– Satisloh GmbH –

Water-Jet Deblocking

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V0.3

The aim of this document is to inform about and explain the production procedure on a basic level; it does not describe technical processes, parameters or settings. Any given information is not binding and can and will be changed without further notice. Contact the owner of the document with any questions (frank.heepen@satisloh.com).

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INTRODUCTION

For more than 50 years ophthalmic prescription lenses (Rx) have been fabricated using a production technique that involved attaching a raw lens blank to a holding piece (a metal block) using melted alloy. The alloy compound contains a number of toxic heavy metals now found on the United Nations Environment Program (UNEP) short term hit list. This fact, combined with unstable alloy costs, has caused optical machinery suppliers to enter into a race to see who can be the first to introduce a practical and cost effective alloy replacement technology.

In today's lens production process, a raw lens (blank), is generated, polished and edged to complete the patient's Rx and to cut the lens shape that fits the eyeglass frame.

For these processes, the blank must be attached (blocked) to a work-piece holder (block), in the required geometrical orientation including the correct angle (prism), to connect it with the respective machine. The bond between blank and block must be tight enough to resist the mechanical forces in the manufacturing process but not so aggressive that the blank incurs breakage, bending, etc.

After lens production is complete, lens and block must be separated. To achieve this, different procedures exist, depending on the blocking process, and will be described below.

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1. Traditional Deblocking of Alloy Blocked Lenses

In a lab's surfacing department where the prescription is machined into the back of a lens blank, the traditional blocking process uses alloy, which melts at a relatively low temperature. The space between a lens blank and a metal block is filled with melted alloy which then cools down, acting as "glue". Alloy blocking requires tape on the blank to protect it and avoid direct heat-contact which could otherwise cause blank surface defects. The tape is also necessary to achieve the required adhesion force for the production process; without such tape the alloy would not stick tight enough to the blank surface.

After the surfacing process (turning, polishing and engraving), the common procedure to separate a lens from the block is shown in the pictures below. The first step is selecting the correct plastic deblock ring according to the cribbed lens diameter, or better, the diameter of the alloy which supports the lens. Such deblock rings are available for any of the 7 standard alloy-block-ring diameters. The next step is knocking the front surface of the deblock ring (opposite the blocked lens) on a rigid base – like an anvil. This mechanical shock separates the lens, with the protective tape on it, from the alloy which is then still connected to the block.
The alloy must be removed from the block for further re-use. This thermal process is done in a hot water melting tank. The regained liquid alloy can be used again immediately after conveying it to the Blocker or it can be stored after solidifying for later re-use. The water temperature for melting is about 55°C/ 126 °F up to max. 60°C/ 140°F. Therefore water and alloy, melted or solidified, must be handled carefully to avoid scalding the operator.
The protective tape must be peeled off by hand before the lens is returned to the tray to be passed on to other departments.

Obviously, the lens diameter must always be larger than the alloy's diameter. However, this causes the risk of lens breakage due to the mechanical shock of deblocking on the outside of the unsupported and with that unprotected lens.

Non- circular lens shapes are handled in the same way. The shortest axis determines the diameter of the alloy-support. In other words, the longer axis is not supported and more sensitive to mechanical shock during deblocking.

Picture 1: Manual Deblocking

Picture 2: Deblocked Lens with Tape

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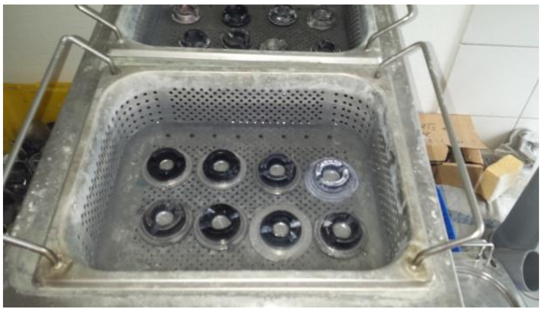
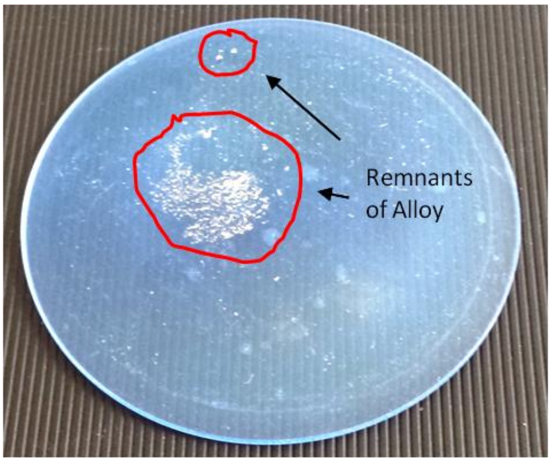
Picture 3: Warm Water Tank



Picture 4: Block and Alloy in Tank

Commonly a small portion of alloy stays on the protective tape and goes into the waste.

Alloy contact with water leads to the water’s contamination with alloy components such as lead or cadmium.



Picture 5: Alloy Residue on Protective Tape

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1.1 Advantages of Hot Water Deblocking of Alloy Blocked Lenses

An automated hot water deblocking process for alloy blocked lenses is available by a number of suppliers. In those machines lenses are clamped by a gripper during the alloy melting cycle which eliminates the mechanical shock of manual deblocking. An automated de-taper removes protective tape with a high pressure water jet or must be peeled off by hand.

The advantage of water deblocking alloy blocked lenses is the elimination of the mechanical shock that the lens incurs during manual deblocking. However, the process of holding lenses by their circumference risks breaking lenses with thin edges or losing control of the lens orientation if a lens is not circular (the gripper can slip).
After the lens is deblocked, the alloy is melted using hot water in a similar process as with manual deblocking and can be used again after separation from water.

Using hot water to deblock alloy blocked lenses and melting the remaining alloy off the block still means contact of alloy with water and its hazardous components, like lead and cadmium, which leads to water contamination. Such contamination converts the water into hazardous waste which is difficult to handle and expensive to dispose.

Protective tape often sticks to the edge of the lens and does not come off completely in the automated de-taper. This disturbs the process and requires manual interaction to get the machine back into production.

As was the case in the manual process, there are remnants of alloy on the blue tape which turns this into hazardous waste as well – see picture 5.

Deblocking alloy blocked lenses is a messy process as shown in pictures 1-5 above. The lead and cadmium used in alloy are toxic and listed in the UNEP hit list. Alloy should be handled in special ways in any lab and the costs of doing so depend on how compliant a lab desires to be and/or how local government interprets EPA regulations. Handling and clean-up costs associated with using alloy include water cleaning and filtering systems, glove and clothing cleaning/handling, alloy disposal costs, and special reporting costs. In at least one area of the World, the local government is now requiring labs to conduct blood testing each month for any employees who handle alloy.

The cost of handling alloy is quickly increasing, although the ultimate costs depend on volume used along with a lab's interpretation of compliance. In the US, some labs are now being designated as alloy "Super Users" by the EPA (Environmental Protection Agency).
These labs now estimate special handling costs of alloy as ranging from $0.10-$0.40 per lens.

To avoid the hazardous characteristics of this blocking procedure a different blocking material must be introduced which requires an appropriate deblocking process as described below.

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2. Alloy Free Lens Production

Some substitutes for alloy have been introduced in the ophthalmic industry like wax, thermoplastics and UV-light curable adhesive.

To block lens blanks with these alternative and non-toxic materials and later deblock them requires adapted blocking and deblocking processes as described below.

2.1 Wax - Blocking and Deblocking

Like alloy, the wax is melted in a tank and applied in a similar way. This process still requires protective tape to avoid damage from hot wax on the surface of the coated or uncoated lens blank. During solidification of the block material a so -called block- or prism-ring is needed to hold the liquid wax in the correct spot between block and blank, which takes usually one or two minutes of cool down time, depending on the amount of wax applied. Such a ring must be selected in reference to the specific job data, which requires inventorying a large variety of different ring sizes.

Manual deblocking is similar to alloy deblocking: using a deblocking ring and hitting this ring with the blocked lens in it on a rigid surface. This mechanical shock risks cracking the lens at the edge or in total. Typically the wax stays on the protective tape, must be peeled off by hand and returned to the blocker for further re-use. There is no automated process for deblocking wax-blocked lenses and for wax recycling.

There are two significant issues with wax blocking: 1) the material is very soft, even after cooling, and due to its lack of stiffness does not provide a strong enough foundation to assure accurate turning of a progressive lens design into a lens; and 2) the wax tends to get everywhere in a lab, including the cleaning systems used in the AR coating room and the wax residue contaminates other processes.

2.2 Thermoplastic - Blocking and Deblocking

Similar to alloy and wax, thermoplastic material is melted in a tank. It is also applied in a similar fashion. Protective tape is needed as well and so are block- or prism rings to hold the liquid thermoplastic material in the right spot during solidification and cool down time.

As in the previously described processes, manual deblocking is typically done using a deblocking ring and hitting the ring with the blocked lens in it on a rigid surface. And, as before, this manual deblocking procedure introduces the risk of lens breakage because of mechanical shock.

The tape typically sticks to the adhesive and must be peeled off by hand to allow re-using the thermoplastic material. It is not easy to separate adhesive and protective tape completely from each other. Because some small “flakes” of tape can remain on the adhesive, it is contaminated for future use, negatively impacting the process due to less adhesive force and worsened melting/solidification characteristics. With thermoplastic materials, there is no known automated process for deblocking or for recycling.

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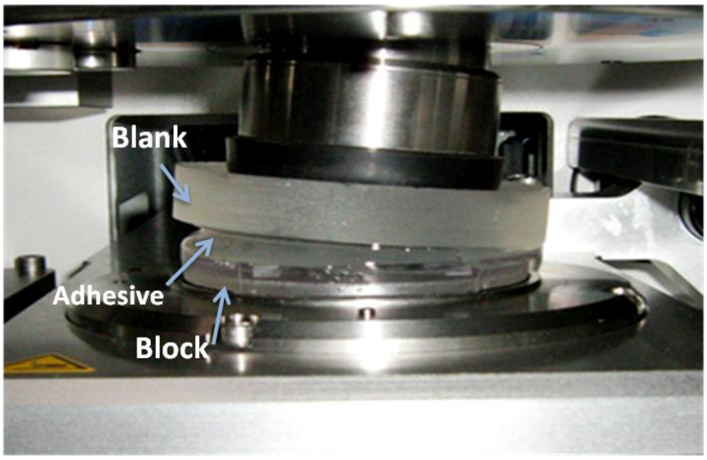
2.3 UV-curable Adhesive - Blocking and Deblocking

Rather than using alloy with all of its hazardous substances, a UV-light curable adhesive can be used to connect a lens blank blank with a block piece.
To allow UV-curing, the block pieces must be transparent for the UV-light's wave lengths. The adhesive, which is very rigid, assures design integrity and lens surface quality. No protective tape is needed on the lens blank. The adhesive flow characteristics do not require block- or prism rings.

The most important advantages of this type of blocking are:

- Non-toxic materials
- Tape is no longer needed
- No cool down period required
- The rigidity, and therefore design integrity, is similar to using alloy as a base



Because of the UV-glue's strong adhesive properties, the manual deblocking procedure used for alloy (hitting the blocked lens using a deblocking ring on a rigid surface) does not work. It is also not desirable due to the potential for lens breakage. Consequently it was necessary to develop a new deblocking process, referred to as water-jet deblocking.

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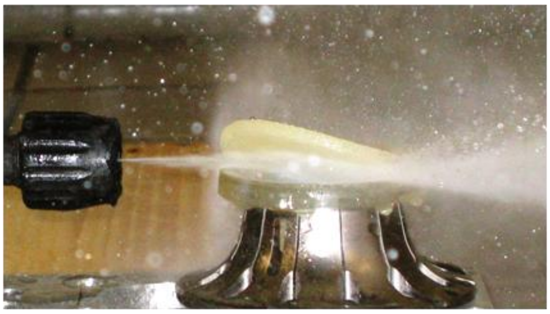
3. Advantages of Water-Jet Deblocking of Alloy Free Blocked Lenses

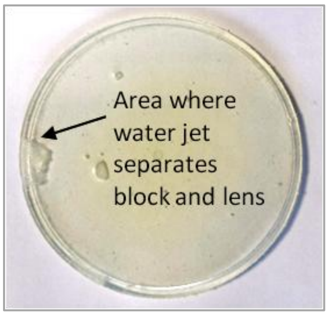
To deblock lenses blocked with UV-curable adhesive, a high-pressure water-jet process was optimized for this specific application. It eliminates the disadvantages of hot water deblocking of alloy blocked lenses, converting the formerly messy process into a clean solution – safe for both the environment and employees.

Water-jet deblocking is the only known deblocking process that can be completely automated. Because the block material is not hazardous for the environment or staff, there is no risk of introducing hazardous substances into the water – it stays clean and is easy to handle and dispose.

Deblocking can now be adapted to the customers' needs: a manual process for small and medium sized labs and a fully automated process for manufacturers that require automation throughout the entire lens production.



Picture 6: Water Jet Deblocking



Picture 7: Adhesive layer

Three important preconditions exist to successfully de-block a lens:

1. Cribbed lens diameter must be bigger or same as block diameter
2. Adhesive supports the entire lens surface
3. Adhesive thickness is at least 0.8mm at the cribbed lens diameter

3.1 Manual Water-Jet Deblocking

The manual deblocking process has five settings, corresponding to the five different block geometries. They guide the water jet exactly to the position where the lens will be separated from the block based on the specific diameter and shape. Selecting the right setting is much less effort than selecting the right alloy deblocking ring: the operator simply uses the handle inside the Deblocker.

The blocked lens is clamped in a chuck. A suction cup holds the lens from the back. Closing the cover of the manual Deblocker automatically starts the water jet. The blocked lens can be rotated by simply turning the outside wheel which is connected to the clamping chuck.

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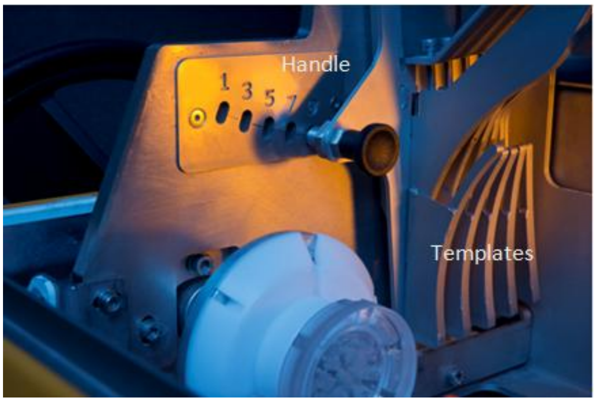
After deblocking, the operator removes the block from the chuck and the lens from the suction cup. As a last step, the adhesive layer is easily removed by hand either from the lens or from the block. The dried block can be used immediately for the next blocking cycle.

A manual block-identifier scans the dot matrix code on each block and provides information on the right bin for re-use, required cleaning or indicates that the block should be discarded into the recycle bin if it has reached its 100-cycle limit.

Picture 8: Manual Deblocker

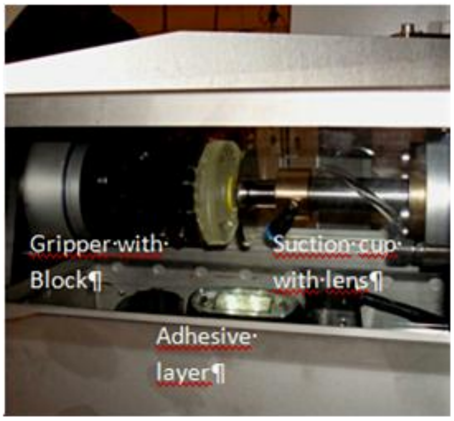


Picture 9: Handle and Templates

3.2 Automated Water-Jet Deblocking

The automated deblocking process separates lens, adhesive layer and block. This process can deblock lenses of almost any shape without the risk of lens breakage. The Deblocker receives the job information from the lab management software (LMS) including the real lens geometry. The high pressure water jet is guided precisely to the interface between block and adhesive, where the deblocking occurs. The first step separates the lens and block; the second step removes the adhesive layer from lens or block. The lens is automatically cleaned, dried, and returned into the tray. The block is then sorted according to its geometry into 1 of 12 different bins for re-use, cleaning or recycling after 100 uses.

Picture 10: Automated Deblocker



Picture 11: Deblocking Chamber

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4. Lens cleaning after deblocking

To remove adhesive residue, different cleaning agents might be needed compared to cleaning agents used for tape residue removal. Otherwise, cleaning is the same.

4.1 Traditional Lens Production

The diagram below outlines typical process steps for alloy-based lens production.

For lens cleaning, three processes are commonly used to prepare lenses for the subsequent coating process.

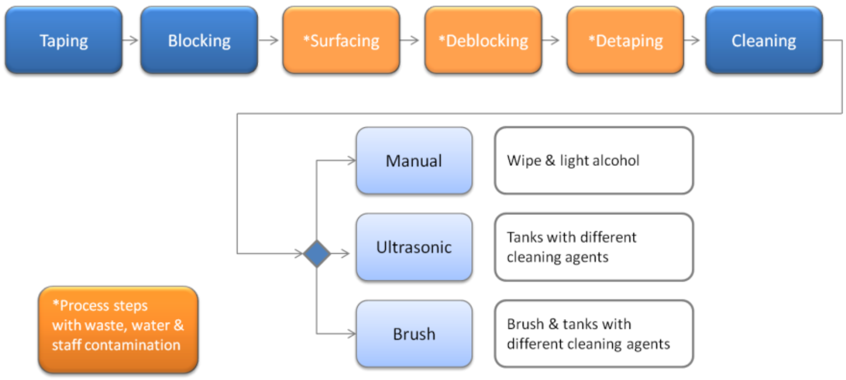

Diagramm 1

For these processes various different machines, manual and automated, are available, including ultrasonic cleaning tanks, brush cleaning systems and dip-cleaning systems.

4.2 Alloy-Free Lens Production

Below process flow for alloy-free lens production shows the differences and similarities compared to alloy. The processes that contaminate water and staff are eliminated and no taping or detaping is needed, which obsoletes these traditionally manual steps during lens production. Cooling is also eliminated which saves time. The cleaning processes themselves are the same as for alloy-based production.

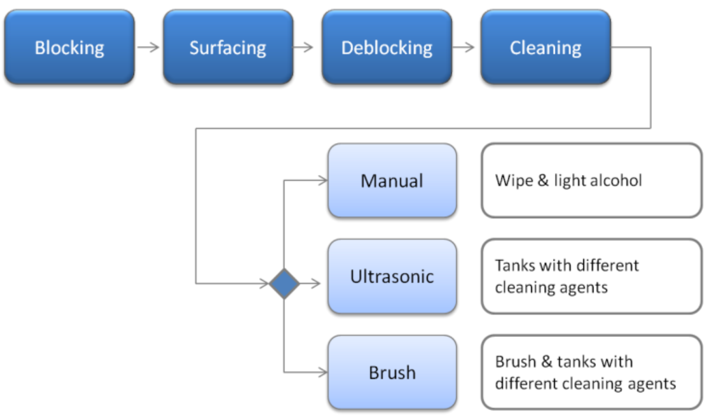

Diagramm 2

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For an automated lens cleaning process, optimized cleaning systems are available. Such machines, produced by the French manufacturer SCL, offer a combination of polish residue and adhesive residue removal in one machine.

There are two basic principles for automated lens cleaning: ultrasonic or a brush system. In both cases specific cleaning additives are required. Picture 12 shows SCL's ultrasonic cleaning system UHP 150, picture 13 shows SCL's brush cleaning system CTE 500

Ultrasonic cleaning works with all lens materials, coated or uncoated, even the most sensitive ones. However, brush cleaning is more effective and able to clean strongly contaminated lens surfaces, e. g. from dried polishing agent or remnants of cured adhesive.

Both types of machines are not specific to the ART process and are needed for alloy based lens production as well if automation is required.

Picture 12: Automated lens cleaning machine CHP150

Picture 13: Automated lens cleaning machine CTE 500

Together with the automated Deblocker, such a cleaning machine closes the loop for totally automated lens production – a first in the industry.

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5. Block Cleaning and Dispensing

A new machine for automated block cleaning, picking and placing is under development by the company P@P. The new system will take blocks out of the tray after deblocking, read the blocks' code, and detect any remaining adhesive on the blocks. A block which cannot be identified, has adhesive on it, or reached a set number of use cycles to require cleaning will be cleaned inside the machine. A block that is successfully identified, goes into a sorting system, and is stored in the machine, ready for re-use. At the beginning of the next cycle, the machine serves as block dispenser: after reading the job ticket the machine takes the correct block out of the magazine and places it properly orientated into a job tray.

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