



Adaptive Aspheres Polishing

Greatly improves long-term process
stability in production

The ASP-Tool has been developed for fast high performance aspheric polishing.

satisloh[®]

ASP-Tool

Long-term process stability in production is the key. Each lens is polished with a fresh polishing foil, tailored to the lens geometry.



ASP-Tool the benefit of optimum process control

The ASP-Tool is a precision tool using pre-configured polishing caps and an air pressure controlled polishing force to achieve a consistently stable process with true elimination of tool wear.

The adaptive tool philosophy completely separates polishing force control and tool compliance from the shape of the removal function. The shape of the removal function of the ASP-Tool stays constant and is fairly independent of the polishing pressure. Preparation of the ASP-tool for production starts with the dressing (grinding) of a number of disposable plastic caps to the desired radius (using a CNC polishing machine with dressing spindle), followed by application of the polishing cloth. The finished polishing cap is then simply pushed onto the ASP-Tool receptor and ready for use.

The polishing pressure is created inside the ASP-Tool. Typically air pressure is used to push the tool against the surface to be polished; a spring load option is also available. Applying the pressure extends the tool by several millimetres along the tool axis. This precision guided linear motion is hermetically sealed against the polishing slurry.

Due to this design the compliance of the tool is effectively decoupled from the removal spot, which is solely governed by the cap shape and

the type of polishing foil used. Furthermore the dynamical behavior, compliance and damping properties of the ASP-Tool are independent from the slurry condition, an advantage compared to approaches, where hydrostatic slurry pressure is used to apply the polishing pressure. Other advantages above the just mentioned type of systems are the absence of slurry induced wear of mechanism and the freely selectable size of the polishing spot.

Elimination of tool wear is a key factor, which is realized by utilization of the exchangeable polishing cap. Polishing foil is applied to a set of polishing caps, which are replaced at the start of each new lens. Each lens is therefore polished with a fresh polishing foil and the process starting point for each lens thus is exactly the same. This greatly improves long term process stability in production. While there is an expense for preparation of the tool caps, this is normally far smaller compared to the expenses involved in coping with the consequences of a less stable production process.

Processing examples

Smoothing, pre-polishing and correction with one tool

Smoothing

An additional surface smoothing after grinding and prior to polishing can save substantial amount of time in finish polishing by removing unwanted topographical features without changing the general shape. For this process the ASP-Tool can be fitted with a diamond doped foil and used in the grinder.

The process has been successfully tested on both soft (e.g. Germanium) and hard materials such as fused silica, as shown right. Due to the fast removal rate, sub-surface damage (SSD) can be efficiently removed.

Pre-polishing

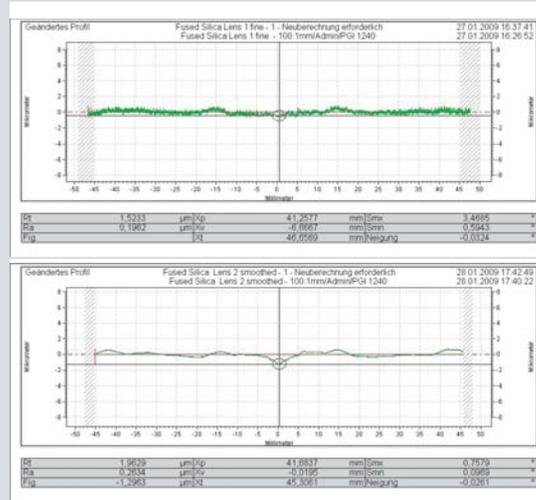
Consistent high quality output in the production of aspheres is a challenge. Owing to the fact that aspherical polishing typically uses a small removal area, tool wear has a significant negative effect on the process stability, which in turn increases the effort for corrective polishing. Elimination of the tool wear by utilization of an exchangeable polishing cap greatly improves long-term process stability - each lens is polished with a fresh polishing foil and the process starting point for each lens is exactly the same. While there is an expense for preparation of the tool caps, this is normally far smaller compared to the expenses involved in coping with the consequences of a less stable production process.

Corrective polishing

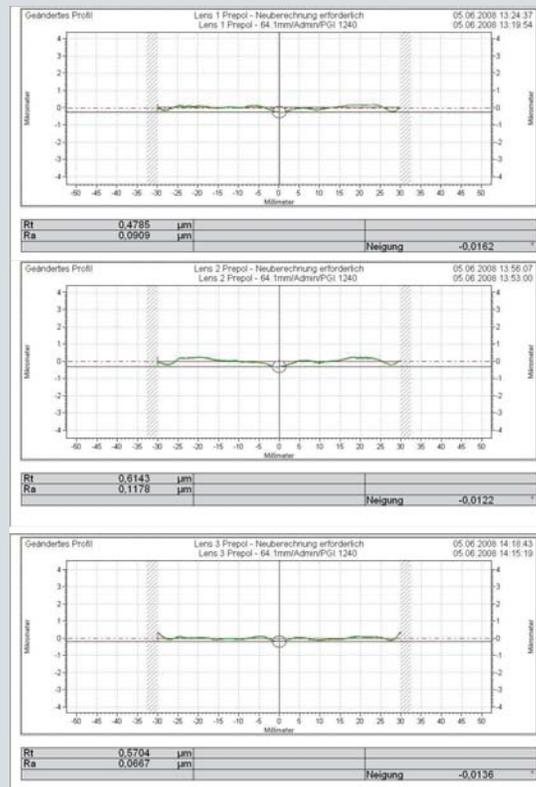
The ASP-Tool makes switching from pre-polishing to corrective polishing particularly easy. The tool can be dressed to the same height, i.e. the same geometric CNC parameters, but to a smaller radius, which yields a smaller, more adequate removal spot for correction. Major benefits of the ASP-Tool for corrective polishing include firstly the finely controlled load by a air pressure, secondly the constant shape of the removal spot, and thirdly the well defined start and end point of the polishing process. The latter is effected by switching the air pressure and this way engaging respectively disengaging the tool instantaneously.

Alternative use

The base of the ASP-Tool can be employed for universal use. Other possible uses include soft polishing, e.g. of free-form optics using a very soft polishing foil/foam sandwich. Exchanging the polishing cap is a matter of seconds. The controlled linear loading force feature also allows combination with a pellet tool for grinding.



Smoothing of a concave fused silica lens (90 mm diam.) was accomplished by a 2 step process using pads with 30 µm and 15 µm diamonds; 9 min total processing time with a spring loaded version of the ASP-Tool in an SPM-140 CNC grinder.



Example of pre-polishing results remaining within $\pm 0.1 \mu\text{m}$. Conditions: SPS-60 CNC polisher equipped with ASP-Tool (with air pressure) and DataCorrect software; 3 convex aspheres (BK 7), 3 fresh polishing caps dressed to the same radius, height, and with the same foil, polishing time 25 min (each lens), Cerox polishing additive.

Technical Information:

- Mounting of the tool is accomplished via a standard (25 mm) Hydrodehn expansion chuck.
- Internal retraction spring is standard
- As a standard the ASP-Tool is equipped for polishing force control by air pressure, and a separate steel spring, which can be easily inserted for the spring-loaded mode of operation.
- The ASP-Tool base features 2 threaded holes for mounting of various tools, in particular the cap carrier plate.

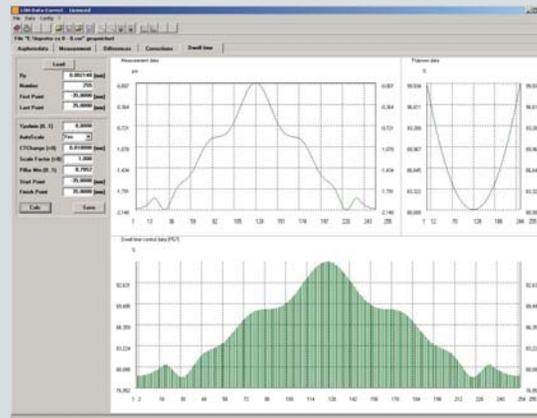
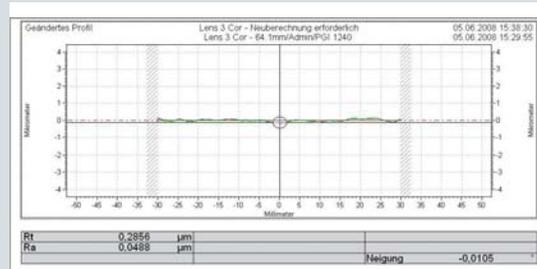
- Replaceable cap are easily fitted to the cap carrier plate via pin guided click-on mechanism.

Dimensions and limits:

- Standard length: 42 mm
- Flexible range: 5 mm
- Max. air pressure: 3 bar
- Max. RPM: 3000 rpm

Recommended options:

- DataCorrect software
- Aspherical polishing tool with carrier (torx) length 42,0
- Polishing tool cap (torx)



Switching between pre-polishing and corrective polishing with the ASP-Tool is a matter of 10 sec. Dressing the polishing cap to the same height, i.e. same CNC machine settings, makes this a straight-forward process. The radius of the cap may be chosen smaller, in order to achieve a smaller removal spot, and polishing parameters can be optimized for the corrective polishing. Polishing dwell-times are controlled by DataCorrect (bottom).

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