

Zirconia: What We All Need to Know

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Dentist
Resource



What We All Need to Know

The zirconia market is likely the most fragmented materials market in dentistry. In the US there are close to 100 different brands of zirconia discs available to labs. For clinicians and labs, there are some important questions that should be answered when prescribing or selecting zirconia restorations and or discs. A dozen years ago this was relatively easy, today this has become far more complex. Today there are three primary categories of zirconia and each is now segmented into several (3-5) sub-groups, resulting in more than a dozen distinctly different material types.

Most recently, there are significant advancements in zirconia every year. This new product introduction pace has likely never been seen in any dental material. Chances are, if you or your lab have been using the same zirconia for two years you are behind the curve in materials choice. Furthermore, if you are only prescribing or providing one zirconia you are not optimizing treatment or material. If this is not complex enough, six months from now (4-17), we will have an additional fourth category that looks like the next game changer in the zirconia market. This new formulation is currently in FDA for approval by a few of the more well-known disc manufacturers.



The Problem

For starters, it is relatively easy to manufacturer zirconia powder and zirconia discs. That said, it is far more difficult to manufacture a high quality powder and or disc. Add the dynamics of current market pricing pressure in the lab market and our industry is ripe for purchasing very inexpensive low grade zirconia powders as well as discs. In addition, to improve profits for both powder and disc manufacturers there must be important quality steps in the manufacturing process simply left out of the process. There is really no way to produce and sell a high quality disc for less than \$100. The sub \$100 disc is now more prevalent than ever and is being fabricated from inferior powders and short cut disc manufacturing processes.

This is filling the demand from both dentists and labs looking for the least expensive (which relates to low quality) material possible. This is not good for our labs, dentists, our patients nor our industry. What is most alarming about this, the difference in price between a high end material and a low end is not enough to justify the purchase of inexpensive zirconia. Unfortunate but true, as our patients are paying in the range of \$1K for a crown and the restoration is compromised to save short money. Lab owners that find themselves in "the race to the bottom" on lab prices are currently supporting the low cost inferior zirconia manufacturers and a low quality market. With an increasing number of labs in this situation, the numbers of low end powder and disc producers is on the rise and the percentage of patients not receiving the best our industry has to offer is growing.

Zirconia Mining

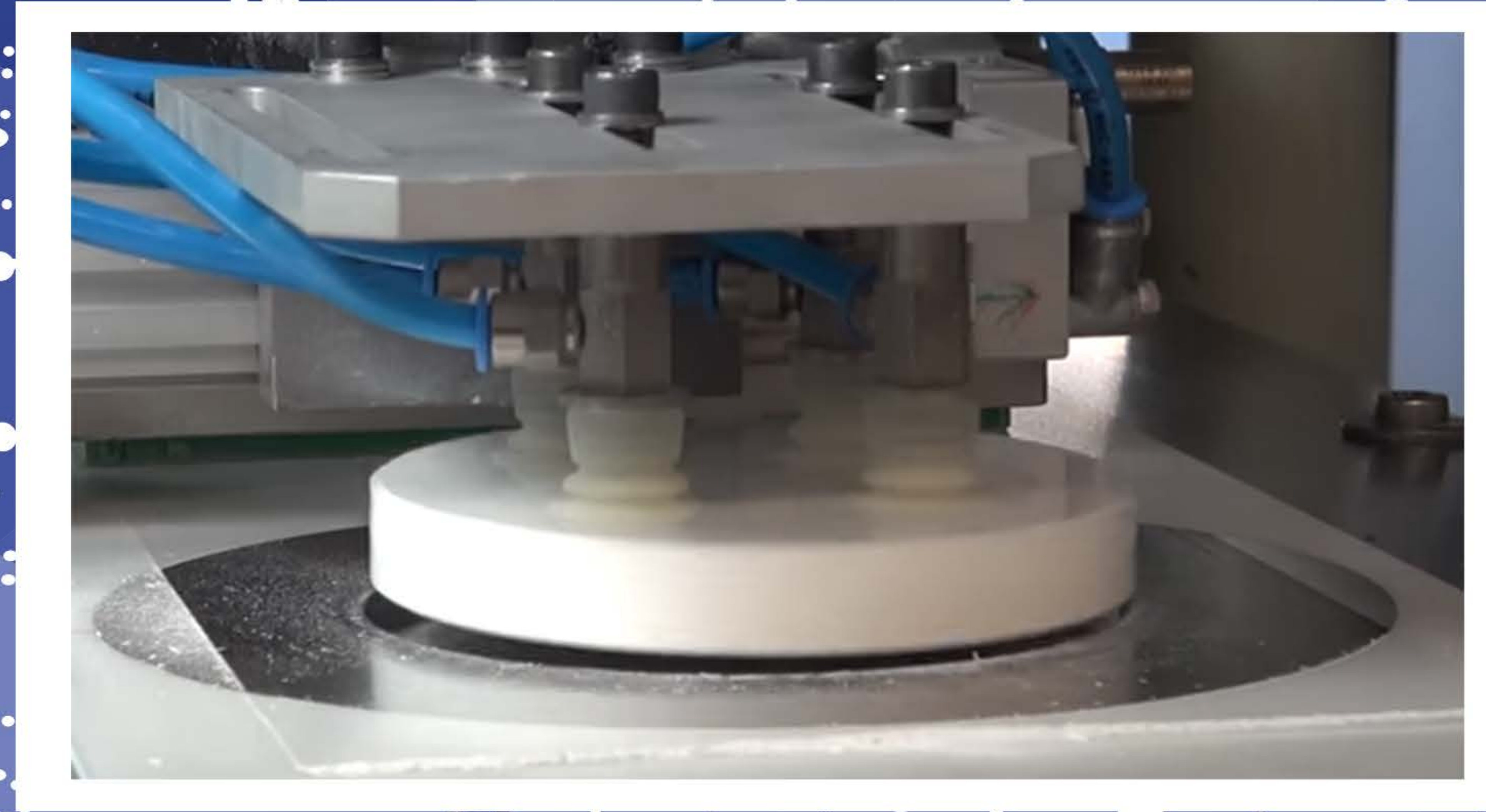


80% of the world's zirconia is mined from Australia and South Africa. Zirconium is always found in combination with Hafnium (Hf) and other impurities, this mixture is difficult to separate or purify. Once separated, the material can be converted to zirconium, the metal or zirconia, the ceramic.

When manufacturing for ceramic the purified zirconia sand is ground to a powder. The purification process is an ideal place to reduce costs. Quality powders are washed multiple times. Low grade materials are washed just once. The sand is next ground into an ideal powder particle size of just .1-.2 microns. This tight tolerance, minute grain size of the powder is critical to the mechanical properties of the final restoration. Yes, another process where ideal tolerances may not be achieved. To improve the properties of zirconia, Yttrium (Y) is added to the compound along with other trace elements to stabilize the molecular and crystal structures.

Lastly, binders are added to the powder to aid in the pressing process to form discs. All the above processes are critically important, percentages of additives is critical to the inherent quality of the final restoration. We must demand precision in our powder manufacturing.

Disc Fabrication



For the most part, but not always, the powders are purchased by disc manufacturers. However, there are some larger disc manufacturers that are now producing their own powders. Through the use of an industrial press specifically designed for manufacturing zirconia parts, powder is automatically poured in a disc shaped mold. Then under enormous pressure the disc is axially pressed. Through this high pressure and the added binders the disc is formed. Next up, in a quality production facility, each pressed disc is weighed and logged into a CPU as a QC step to help insure density and track each disc long term. In most quality production facilities these discs will go through a second isostatic press process. This second pressing requires each disc to be individually shrink wrapped. The wrapped discs are placed in a liquid tank that is loaded under massive pressure from all sides. This isostatic press process insures consistent particle density throughout every disc. Manufacturers skip the isostatic press process which has significant risk of compromised disc density but also reduces manufacturing costs. Regardless of using a single axial press only or adding the second isostatic press the next step is pre-sintering. All discs are placed into sintering furnaces for about 3-5 days. These furnaces pre-sinter the discs for optimal milling characteristics. Top temp, about 1000 degrees C. Again, we can easily see there is room for disc manufacturers to cut corners to reduce cost and prices.

At the Lab

Finally, the disc placed in a mill for milling dental prosthetics and a subsequent higher temp (1450 C) sintering cycle is performed to insure the ceramic structure is stabilized. The results, Y-TZP is the Yttrium stabilized Tetragonal Zirconium Polycrystal. This is the material that has become so very popular in dentistry.

As you can see, there are many critical steps that go into making a high quality dental zirconia powder and disc, not to mention the final prosthesis. As in most everything, cutting corners to reduce costs equates to compromised results.

For labs the sintering furnace is now extremely critical to achieving proper crystal structure. Quality sintering furnaces start at about \$10k. For labs fighting the price war many are sintering in inferior, low cost furnaces. Inexpensive furnaces tend to have hot and cold areas within the sintering chamber. Keep in mind, a 50 degree difference in the top sintering temp makes a difference in the crystal structure of the restoration. Firing at 1450 C requires a furnace design that is properly insulated, real time temp feedback of muffle temp to the control panel, adequate heating elements, a well designed thermocouple and a well designed insulation platform. Sintering furnaces designed for optimal consistent sintering can not be made and sold for much less than \$10K. Today's sintering market is loaded with sub \$7K furnaces. To quickly identify a low cost sintering furnace, most are loaded from the front of the unit. The more accurate furnaces tend to be bottom entry or loaded. With today's new generation materials even if you are using the best of zirconia discs you may be compromising the end results by sintering in a low quality sintering furnace.

When Prescribing

When buying or prescribing zirconia we should all know what we are purchasing, there is no reason to purchase inferior materials for final restoration. It has never been easier to manufacture a highly esthetic, high quality restoration and doing so with a high grade multi layered zirconia disc made from a high grade powder that is sintered with precision is best for our patients and our industry. So, what do we look for when either prescribing or purchasing zirconia discs or restorations?



AG Zolid FX Multi Layered

How to Choose?

First, I would suggest it's best to stay with well-known dental ceramic manufacturers name brand discs. Companies having dental ceramic manufacturing experience provides the needed knowledge of understand how to best replicate human dentition. These companies would include, but are not limited to Dental Direkt of Germany, Amann Girrbach of Austria and Noritake of Japan. These three companies have been producing very high quality products for dentistry for many years. The related disc branding from these three are CubeX2 (form DD), Zolid (from AG) and Noritake, Katana UTML and or STML. Clinicians should be asking for one of these manufacturers materials for all single units and most small bridges.

There is a second group of industrial zirconia manufacturers that have identified dentistry as a great new market and are now manufacturing dental zirconia discs. These companies usually have a wealth of knowledge on the industrial side but much less knowledge of what's needed for optimal results in dentistry. This group seems to be in a continuous mode of playing catch up and are often a couple of years behind in the development cycle. Please remember, the best producers are leading the development cycles and are in constant R&D and we are now seeing new zirconia developments every nine months to a year. Many of these advancements are not just incremental but rather much improved next generation materials. Being two years behind equates to potentially missing out on three generations of advancements. In a recent survey (12-2016) of decision makers in dental labs, the question "Do you feel you have adequate knowledge of the zirconia market to insure you are purchasing the correct material?" Over 27% responded "NO".

What's Best in Class Right Now?

When zirconia was first introduced to dentistry the material was snow white and very opaque. At the time, 3M, the leader in this market quickly developed acid based coloring liquids for shading their material before sintering. Today due to no further product development in zirconia 3M is gone or nearly gone from the zirconia market.

Next came pre-shaded discs. Now labs could eliminate these acid based liquids from the workflow and just mill the restoration from the correct pre-shaded disc. These monochromatic pre-shaded discs are still popular today.

In 2014 multi-shaded or multi-layered discs that mimic natural dentition with a cervical, mid body and enamel shades build into each disc were introduced and very well accepted by the industry. At this time most zirconia materials were all about 1100 MPa flexural strength and more opaque (40% light transmission at 1 MM) than natural dentition. The following year, a new generation of cubic zirconia was introduced. This new category of cubic zirconia more closely matched the needed translucency (49% light transmission at 1 MM) of teeth but to do so the flexural strength was reduced to 600-700 MPa. At 600 MPa this new product was still 50% stronger than lithium disilicate (LD) and unlike LD this cubic zirconia has nearly zero strength degradation over time.

Next up, from Amann Girrbach, Zolid FX Multi And Katana UTML. These materials are likely THE highest quality most esthetic materials available today. Made from the Cubic powder material and multi layered for what is the most life like monolithic ceramic restoration available. For all your zirconia single crowns and small bridges these are the best materials offered in dentistry. Next up, due to arrive late 2017 a multilayered 900 MPa very translucent zirconia.

Conclusion and Why So Many Brands?

It's obvious zirconia disc manufacturing must be a profitable business. This combined with most people being under the misconception that all zirconia discs are about the same has made for tens of thousands of inferior disc being manufactured and sold into our market. This is now come to a point where there are likely many low quality disc manufacturers. Unlike dental implants, where there are leaders that seem to have the best products and the best success rates. Implant success data is readily available as there are so many studies ongoing. Unfortunately, this is not the case with zirconia discs. We must remember, we are treating patients and setting the bar high is always the best path. For the good of dentistry, let's all join in and buy quality to serve in our patients best interest.



Click a Disc to Purchase