Zirconia has become one of the most popular restoration materials at our lab over the past few years. Its strength and aesthetic properties have made it a material of choice for many patients and dentists. However, strict protocols have to be respected during the entire production process when working with this material, to ensure the solidity of the restoration.

Zirconium dioxide powder needs to be stabilized (commonly using yttrium oxide) and isostatically pressed for homogeneity. This allows the material to be stable in blank form and withstand the milling process. Since the material is pre-sintered and not fully sintered, porosities are an important part of this phase, the material is therefore brittle and must be processed with care.

The restoration design, the milling machine’s parameters, and milling conditions (wear on tools etc.) will all affect the mechanical properties of a zirconia restoration. These stages must be carried out with care so as not to create stresses and micro-defects within the material.

However, respecting these protocols is not enough to ensure optimum mechanical properties. Properly mastering the sintering process is essential to guarantee a quality microstructure.

This article will specifically focus on the sintering process of zirconia, and on my experience using the new Sintra Plus furnace (fig. 1). Naturally, we have all developed our own techniques for baking porcelain fused to metal restorations in our furnaces in-lab. However, the sintering of zirconia is quite different to the fusing of the porcelain to metal that occurs during baking a PFM restoration, and the sintering conditions of zirconia will determine the size of the crystals, the translucency and ultimately the stability of the material.
**Substructure design and milling**

After the digital scan and design process of a dental restoration, the design needs to be nested in the virtual zirconia blank using the CAM piloting software. This file is then launched, and the milling machine mills the restorations out of the zirconia blank. Due to the porosities of the green zirconia material, the restoration must be milled about 28% larger than the required size (consult the product guidelines for exact figures).

The restoration will retract during sintering. The milled restoration is then removed and prepared for sintering using diamond grinders, carbide burs or rubber wheels to remove and smooth out the connectors.

**The substructure**

When sintering zirconia, it is important to be sure of the sintering furnace results. The parameters need to be checked for each furnace, as the results can vary between furnaces. The results can even be influenced by different positions in the same furnace. It is essential to regularly maintain these parameters, as the heating elements can deteriorate over time, the controls may deregulate or the interior of the furnace may be altered.

Between sintering furnaces, the accuracy, reliability and control can vary a lot. During my career as a technician I have used numerous sintering furnaces. I would like to share my experience using the Shenpaz Sintra Plus.

**Sinter Tray**

Once the substructures have been prepared for sintering, they must be placed in a sinter tray: this usually has sinter beads in it to allow the restorations to move. Several substructures can be placed in the sinter tray, but they must not be touching each other.

One thing I particularly appreciate about the Sintra Plus is that the furnace comes with a beadless tray, for better control during the sinter process. The beadless tray allows the substructures to move freely in the sinter tray during the sintering process (fig. 2), without requiring the use of sinter beads.

It is crucial that the substructures move freely, because during the sinter process, the restorations are shrinking to their required size.

The substructures must be placed in the sinter tray. This tray is beadless, allowing the substructures to retract during sintering without requiring sinter beads.
Any restrictions to the movement during this process can create stresses in the substructure, resulting in micro-fractures or even breakage.

Once the tray has been loaded and put into the furnace (figs. 3 and 4), the sinter cycle can be launched (fig. 5). It is essential that different zirconia types be kept separate during the sinter process. This is because different zirconia brands have different sinter temperatures. Most of them sinter between 1450°C and 1650°C. Obviously a zirconia with a sinter temperature of 1450°C is not compatible for sintering with a zirconia of 1650°C. Sintering at the wrong temperature will compromise the microstructure, because the sintering temperature determines the crystal size. The average size of the crystals after sintering must be smaller than 0.6 microns. If the crystals are larger than this, destabilization can occur in the monoclinical phase.

Besides the temperature differences, each zirconia material has its own chemical composition. If mixing zirconias of different compositions, the final quality can be negatively affected.

Another feature of the Sintra Plus that we appreciate is that you can stack sinter trays, and each sinter tray has a lid, so that different zirconia brands can be kept separate without the risk of cross-contamination.
Sinter cycles

There are various sinter cycles available. In addition, the Sintra Plus is fully programmable, with a maximum temperature of 1650°C. There are 30 programmable parameters, allowing for the sintering of all dental materials requiring sintering. I personally use three main programs. For single unit substructures and small bridges, I use a seven-hour program. Due to the smaller size of the restorations, the cooling time can be shortened, since a shorter cool-down time will not create the same stresses as with a long-span bridge. For long-span bridges I use a 14-hour sinter programme. This first allows the material to dry out completely, for example if an infiltration colour technique was utilized. The cooling after the sintering must be done very slowly, to prevent stresses in the restoration. The results obtained with the Sintra Plus are highly satisfactory (figs. 6 and 7).
Here is an example of a full arch screw-down bridge (figs. 8 to 10). Another cycle that I use often is the fast program, which is very useful for emergencies and cases that need to be done quickly. The time frame for this cycle is around two hours. However, this program has to be used with great caution. It is important not to put many individual units in the sinter tray and no bridges. Because of the fast process, absolute control over temperature has to be maintained, and this gets harder the more units there are in the furnace. Using the Shenpaz Sintra Plus, I was able to successfully sinter ten units in a 90-minute fast cycle program. This requires an exact knowledge of your furnace and the materials you are using, and needs to be tested with the zirconias you usually use in the lab. I tested this with Noritake and Amann Girrbach’s Zolid.
I use my Sintra Plus furnace on a daily basis, and am extremely pleased with the results I obtain. The furnace offers predictable results and can be programmed according to the lab’s requirements. The extra features offered by the Sintra Plus, such as the compressed air and beadless tray, make the process more sure, functional and efficient. Obtaining predictable results is essential when working with zirconia.

Compressed air

One feature that I particularly appreciate with the Sintra Plus furnace is the hookup for compressed air. I have been using this feature for some time, with fantastic results. The sintered restorations are very clean and the results obtained are very reliable.

The compressed air offers excellent control over restoration cooling during the sinter cycles. It allows for the degassing of the furnace. I use it when drying out colored zirconia and when heating up at the beginning of every sinter cycle.

The compressed air also keeps the heating elements extremely clean and prevents oxidation, which in turn helps to lengthen the lifespan of expensive parts, such as the heating elements.

The heating elements are further preserved by being used to only 70% of their capacity, meaning that they never run at their limit.

Conclusion

I use my Sintra Plus furnace on a daily basis, and am extremely pleased with the results I obtain. The furnace offers predictable results and can be programmed according to the lab’s requirements. The extra features offered by the Sintra Plus, such as the compressed air and beadless tray, make the process more sure, functional and efficient. Obtaining predictable results is essential when working with zirconia.

ABOUT:
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Alexander Wünsche is the President of Zahntechnique Dental Laboratory located in Miami, Florida. Alexander completed a 4-year multidisciplinary program at the Otto Umfried school of dental technology in Nuertingen, Germany. He attained accreditation as a CDT Germany and also attained a accreditation as a U.S. CDT in Ceramics. Today, Alexander fabricates a wide variety of case types and also specializes in cosmetic and complex implant restorations.

He has been published in dental journals such as Compendium, Inside Dental Technology, The Journal of Dental Technology, Lab Management Today and ACP Messenger. Alexander speaks internationally regarding innovations in dental technology.