering accessories (e.g. sintering bowls). The restoration should be positioned in the heat center of the furnace during sintering.
- Replace the **sintering beads** regularly, at the very latest when the first signs of discoloration are visible.
- **Calibrate the sintering furnace** regularly to ensure an exact firing temperature, e.g. with the aid of TempTABs or PTC rings (PTC = process temperature control). If you need help, contact your Kuraray Noritake Dental Inc. product advisor.
- Avoid contamination of the sintering furnace and **clean** the **sintering chamber** before the sintering process, e.g. by removing dust, cleaning the heating elements with a soft brush. With the help of a soft brush, the impurities or powder residues accumulated on the heating elements can be removed in a controlled way.
- **NO-GO:** Do not experiment with the sintering temperature. Although an increase in the sintering temperature or time can result in higher translucency (grain growth), this has a significant effect on the mechanical properties at the same time. It is therefore important to follow the specified sintering parameters.



Lately replaced white sintering beads (left) and already discolored, yellowish sintering beads (right) that should be replaced immediately.

The use of compressed air should be avoided. If compressed air is used for this purpose, the difficulty in controlling the air stream and pressure can lead to counterproductive cleaning results - the powder residues may end up on the walls of the furnace and not outside of it as desired.

PTC ring placed in a digital caliper.

6.2 COLOUR DEVIATIONS

If the colour of the restoration after firing does not match the target shade and/or if (yellowish, grayish) discoloration impairs the result, this is generally due to processing errors.

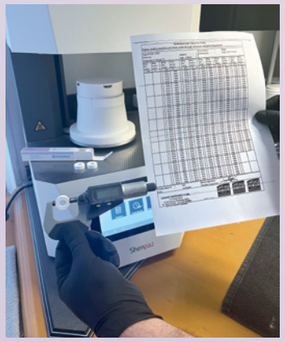
KATANA™ Zirconia has demonstrated its extremely high colour accuracy and harmonizes exactly with the reference shades (VITA classical shade guide) without the need for reworking.

COMPUTER-AIDED DESIGN AND MANUFACTURING

- Find out what **thickness the restoration walls** have. If the wall thickness is greater than 2 mm, the restoration may appear deeper, darker and/or more opaque. In such cases, we recommend choosing a zirconia blank one shade lighter than the target shade and then, if necessary, adapting the colour via external staining.

SINTERING

- Check whether the restoration has been fired according to the specified **sintering and firing parameters** (manufacturer's specifications). Deviations in the firing temperature and time can impair the colour result.
- Avoid furnace contamination. **Clean** the **sintering chamber** on a regular basis, e.g. by removing dust, cleaning the heating elements with a soft brush.



Furnace calibration with the aid of a PTC ring, a digital caliper and a temperature table.

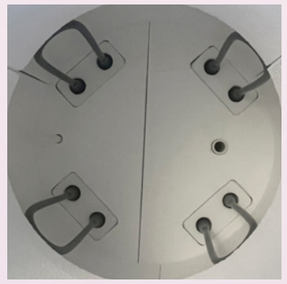
The use of compressed air should be avoided.

- **Calibrate** the furnace regularly to ensure exact temperature control.

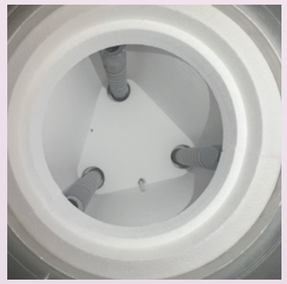
1.300°C 1.350°C 1.400°C 1.450°C 1.500°C 1.550°C 1.600°C

Residual pieces of non-shaded high-translucency zirconia placed in a sintering tray on sintering beads for furnace decontamination.

- A bluish-gray colour and low chroma are often attributed to mineral residues in the sintering chamber. These can be removed with a **decontamination cycle**. Select the decontamination program on the furnace and equip the sintering chamber with residual pieces of highly translucent, non-shaded zirconia blanks. As soon as the first decontamination cycle is completed, the chromatic intensity of the originally white residual zirconia parts indicates whether a second cycle is required.



- Greenish or yellowish discoloration may indicate aging **molybdenum disilicide** ($MoSi_2$) **heating elements**. The inner part of the heating elements is made of molybdenum (Mo), which is covered by a protective layer of silica. If the protective layer is damaged, the molybdenum core is exposed and reacts with oxygen in the sintering chamber. The resulting molybdenum oxide (MoO_3), together with ions and metal oxides, can cause green-yellowish discoloration on the surface of the restorations. Regeneration firing can initially solve the problem, but only temporarily. Ultimately, replacement of the heating element is generally the only option. The problem can be avoided by using a furnace with silicon carbide (SiC) heating elements. These furnaces are aging-resistant, do not cause any discoloration on the firing goods, and deliver constant firing temperatures.



Heating elements made of molybdenum disilicide (above) and silicon carbide (below). The silicon carbide heating elements are aging-resistant and therefore preferable.

6.3 RESTORATION TOO LIGHT OR TOO DARK

When used correctly, KATANA™ Zirconia has a high colour accuracy. The polychromatic colour gradient (multi-layered) produces wonderful, natural aesthetics. If a restoration is too light, this may be due to various reasons, e.g.

Generally, the small 12Z block can be used for almost all single tooth restorations.

- A restoration that is too light could indicate the incorrect **block size**. KATANA™ Zirconia has a colour gradient that must be taken into consideration when positioning the restoration in the block. The 12Z block (small) and 14Z block (large) are available. For an optimum result, the restoration must be positioned in the middle of the block, which is easy to implement with the correct block size. If the block chosen is too big (14Z), there is a risk of the crown being positioned too high or too low. This causes parts of the body shade or parts of the enamel shade to be lost. The restoration then appears too light or too dark.

- Wet milling: A restoration that is too light could indicate insufficient **drying** before sintering. We recommend processing KATANA™ Zirconia in the **dry milling machine**. Wet milling is possible. However, you should be aware of several aspects. Wet milling heavily saturates the zirconia; without pre-drying, this can result in the crown becoming too light and too opaque (almost whitish). This is why pre-drying before sintering (about 10 minutes at 200 degrees) is important with wet milling. It may be recommended to select a KATANA™ Zirconia block one shade darker for wet milling. Also note that wet processing of zirconia is carried out with **purified/distilled water**. We advise against the use of milling additives (e.g. Dentatec).

- The common cause of colour deviations is the **sintering temperature**. Regular cleaning of the furnace **(decontamination cycle)** is also important. Check and calibrate the sintering furnace regularly. A restoration that is too light could indicate incorrect **firing parameters** (e.g. too high or low temperatures) or contamination in the furnace.

6.4 WHITE SPOTS ON THE SURFACE

Whitish discoloration or stains on the zirconia surface may occur for various reasons during and before the sintering process. In general, white spots indicate procedural contamination. This occurs, for example, due to foreign milling dust or the use of milling tools that are either too coarse and/or are used for other materials, which can result in cross-contamination. Contact with water (“contaminated” water such as tap water) is also critical.

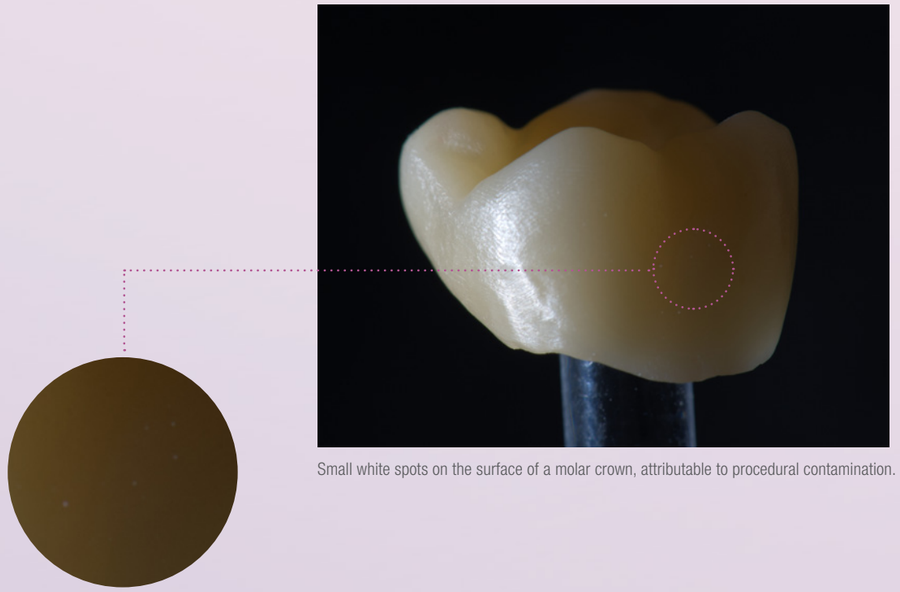
WORK ENVIRONMENT

- Find out whether scan spray is used in the CAD/CAM department or in the proximity of the zirconia milling area. White spots may occur if **residue from the scan spray** (contains titanium oxide, TiO_2) is deposited on the zirconia surface and fired in.

- Find out whether plaster is used (e.g. model production) in the proximity of the zirconia milling area. White spots may occur if **plaster dust** (contains calcium phosphate, $CaSO_4$) is deposited on the zirconia surface and fired in.

- Find out whether glass ceramics are used in the proximity of the zirconia milling area.
White spots may occur if **dust from ceramic materials with silica** (SiO_2) is deposited on the zirconia surface and fired in.

The state of the raw materials, the purity of the powder mixture, as well as the homogeneity and density of the blanks – the material properties of KATANA™ Zirconia are ideally matched.



Small white spots on the surface of a molar crown, attributable to procedural contamination.

COMPUTER-AIDED DESIGN AND MANUFACTURING

- Prior to milling zirconia, clean the milling machine, for example, **of lubricating coolant or, if applicable, even metallic chips**.
- We recommend dry processing of zirconia. If you mill zirconia using wet processing (CAD/CAM process) and use the same machine for processing glass ceramics, we recommend using a system with **three water tanks**. One tank contains wash water. The second tank is filled with water and additives for the processing of glass-based materials. The third tank contains purified/distilled water without any additives for the processing of zirconia.
- **Liquids contaminated** with glass ceramic residue or plaster residue (e.g. cooling water for grinding glass ceramics, trimmer liquid), which adhere to the surface of the zirconia restorations before sintering, cause white spots or discoloration.

MANUAL PROCESSING PRIOR TO SINTERING

- After milling, thoroughly remove the **milling dust** from the restoration surface, e.g. with a soft brush. Only use oil-free compressed air.
- White spots may also occur if **silicone residue** remains on the surface of the zirconia restoration before firing.
- Find out whether oil-smeared substances come out of the compressor. Contamination from **leaking lubricants** (“oil mist”) deposited on the zirconia surface prior to firing can result in whitish spots.

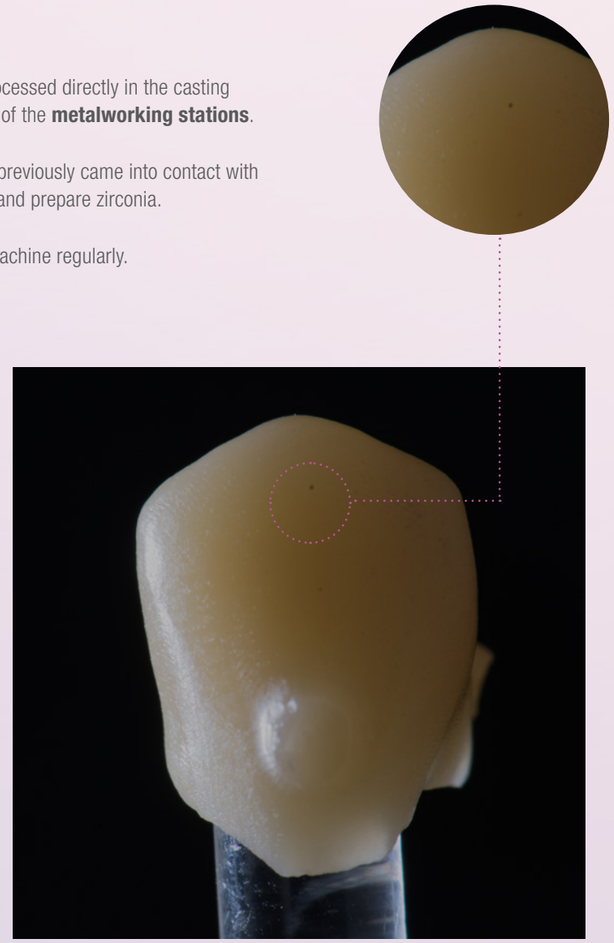
SINTERING

- Clean, maintain and calibrate the sintering furnace regularly. The surface of the **heating element in the sintering furnace** should not be rough or damaged, and no oxide layer should come off. This can also cause white spots on the restoration.
- White spots also frequently come from **contaminated sintering beads**, which are primarily made of alumina. They absorb metal oxides, become discolored, and the surface smoothness is lost following multiple firing cycles. This causes white transfer areas that appear whitish opaque, particularly on the contact surfaces to the restoration.
- **Discolored sintering accessories** can also cause white spots. Make sure the sinter plate and/or sintering beads are not discolored.

6.5 DARK SPOTS ON THE SURFACE

Dark spots, clearly visible black inclusions, etc. in the zirconia restoration are generally attributed to contamination.

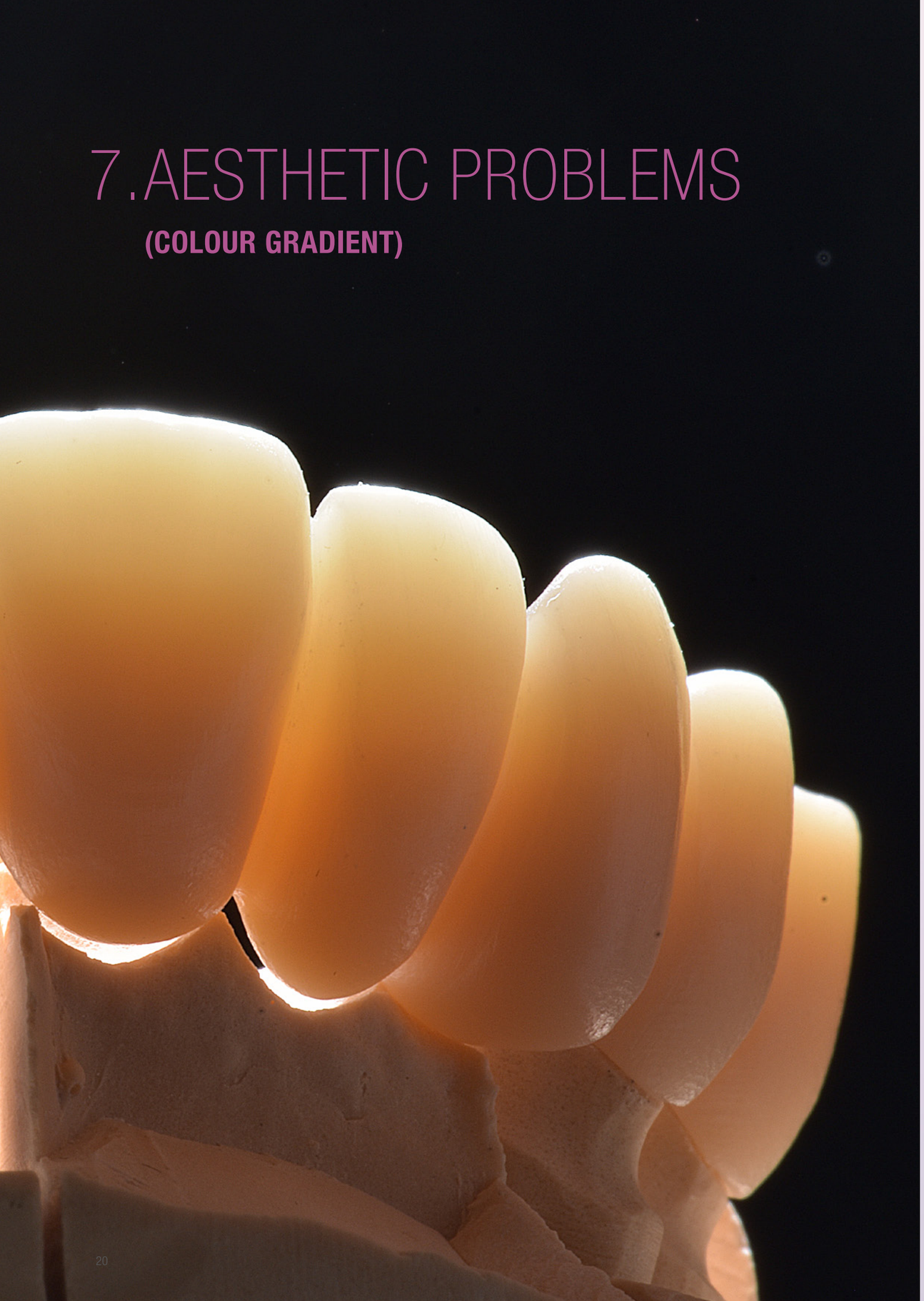
- Make sure that zirconia is not processed directly in the casting room or in the immediate vicinity of the **metalworking stations**.
- Do not use any milling tools that previously came into contact with metallic materials when you mill and prepare zirconia.
- Clean the **inside** of the milling machine regularly.



Dark spots on a restoration surface after milling, also attributable to contamination.

7. AESTHETIC PROBLEMS

(COLOUR GRADIENT)



7.1 COLOUR GRADING

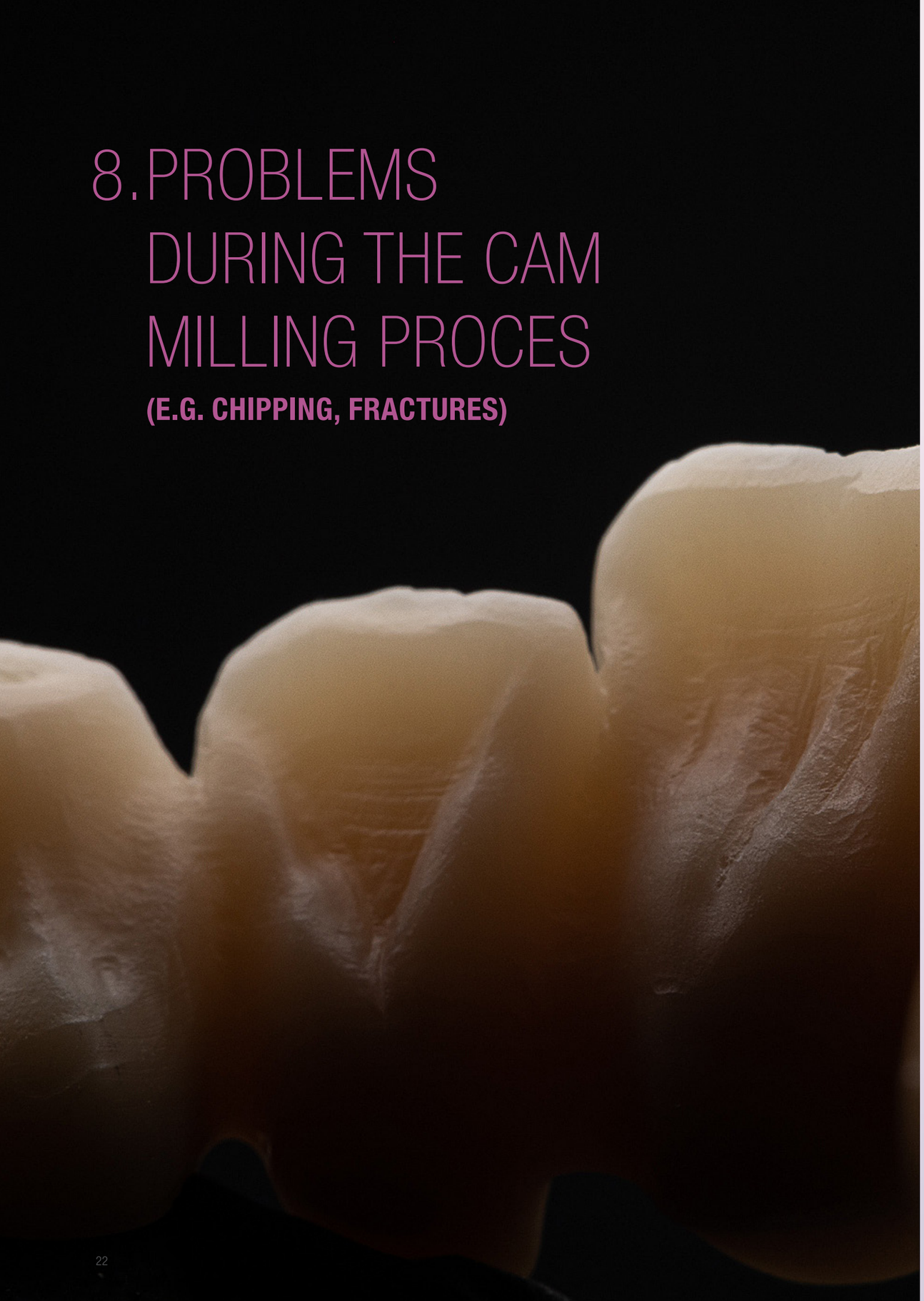
If the boundaries between the layers are visible and/or excessively defined with multi-layered zirconia after sintering, this will impact the result. The good news is that KATANA™ Zirconia multi-layered materials have a seamless colour gradient that matches the natural model when processed correctly. If problems nevertheless occur, they can generally be resolved quickly.

- Make sure the **firing parameters** are observed exactly.
- Select the firing parameters according to the **framework dimension** and follow the processing instructions.
- If the problem continues, **calibrate the furnace** and check its proper functionality. Deviations in temperature control can affect the reproduction of the seamless multi-layered structure of KATANA™ Zirconia.

Even with rush jobs, you should observe the manufacturer's sintering protocol. KATANA™ Zirconia offers the choice between three different sintering times – high-speed sintering (54 minutes), speed sintering (90 minutes), conventional sintering (7 hours).

8. PROBLEMS DURING THE CAM MILLING PROCES

(E.G. CHIPPING, FRACTURES)



8.1 DAMAGED RESTORATION FOLLOWING CAM MILLING

If the restoration was damaged and/or incorrectly milled out during CAD/CAM, this is generally due to processing errors or difficulties during milling.

- KATANA™ Zirconia disc: Make sure there is **a distance of 2 mm between the interior of the plastic ring** (supports the disc) and the margins of the restoration. Milling with a distance of less than 2 mm between the plastic ring and restoration or an actual “collision” between the milling tool and plastic ring may cause the zirconia disc to come off during milling.

- KATANA™ Zirconia disc: Find out whether the **tightening torque of the plastic ring** was appropriate. If KATANA™ Zirconia is tightened to the screws of the plastic ring using too strong a torque, the disc will be overstressed. This may damage the restoration to be milled.

- Check whether the **rotating tools** (milling tools) in the CAM unit have a sufficient service life. If a milling tool is used beyond the recommended measure (units/milling tools), this can impair the milling result. We recommend replacing a milling set after processing 10 to 15 units. By then, the degree of wear will be at about 50 percent. Longer use increases the risk of the zirconia’s microstructure becoming weakened due to microcracks and very fine chipping that are caused by blunt tools and may result in chipping and fractures especially in the area of pontics.

- Check whether CAM milling has used a suitable **milling path**. If the zirconia disc or zirconia block is milled with a tool path that has an incorrectly programmed or incorrectly selected milling strategy (e.g. speed, feeds), this can considerably impair the milling result. If needed, contact your CAM software dealer.

- Find out whether the zirconia disc or block was installed correctly in the **blank holder** during CAM milling. If the disc or block is incorrectly inserted, the zirconia may come into contact with the milling tool outside of the specified working area. As a result, the restoration may have become detached from the holder. If needed, contact the CAM software dealer.

- Make sure the connectors of the restoration are solid enough to withstand the stresses incurred during CAM milling.

Damaged restoration on removal from the milling machine.

The high edge stability and reliable accuracy of fit of KATANA™ Zirconia are the result of a unique manufacturing process and a proven formula. For you, this means excellent marginal quality and edge stability. Precisely prepared surface details simplify manual reworking.

9. TECHNICAL PROBLEMS

(FRAMEWORK)

9.1 FRAMEWORK FRACTURES, CRACKS IN THE VENEER OR OTHER PROBLEMS WHEN FIRING RESTORATIONS

Fractures, cracks or fissures in the veneering ceramic (chipping) or other problems during firing/finalization of zirconia restorations are not just annoying, they also have an impact on efficient workflows. High-quality zirconia is generally safe and reliable during processing, as long as the corresponding requirements are observed.

COMPUTER-AIDED DESIGN AND MANUFACTURING

- **Microcracks** occurring during CAM milling could lead to fractures in the restoration during firing (e.g. veneering ceramics). If this problem repeatedly occurs, please check the CAM milling tools and the milling strategy.
- Make sure you have the correct **framework dimensions** (anatomically reduced framework design, uniform layer of veneering ceramic). Zirconia has low thermal conductivity, which could result in residual stress during high-temperature sintering. If the framework walls are too thin, a solid layer of veneer may cause tensile stress, resulting in chipping.

AUTOMATIC AND MANUAL PROCESSING PRIOR TO SINTERING

- Find out whether the fired zirconia restoration may have absorbed **too much moisture** (possibly during wet milling or due to the use of a shading liquid). If this is the case, the zirconia restoration could have been damaged during firing in the furnace due to quick evaporation of the liquid.

SINTERING

- Cracks may occur if the zirconia restoration **cools down** too quickly after firing.

Even when pressed for time in everyday laboratory work, never remove the restoration from the furnace until it has completely cooled down.

The result of working with a high-quality material such as KATANA™ Zirconia is a stable framework as the optimum basis for aesthetic finalization of the restoration.

Anterior crown with a micro-cutback and a crack that might have been induced during milling.

KATANA™ Zirconia is a material that supports users in achieving high-quality results in a cost-effective way. That being said, zirconia is a sensitive material. As a result, please follow the processing requirements that are based on extensive internal testing and scientific evidence. If you are still having difficulties, we will be happy to advise you. Kuraray Noritake Dental Inc. offers extensive assistance, e.g. with a specialist support team of trained material experts. For rapid user troubleshooting, you can use this Troubleshooting Handbook to help you avoid many hurdles and obstacles in the first place or find specific solutions to your problem.

- Before using this product, be sure to read the Instructions for Use supplied with the product.
- The specifications and appearance of the product are subject to change without notice.
- Printed colour can be slightly different from actual colour.

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- Read the IFU (Instructions For Use) before the procedure.

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