POLISHING UP ON FINISHING

OR

HOW TO STAY COMPETITIVE DUE TO OPTIMIZED SURFACE FINISHING

1. The Company

The company OTEC Precision Finish was found in 1996 by Helmut Gegenheimer. Today there are more than 30 people employed. Technical innovations and a large amount of know-how make us one of the worldwide leaders in the surface treatment market.

2. Introduction

The biggest, often not even calculated, costs in jewelry manufactory are, without doubt, caused by the surface finishing.

Just today, when the demand for silver, white gold and platinum is increasing more and more, one has to look for solutions how to decrease costs and stay competitive.

Finishing technology has been used in industry for decades. Its primary use is to debur, smooth, descale, grind and polish work-pieces by using a surface abrasive or polishing agent. Single barrel tumblers, hexagonal drums, vibrators and disk-finishing machines have traditionally been used. As a result of the abrasive friction between the work-pieces and the media, the surfaces and edges of the work-pieces become processed. These machines were frequently found in the metalworking industries and, to a limited extent, in the watch and jewelry industry

Progress in recent years has provided new opportunities for more and more efficient means of surface treatment by using machines. The many advantages of using machine processing, as opposed to manual processing, helped to form the cornerstone for a revitalization in the jewelry and watch industries. A prime example is how machine polishing is increasingly replacing manual polishing. Today, increasing competitive pressure and market globalization demand continued advances in finishing technology. These developments are directly beneficial to precision and jewelry industries--as precision is often an integral part of the jewelry industry.

Advantages and goals of modern finishing technology include reduced operation times, increased value, waste reduction, high quality and decorative surfaces.

Friction abrasion machines are highly effective in producing a high-gloss polish on decorative surfaces, such as watches, jewelry and also in the optical industry. While Ra. - values in the micron range are not the main objective here, hand-polishing quality is.

Requirements for attaining this quality with finishing machines are as follows:

- Suitable disc finishing machine with precision gap system or a drag-finishing machine
- Optimal processing technology
- Suitable work-pieces design
- High quality material (catchword: casting faults)
- Machine operator

3. Finishing media

3.1. Quality (roughness) of media and its effects

3.1.1. Why do we need an even surface?

Before we compare the machines, let us have a look at some physical factors. A surface can only reflect the light into ONE specific direction, when the surface is absolutely flat and plane. Once there are too many "bumps" and holes, the jewelry, even polished, does not "shine".
Let us have a look at the following illustrations:

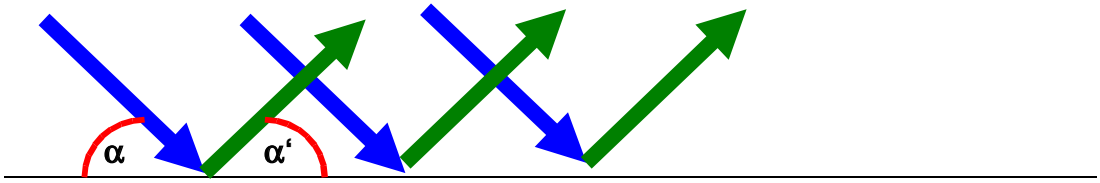
3.1.2. Refraction of the light

Refraction of the light on a flat surface

Physics: <<the light is refracted from an obstacle in the same angle (α') than it is touching it (α)>>

light coming parallel from the sun is touching an even surface

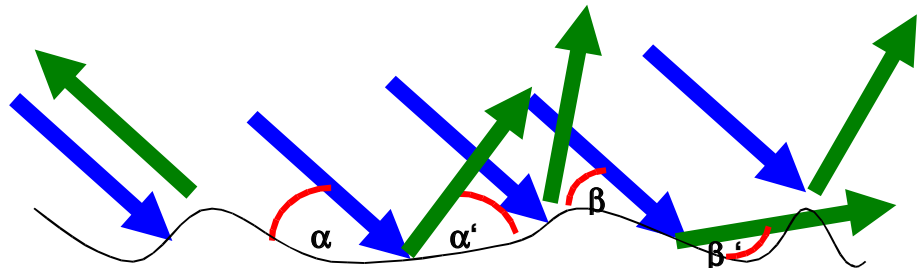
Parallel beams which touch our eyes -> we see a polished surface – all the beams reach our eyes at the same moment



EVEN SURFACE OF THE JEWELLERY

light coming parallel from the sun is touching an uneven surface

Parallel beams which touch our eyes -> we do not see a well polished surface, because only a few beams reach our eyes at the same moment



BUMPY SURFACE OF THE JEWELLERY

3.2. Physics and their influence to the surface in finishing machines

3.2.1. Influence of centrifugal force , pressure, shape of the media

From the physics we all know:
When we have a rotating disc with media on it, the media experiences a specific force, which is depending on its weight and speed.

In other words:
The faster the disc, the bigger its diameter , the bigger (heavier) the media, the bigger is the force with which the media treats the work-piece.

3.3. Size and shape of the different media and their effects

Pyramids
On principle, flat surfaces of the media have a higher abrasive effect than convex or round surfaces. (here: friction caused by the sliding pyramids)
Cones
Round surfaces, such as cones, have a greater abrasive effect on internal areas such as drill holes or the internal contour of jewelry rings. (here: friction caused by the rolling cones)
When both the internal and external surfaces need to be ground, a combination of flat grinding chips (pyramids) and round grinding chips (cones) should be used.
Density : The higher the density, and consequently the heavier the abrasive media, the greater the abrasive effect.

Binding:

- The tighter the abrasive elements are bound among themselves, the weaker the abrasive effect. The self sharpening effect (usually caused by weaker bindings which let the rounded (used) abrasives break off easier) is much less.

This smooth surface has a minimal roughening effect which makes it suitable for precision grinding and polishing.

- Advantage: long lifetime
- Disadvantage: little grinding effect, tendency to orange-skin development (arising).

Grinding agent additive: "Grinding flour" is the abrasive element added to the basic (carrier)-media material and the coarser it is, the greater the abrasive effect. Without this additive, the material would be unable to grind, because the basic material often possesses virtually no abrasive effect at all.

Designing jewelry for mass finishing

A finishing machine achieves the best results if the design of the work-piece is as follows:

- No flat surfaces
- No sharp edges
- No sharp corners (catchword: Rounding-off of abrasive medium)
- Convex shapes preferred

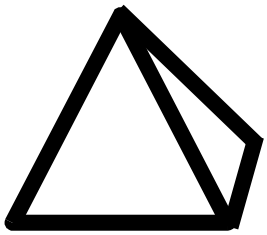
Work-pieces meeting these criteria can easily be processed in modern finishing machines and hand-polishing standards can be achieved, e.g., for wedding rings.

In reality, it is the jewelry and watch design which dictates the market. Today's design often demands sharp edges, flat surfaces and sharp corners. These requirements make it necessary to prepare the tools in a manner which works best with the finishing process. Take, for example, the preparation of cast

jewelry rings. These would need to be cleaned with a 400 sand paper in order to minimize processing time while still using the optimal grinding media.

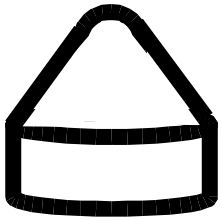
3.3.1. Different shapes of grinding chips and their effects on a work-piece

pyramid-shaped chip



Pyramid:
A pyramid has the tendency to slide on the surface.
Because a pyramid has sharper edges than a cone, the pressure of these edges will be bigger.
Therefore, a pyramid will grind stronger than a cone but will also **leave deeper "grooves"** in a work-piece than a cone, due to the higher pressure on the edge.
The tendency to orange skin development (arising) with soft metals is bigger than with cones.

cone-shaped chip

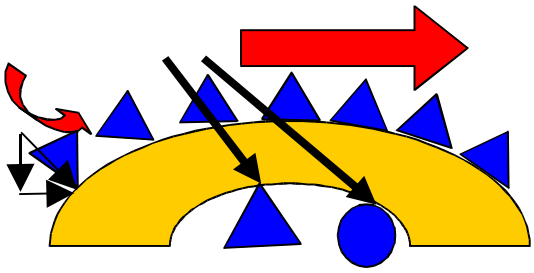


Cone:
A cone has the tendency to roll on the surface.
Because a cone has rounder edges than a pyramid, the pressure of these edges will be lower.
Therefore, a cone will grind smoother than a pyramid and will **leave less "grooves"** in a work-piece than a pyramid, due to lower pressure on the "edge".
Additional, a cone can work better in the inside of e.g. rings, due to it's bigger radius.

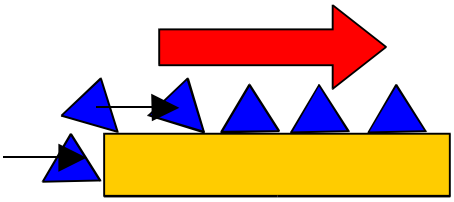
Let's compare two different shapes of geometrical surfaces:

On a convex surface the media can "flow" with a high pressure to the surface

Touching radius



On an even surface the media can only "flow" with little pressure to the surface



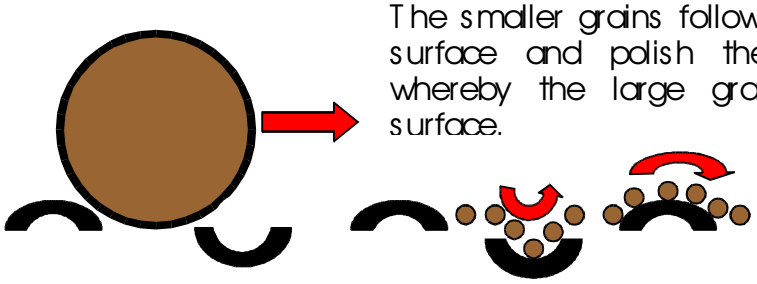
Observation:

1. The impact of the chips on a convex surface is stronger than on an even surface.
2. On a bend surface the media can work more than on an even one, due to the vertical pressure to the surface.
3. A pyramid-shaped chip causes a bigger pressure of the edge – compared to a cone.
4. The bigger and therefore heavier the chip the higher the pressure to the surface.

Conclusions:

- If we want to process concave work-pieces, we can easily mix pyramids and cones because the polishing media (walnutshell-granules) will also work more, due to the also bigger vertical pressure to the surface.
- If we want to process flat work-pieces, we avoid using pyramids and grind only with cones.

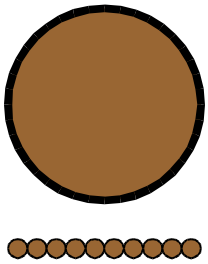
3.3.2. Why do we advice to use different sizes of walnut-shell granules?



The smaller grains follow the contour of the surface and polish the soft areas out, whereby the large grain will flatten the surface.

surface.

Walnutshell-granule impregnated with polishing paste

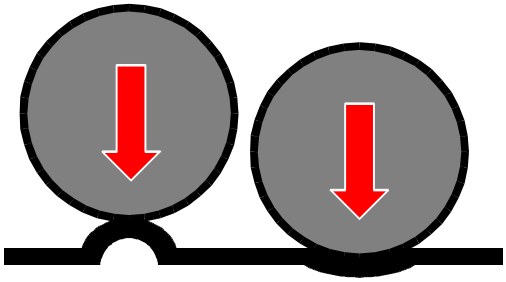


A small grain has more touching points than a big one.
For it is also lighter, the grade of scratching the surface is also much lower.
A big grain can enter deeper the surface.

Conclusion:

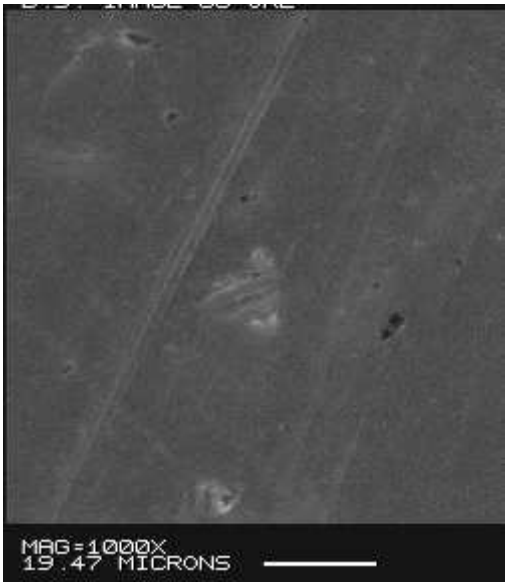
When we want to flatten the surface we use big walnut-shell granule (H1/100), and for the final polishing we would use the finest one(H1/500)

3.3.3. Steel ball-polishing: the principle of densification

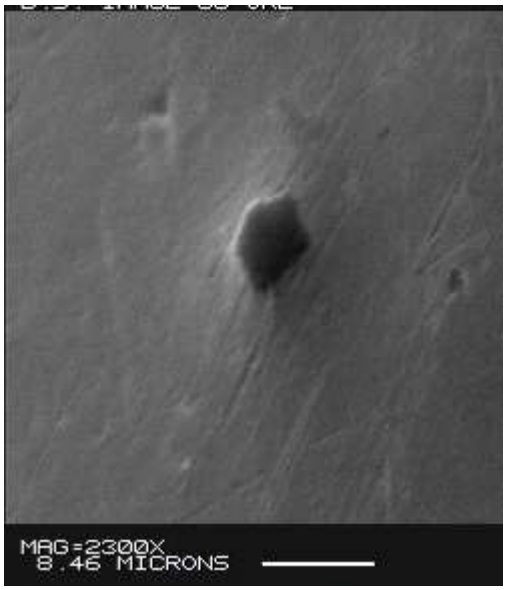


The immense density and therefore weight of the steel-ball melts the spot and flattens it.
The surface becomes mechanically denser
Because of the heat that develops during the "flowing" of the metal, there will be an oxidation on the surface. A proper polishing therefore is almost not possible. This situation is very critically with silver. Even hand polishing afterwards is not possible.

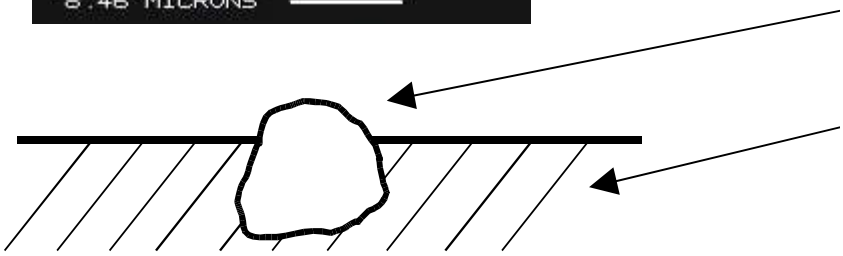
3.4. Influence of different media on the surface under the magnification of an electronic microscope (up to 60.000 x)



Magnification: 1000x
Metal: silver
Quality of the chip: "E"
Color: green
Surface: You can see already the marks the chips left on the surface



Magnification: 2300x
You can see the fragment of a chip left in the surface. This fragment was pressed (hammered) into the surface by other chips.



This fragment of a chip was pressed into a micro-pore.
The corn will either stay there and the metal around it will be taken off in the polishing process.
When the corn will be ripped out in the polishing process it will lead to little holes which can be washed out. The result can be: <u>orange skin</u>

3.5. Explanation of the different finishing media (grinding and polishing)

3.5.1. Overview

Grinding	Polishing	Grinding	Polishing
Ceramic chips	Porcelain-chips	Walnut-shell-granule	Walnut-shell-granule
Plastic-chips	Steel polishing agent	Maize	Maize
		Wood	Wood
		Plastic	Plastic
		Others	Others

3.5.2. Grinding

As a rule, mechanical surface processing begins with an abrasive process which prepares a surface for polishing.
After casting the skin of the work-piece does not consist of a homogenous mixture. For this is of big importance in the polishing process, the skin has to be removed in a so called grinding process or by hand. (sandpaper-work)

3.5.2.a. Wet grinding

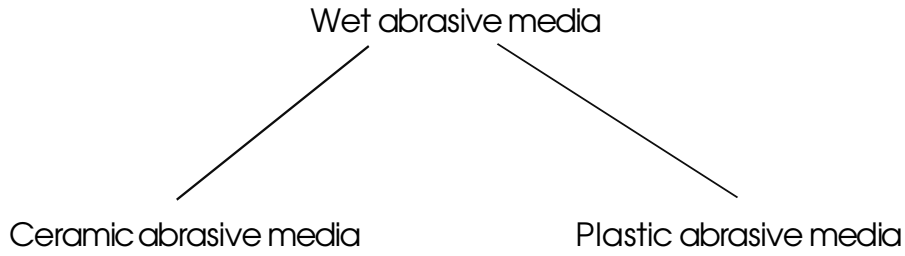
During wet treatment, the abrasives and work-pieces are surrounded by a mixture of water and a tenside solution (compound). Wet grinding is more intensive than dry grinding because mainly ceramic and plastic grinding media are used. The water and the compound take up the

abraded material, so the work-pieces remain clean and the grinding media remains sharp. The compound-water mixture consisting of 1-3% compound, is used for the following purposes:

- Degreasing (e.g., oily work-pieces)
- Preventing corrosion or oxidation
- Lightening work-pieces
- Descaling heat-treated work-pieces (e.g., adding acid)
- Building a buffer between the work-piece and the media. This prevents the media to enter (cut) too deep into the work-piece.

The mixture is pumped in measured amounts into the container where the process begins.

Again, wet grinding uses mainly ceramic and plastic grinding media. The abrasive media differ in form and grinding effect. The abrasive's potential to remove excess material is mainly influenced by the following:



3.5.2.b. Ceramic abrasive media

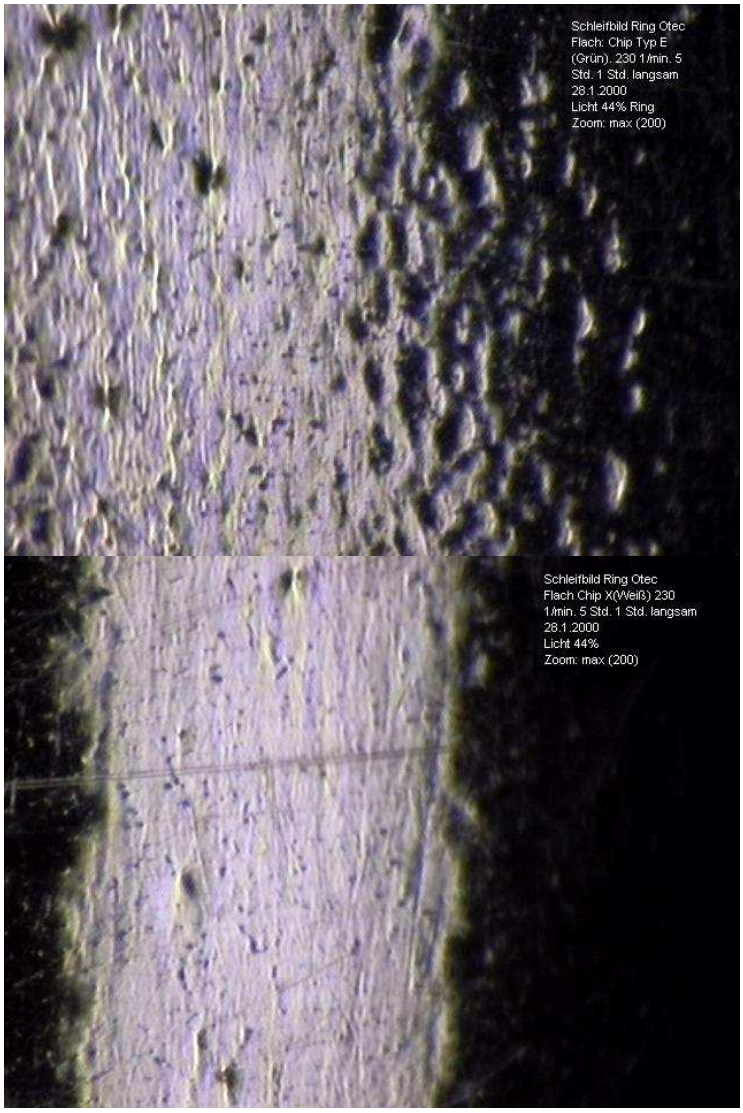
Ceramic abrasive media are normally used for industrial purposes, such as grinding hardened steel, and are easy to manufacture and cheap, compared to plastic-chips. The density is about 2-3 times bigger than the one of plastic-chips. This kind of abrasive media is most frequently used in the metalworking industries, Because it is available in many different shapes and sizes.
Because of their powerful abrasive effect, they are especially suitable for deburring work-pieces, but they are also important for the jewelry industry. Here they are used primarily for the pre-grinding of steel and titanium. (max. size to choose is 3x3mm to 6x6mm-bigger chips would make it here very difficult to get rid of the deep grooves they are leaving while processing). Their powerful abrasive effect ensures that they achieve better results with such hard, tough alloys than generally fine-grinding plastic abrasive media. They also dense the surface due to their weight.
While appropriate for steel and titanium, tests have shown that the high silicium content of ceramic media has a harmful effect on the surface of silver work-pieces. The silicium that separates from the ceramic either scratches the surface or gets even "hammered" into it by the chips. This "waste" in the surface cannot be removed by polishing. The result is an uneven, unattractive surface.
For this reason, ceramic abrasive media are not recommended for use with silver.
Ceramic abrasive media are available in triangular cylinders, ellipses, pins cones and many more shapes.

3.5.2.c. Plastic abrasive media

Plastic abrasive media tend to have a medium to fine abrasive effect. It is often used in pre-grinding unfinished castings made of silver and gold as well as in fine grinding.
Soft and fine-grinding plastic-chips are good for soft alloys such as gold and silver.

The type of metal being ground and the condition of the work-piece should determine the type of media to use. The harder and tougher the alloy, the greater the needed abrasive effect. A soft and fine smoothing chip is good for soft alloys. If the work-pieces need to be processed immediately after casting, they may need to be pre-ground by using a highly abrasive plastic media to remove the hard outer surface of the work-pieces, the so called casting crust. However, if the work-pieces have already been pre-ground (e.g. by hand), advance treatment will not be necessary.
The objective of surface treatment is achieving a fine surface. The better the ground surface, the better the quality of the finished product.
The most common plastic abrasive media are cones and pyramids. The shape influences the grinding effect and its range of uses. Cones grind more finely than pyramids, and are particularly suitable for polishing the inside of rings and drill holes. Pyramids have a greater grinding effect and work well on external contours. It is common to use a mixture of 50% pyramids and 50% cones.

3.5.2.d. Comparison of surfaces using different grinding chips



This are two rings made out of silver.

- magnification 200x.
- Time processed: 5 hours
- Quality of the chip: "E"
- Color: green
- Surface: not sufficient. There are too many grooves and bumps.
- Result after polishing: dull surface, no shining

- magnification 200x.
- Time processed: 5 hours
- Quality of the chip: "X"
- Color: white
- Surface: very good. There are almost no grooves or bumps.

Result after polishing: mirror shining

3.5.2.e. Dry grinding

The dry grinding process often produces an even finer surface than wet grinding. We recommend dry-grinding difficult alloys (i.e., silver) as an intermediate step between wet grinding and dry polishing. The superior surface can easily be seen with a magnifying glass.
If the work-pieces have been manufactured by pressing or punch processes, dry grinding is often sufficient in achieving a good surface.
Coarse walnut shell granules have proven their value as a dry abrasive medium. They are often used mixed with mineral dry grinding media.

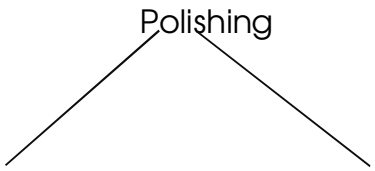
3.5.2.e. Duration of grinding times

Jewelry industry
The duration of grinding times is heavily dependent on the alloy and manual sandpaper pre-treatment. For wet processing in a disc finishing machine , the following grinding times apply to cast work-pieces:
Grinding: 2 to 4 hours (fine grinding plastic chips)
Even when time is at a premium, it is important to adhere to the grinding times. Otherwise, it is not possible to achieve optimal quality.
In precision grinding, it is important to reduce the speed at the end of the cycle. This speed reduction improves the grinding results, due to less pressure of the chips to the work-pieces, and ensures a glossy surface once the process has been completed. It is of a great advantage, using a disc finishing machine equipped with an automatic speed reduction device which can be set for each container separately. The speed can automatically be reduced at the end of each cycle without manual intervention.

If only one container is used for both, pre-grinding and final grinding, the container must be carefully cleaned when changing chips. If not, a mixture of different abrasives can accumulate, causing markedly poorer results. Just a few abrasive-grinding plastic media can leave marks on the surface of work-pieces that can often not be removed during the polishing process.

3.5.3. Polishing

With alloys requiring a high-gloss polish though dry polishing, be sure they have been cleaned in an ultrasonic bath for approximately 2-3 minutes, to remove all dust from the grinding procedure from the surface. The polishing process can be divided into two methods.



Dry polishing Wet polishing

3.5.3.a. Dry polishing

Dry polishing is the surface treatment which smoothens the work-piece and produces the gloss.

Walnut shell granule is commonly used because the fine grain allows increased contact with the surface. Because of this increased contact a high-gloss polish is achieved.

Note, that there is a greater risk of damage to surfaces (impact marks) during polishing than during grinding due to the lower density compared to that of the grinding chips. The finer granule provides less of a buffer between the work-pieces, making it easier for them to collide which causes the damage. For this reason we recommend to reduce the quantity of products treated during dry grinding.

The best glossy finish is generally achieved by using fine walnut granule. If the surface is not smooth after polishing, pre-polishing with coarse walnut granule can correct this. Coarse granule gives the surface a smoother finish.

In practice, polishing times of about 3 hours have proven adequate-platinum requires longer polishing times.

Longer polishing times achieve only minimal improvements. If pre-polished with a coarse granule (for approx. 2 hours), the work-pieces only need to be polished with a fine granule for approximately 1 hour.

If an alloy with different degrees of hardness is being polished, be sure that the polishing process is not too long. This causes the soft components of the alloy to "polish out", leaving only the harder alloy components. The result is an orange-skin which is getting bigger the longer you polish. The glossy effect is not achieved, leaving an unsatisfactory surface. For such alloys we recommend to smoothen first the surface with coarse walnut (called H1/100) and then polishing for about 1 hour using fine walnut (called H1/500). Even better but requiring additional time: dry-grinding before dry polishing.

3.5.3.b. Wet polishing

For wet polishing it is common to use **porcelain polishing** media or inox steel bodies.
When the pieces of jewelry are too heavy for dry treatment, or when the surface is too hard, very good results can be achieved by using porcelain polishing media. This applies in particular to brass, silver alloys and especially to materials containing lead (white metal).
Porcelain polishing media makes the surface a little denser and is taking off some material at the same time. The more older (used) the porcelain polishing media is, the better is the capability of polishing-the smoother the surfaces will be.
Because this treatment involves a compound-water mixture some work-pieces, like silver or brass, can oxidize. Oxidation makes the surface blotchy and hard, which is difficult to correct by hand-polishing. Some disk-finishing machines avoid this oxidation by allowing a programmed manual delay of the machine's start-up time (i.e., the end of batch processing can be set at exactly defined times).

Steel balls polish on the principle of densification. The surface is compacted by gravity and not worn away. The peaks on the surface are not removed, but flattened. This results in a gloss finish, but leaves the surface unsatisfactory. Under a magnifying glass the surface appears "crusty" (orange skin), so that the pieces of jewelry need manual follow-up in order to achieve a good quality. However, the compacted surface makes this difficult (see magnet polishers).

4. Modern, state of the art, finishing machines

4.1. Different finishing techniques

Traditional hand polishing and machine finishing are two finishing methods which both have their authorization for existence.
While hand-polishing is nowadays mainly used for very complicated jewelry with deep, concave areas or when the casting shows minor porosity, machine-polishing is used for mass production, low cost jewelry, but also for jewelry of a higher value of up to 18 ct. (or higher) gold.
As the demand for silver jewelry has increased to 60% of the market volume in recent years, fewer companies can still afford to do all the finishing by hand. For example in Middle Europe hand-polishing of silver is too expensive. It is also common to process jewelry with wax-set cubic circonia.
The finishing of machine-polished jewelry using modern grinding and polishing machines can often not be distinguished from the results of hand-polished jewelry.

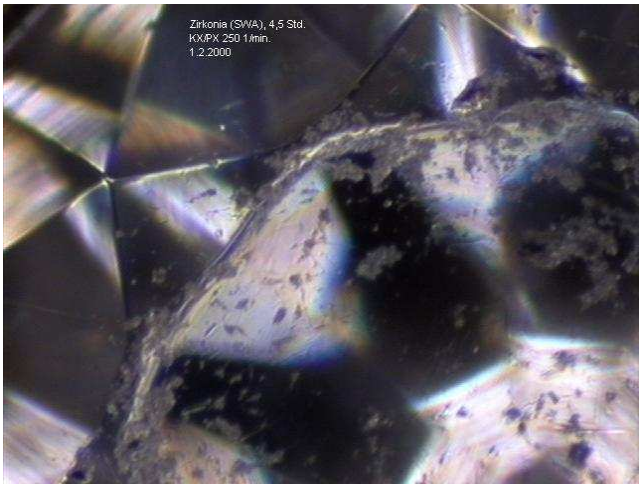
High material quality

The condition of the cast material influences the final polishing result. Material faults caused by errors in alloy processing or manufacturing become visible during high-gloss polishing. These faults cannot be corrected by the finishing machine. Therefore be sure to have good wax-model without marks and a good casting quality to achieve good jewelry.

Machine operator

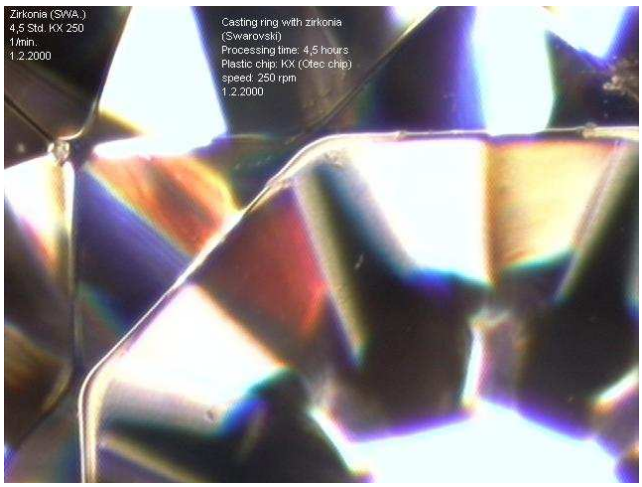
There are only a few parameters which will affect the polishing result, including machine running time, speed, water-compound flow and processing methods. However, these parameters rely on human intervention. While every machine can produce results, it is the operating personnel who plays the decisive role. Proper training is imperative, but motivation and thinking about the process involved are core elements of what we refer to as an instinctive feeling for the process.

As mentioned before, jewelry with wax-set cubic circonia can be processed by using the suitable wet-grinding method:



This is a cubic circonia after grinding 4,5 hours with white plastic chips (pyramids and cones mixed).
The surface is damaged completely due to the "aggressive" behavior of the pyramids.

This is a cubic circonia after grinding 4,5 hours with green plastic chips (only cones).
The edges are damaged due to the "strong cutting" behavior of the cones.



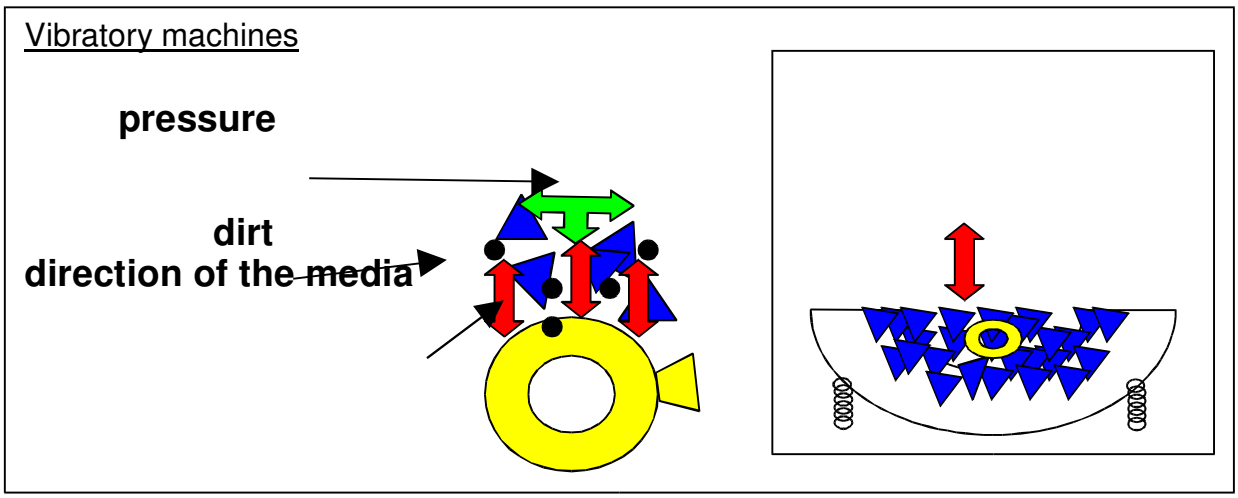
This is a cubic circonia after grinding 4,5 hours with white plastic chips (only cones).
Neither the surface nor the edges are damaged.
This is the result of using the perfect plastic chips with the perfect shape.
It is also of great importance to have a proper mixture of compound and water. Too little sliding effect would also damage the cubic circonia.

4.2. Comparison of different finishing machines

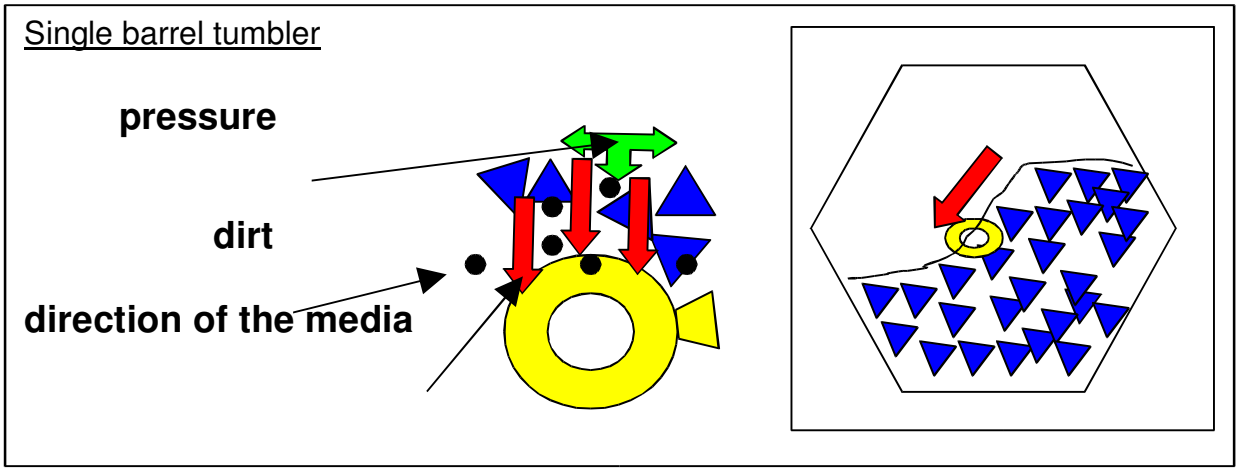
Machine Type	Polishing Media	Grinding Media	Advantages	Disadvantages	Work Pieces
Vibrator	• Wooden media • Porcelain • Walnut • Corn • Steel balls	• Ceramic • Plastic	• Inexpensive • Heavy Pieces • Stamped Pieces	• Long process time • Little pressure force • Impact marks • low smoothing effect • Dry processing not possible to a satisfying result	• Small chains • Machine made chains
Magnetic Needle Polisher	• Needle pins	• N/A	• Shining surface • Short- Processing time	• Does not smooth • Impact marks • Steel pins get stuck. • No high shine	• Filigree Jewelry • Inside of jewelry
Single Barrel Tumbler	• Wood cubes • Wood pins • Walnut • Corn	• Ceramic • Plastic	• Inexpensive	• Long process time • Impact marks • Uncomfortable handling • Dirt in surface • Surface compression	• All kinds of jewelry
Centrifugal Tumbler	• Wood cubes • Wood pins • Walnut • Corn	• Ceramic • Plastic	• Very Aggressive • Short- Processing time	• Long process time • Impact marks • Uncomfortable handling • Dirt in surface • Surface compression	• All kinds of jewelry which is not too heavy
Disc-Finishing Machine	• Walnut-shell granule • Porcelain • Plastic	• Ceramic • Plastic	• Very Efficient • Short- Processing Time • 70% done by machine. • Few working steps. • Clean jewelry • Easy handling • Top quality surface	• No heavy work pieces (max. 20 gr.) • No colliers • No small chains	• most jewelry (ca. 90% with exceptions.) • Watch cases • Industry products
Drag-Finishing Machine	• Walnut-shell granule	• Walnut-shell granule	• Polishing of large and heavy pieces possible. • No impact hitting • Short processing time • Easy handling • Top quality surface	• No wet grinding	• All kinds of jewelry which can be fixed on the racks.

4.2.1. Comparison of the angles in which media touches the surface

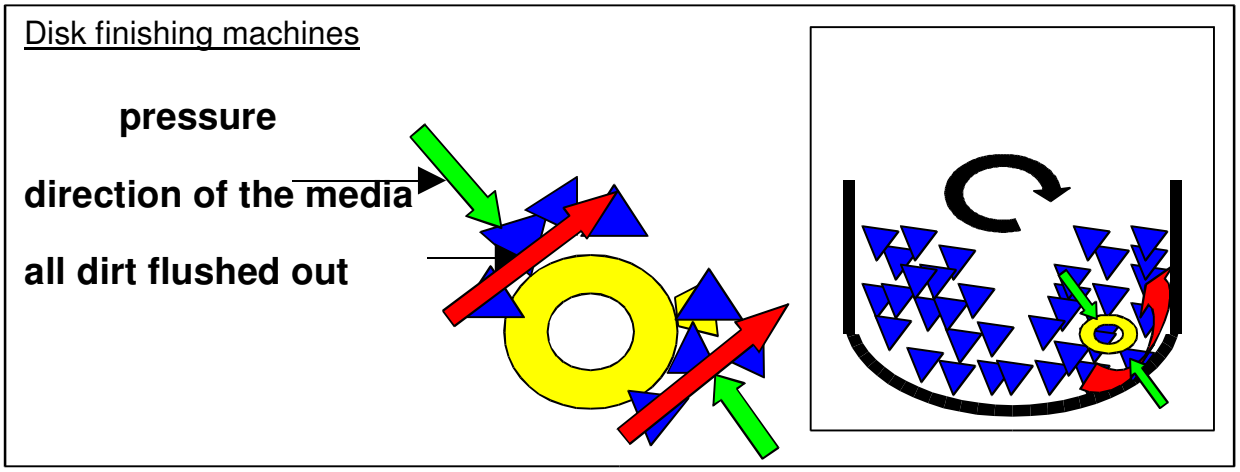
Vibratory machines



Single barrel tumbler

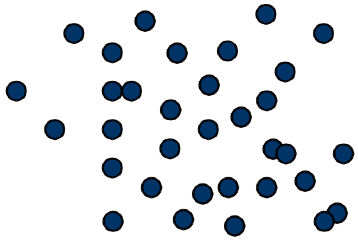


Disk finishing machines

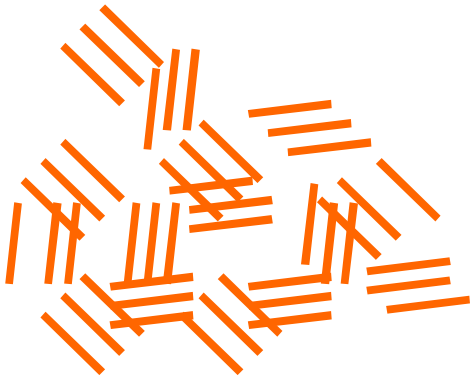


4.2.2. Illustration of patterns on surfaces after grinding with machines

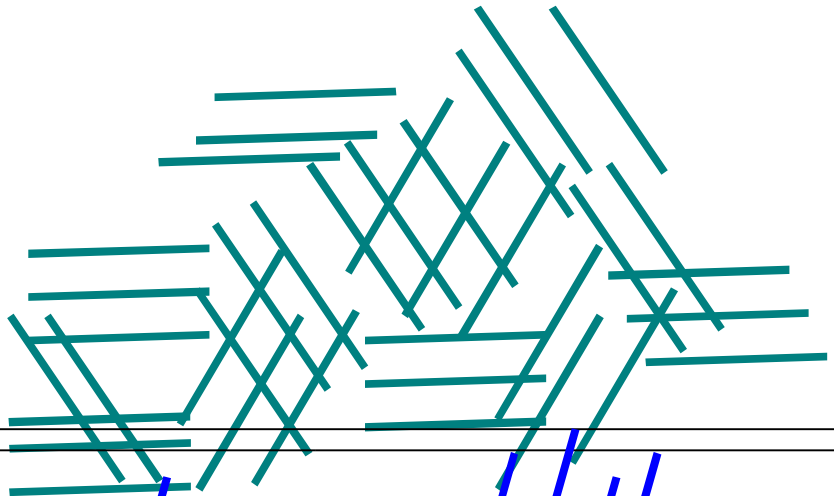
Magnetpolisher



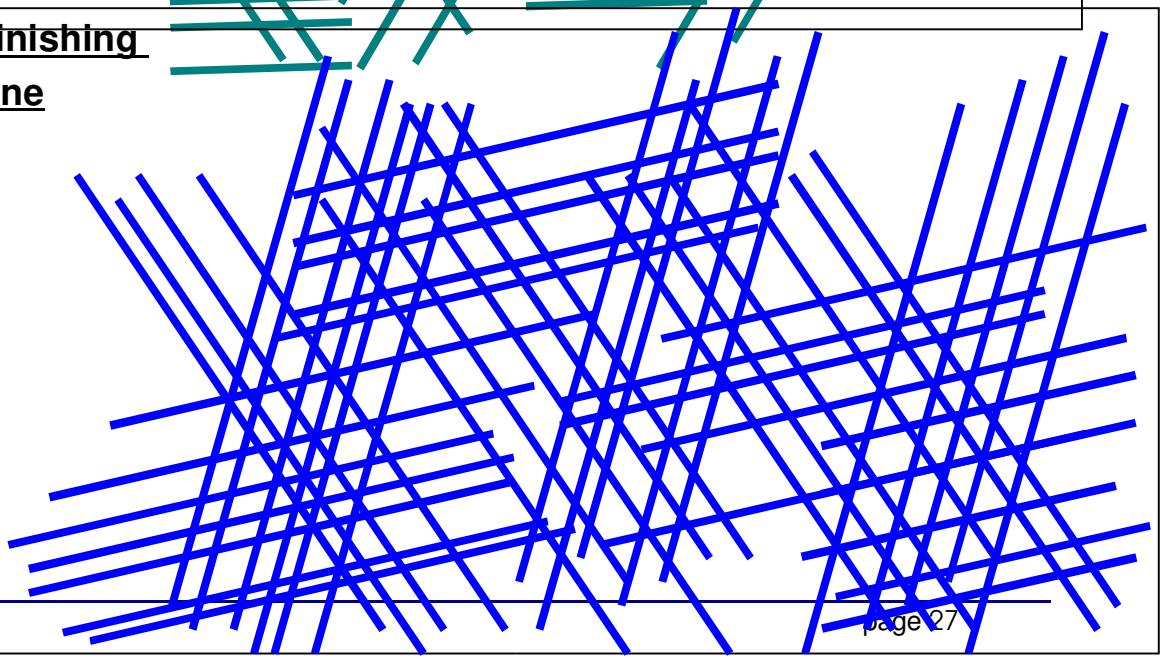
Vibratory tumbler



Single barrel tumbler



Disk finishing machine



4.3. Different finishing machines for different uses

Vibratory machines

These kind of machines are very good for machine made chains. They are often used in connection with steel balls. For they do not have a constant waste water exit while operating and the constant chock movements, it is very difficult to achieve a good mirror shining result with other jewelry.

Needle Polisher

This machine is a very good tool in combination with different other finishing machines. Although the surface will always look "marked" it leaves a nice shining, even on concave areas. This needle polishing process in combination with grinding and polishing process must always be done BEFORE the grinding and polishing process. Otherwise it will leave marks on the already for the polishing prepared surface.

Single barrel tumbler

As mentioned before, this is the oldest of all mechanized processes. You can process almost every kind of jewelry in this machines. The biggest disadvantage is, that for they do not have a constant waste water exit while operating, all the waste of the grinding process remains in the barrel. Through the constant rotation and shocks in the often hexagonal barrels, little fragments of the waste (dirt, grinding chips, rests of the investment powder) will be hammered back into the surface. This spot on the surface can therefore not be polished. (see chapter 3.5.)

Disk-finishing machine

Smoothest grinding and high-gloss polishing which can be compared to hand-polishing, can be achieved using a newly-developed (and patented) gap system with disk-finishing machines.

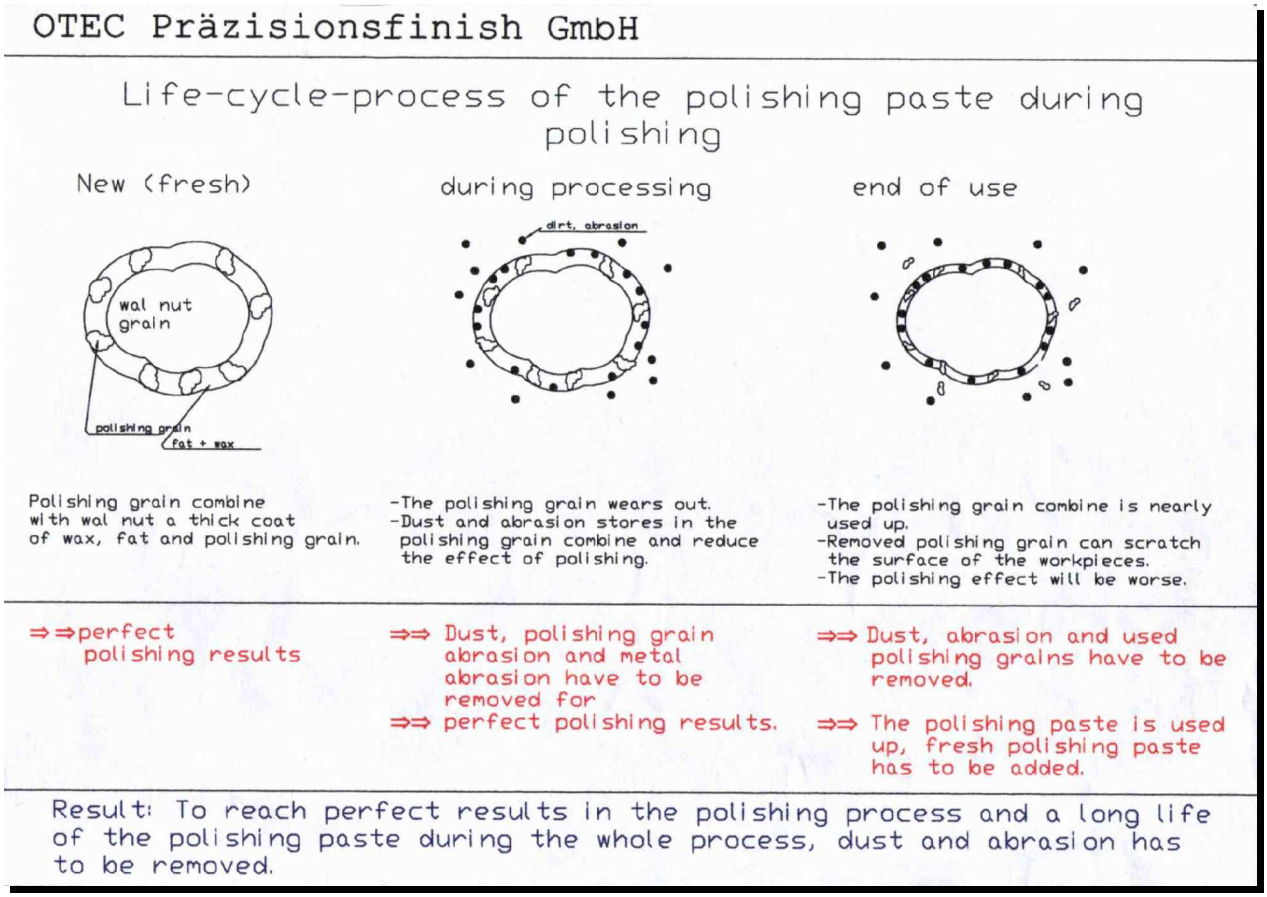
The disk-finishing machine base is designed as a rotating disk in a container which is open at the top. The wall of the container does not rotate. Between these two components there is a **micro-gap**.

When a grinding or polishing medium is put into the container and the container is set into motion, a toroidal motion is created which effectively processes the work-pieces.

In the past, the gap in machines available on the market was between 0.25 mm and 0.5 mm wide. This means that the gap was too big to process thin work-pieces or to use very fine processing media.

A unique and revolutionary gap system developed by Helmut Gegenheimer, a graduate engineer, makes it possible to use the finest walnut granules with a gap set to even less than 0.05 mm.

This so called precision gap is very important, because the used polishing paste has to be removed. The only way to get rid of it is through the gap or through vacuum suction.



The finer the walnut granule, the better the gloss. The smaller gap prevents penetration by the granules. The new method has proven itself on the market hundreds of times. These machines are producing polishing results which in the past could only be achieved by hand polishing. An additional benefit of this system is the wear-resistance of the gap. The gap is sealed with ceramic rings with a high degree of hardness (2600 HRV 01) or (9.5 Moss) compared to diamond which has 8000 HRV or 10 Moss. They increase the service life several times compared to the steel rings used in the past.

An important development in finishing technology was the introduction of the drag-finishing machine in the jewelry field in about 1992. Drag-finishing is very different from previous methods because the work-pieces are dragged through the granule while the granule itself is not set into motion.
Each work-piece has its own place on a support so the surfaces do not come into contact with each other and cannot be damaged. This method drags the work-pieces through the granule in special holders, producing a higher relative movement and a far more intensive treatment than with traditional finishing methods and cuts processing times considerably.
This is a great advantage with heavy work-pieces. In the past, these work-pieces could only be machine-processed to a limited extent. Now, they can be polished up to a high-gloss. This means that using these machines can result in a decisive competitive advantage.
The drag-finishing method is especially suitable for **heavy rings, cufflinks** and **watchcases** but also for many other work-pieces capable of being suspended, which are too heavy to be polished by the disk-finishing machines without getting impact marks.

4.4. Summary

- With modern mass finishing machines you can:
- Save time
- Save water
- always clean goods (work-pieces)
- mirror shining surfaces
- always same quality
- save money due to optimized finishing processes

5. Gold loss and recovery

5.1. Differences of the loss in the hand-finishing to the machine-finishing

The following values mean percentage in weight which you cut off from the work-piece. This does not mean that this percentage is lost.

- loss in the hand-finishing: up to 10 %
- loss in the machine-finishing: between 1.5 % to 4 % - depending on the condition of the work-piece prior to the machine operation.

In comparison to hand-polishing, where you can not determine where the loss is gone to, in the machine-finishing all the metal which is cut off must be in the waste-water container.

Here I would like to refer to the seminar of WGC.

5.2. Some recovery methods for mass finishing wastes.

For in the machine-finishing the metal-particles are less than 0.001mm in size (compared to hand-finishing 0.02mm-0.03mm) the recovery is more difficult. To treat the waste-water directly with a filter is therefore not possible.

- The easiest way to get the metal back is to dry up all the waste and refine it. This method has one big disadvantage which is the high costs of drying (energy).
- Separation through a cascade container. Disadvantage here: not all the metal can be recovered.
- Microfiltration: a common and very effective way of recovery.

5.3. Percentages of the loss and the possibility of recovery

- Through a cascade system you can recover about 70 % to 80 % of the metal in the waste. The rest of the metal is still in the waste water. This depends on the size of the cascade-container: the bigger it is, the more (longer) the waste can settle.
- Through a microfiltration system you can filter 100 % of your metal from the waste-water. Also there is the advantage of saving up to 90 % of the

costs of the compound. Because the water-compound-mixture it is circulating, it can be used up to 3 months.

For more detailed information about the machines, please contact the manufacturer of microfiltration systems.

6. Check your production line

6.1. Potential problems while casting

The most common way of producing jewelry is the lost-wax casting process. For good quality polish, the following factors need to be considered:

- Masterpiece – designed to be machine polished (see: optimized flow of the media) and with top quality surface
- Rubber Mold – top quality
- Wax Injection Machine with vacuum
- Wax piece with no parting-line or knife blade cuts
- Casting machine
- Casting temperature
- Control alloy (good quality alloy)

6.2. Potential problems while grinding:

- Mixing of different grind-media qualities
- Too little or too much compound while processing
- Too many work-pieces in the work-container
- Wrong processing speed
- A too short processing time

6.3. Potential problems while dry polishing:

- Poor treatment of the surface in grinding-process
- Too little or too much polishing paste while processing

- Polishing-granule too old (too long used)
- Wrong (too high) processing speed (impact marks)
- Too many work-pieces in the work-container
- Big and small work-pieces are mixed together (approx. same size or shape is better)