TRIOPTICS
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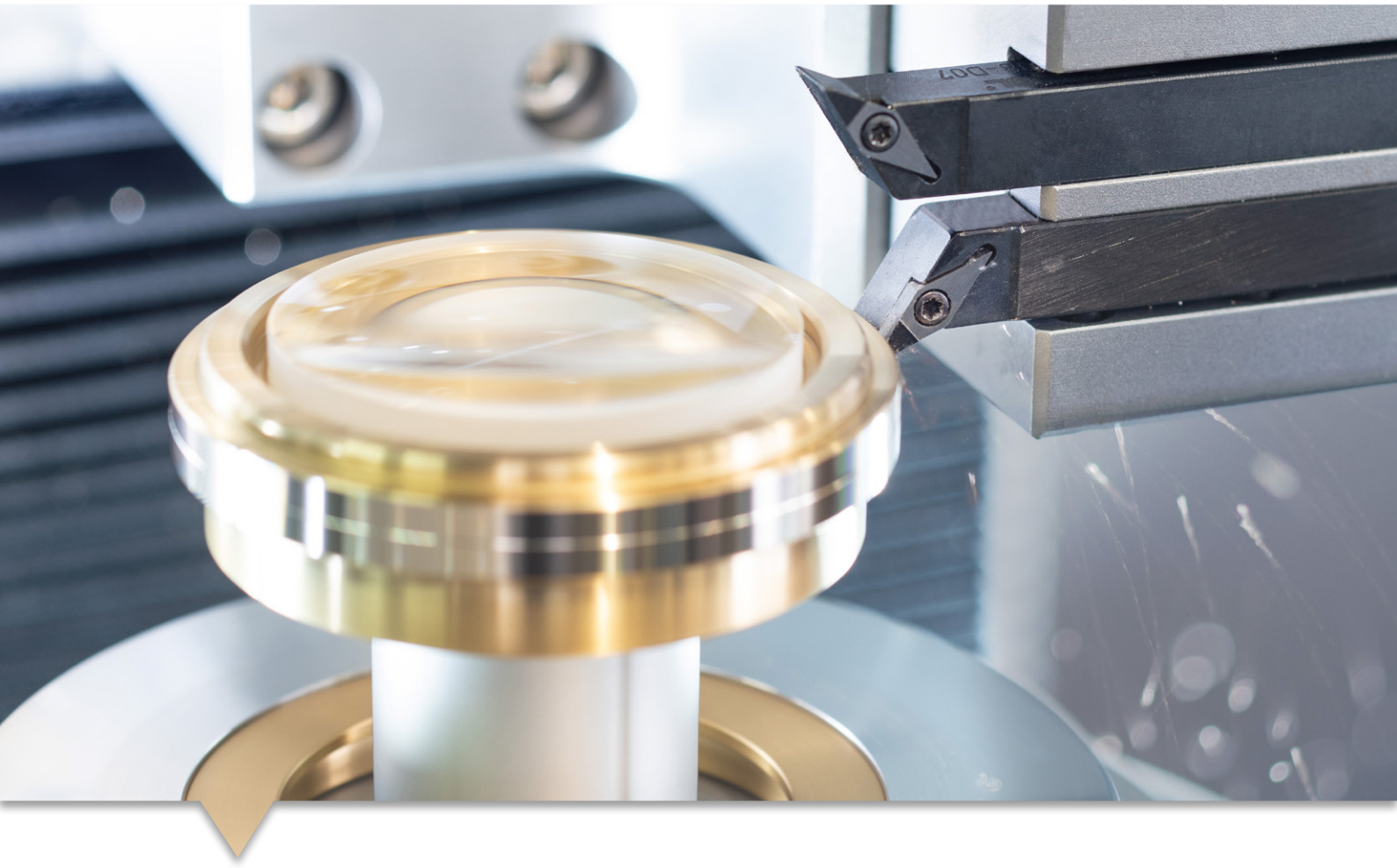

Cost-efficient production of customized precision objective lenses

Application report ATS

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The ATS alignment turning stations from TRIOPTICS not only offer a solution for high-precision, cost-efficient lens manufacturing processes, but can also be used in the production of customized objective lenses.

In today's fast-paced world, the distinction between goods, services and the companies themselves in their environment is often crucial. Companies are increasingly gaining competitive advantages through the specific orientation of products to a selected segment or sector. It is not only manufacturers of end products that have to tackle these challenges, but also their suppliers – and that is exactly the case for many manufacturers of optical systems. The demand for specific microscope lenses with superior image quality, high reproducibility and attractive pricing in series production is one such requirement that needs to be met. Conventional microscope lenses are not suitable for this application, since they were primarily developed for universal use, and often do not meet the requirements of a specific application. Possible characteristics of these customer-specific microscope lenses include diffraction-limited, non-vignetting and exceptionally low-distortion imaging over several wide wavelength bands as well as the entire FOV (field of view) and/or a broad temperature range. Since the necessary cost efficiency of these highly customer-specific requirements cannot be ensured using conventional manual production, an efficient tool is frequently needed. Many manufacturers have already found the optimal solution for this: the ATS alignment turning station by TRIOPTICS.

The image quality of an optical system depends on the precise centering of its lenses, among other factors. In conventional processes, a lens is manually glued into its mount with the greatest possible precision and then aligned within the lens barrel by hand as well. This step is very time-consuming and depends heavily on the experience and day-to-day capability and performance of the individual employee doing the task. Since even very experienced employees often need a long time for centering and aligning the lens, this makes small lens series production particularly expensive.

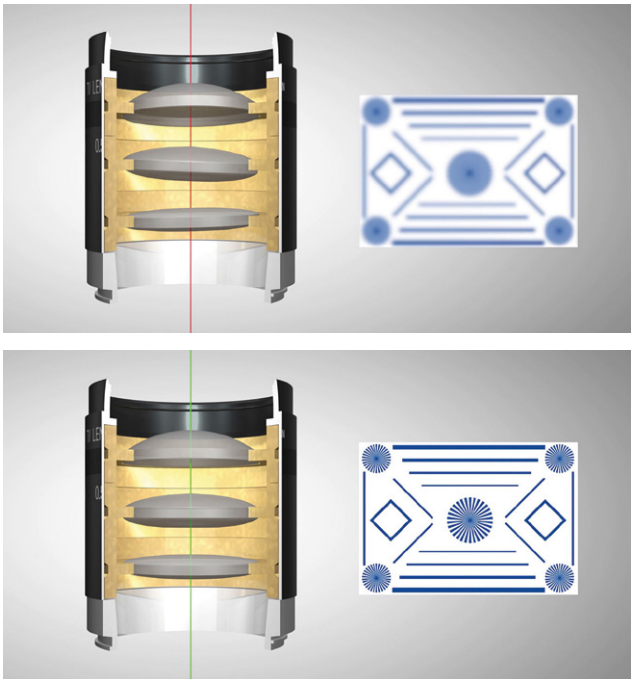
The alignment turning station ATS 200 by TRIOPTICS

To supply the customer with high quality products, but at a lower price than previous customized solutions, integrating the ATS into the production process offers the ideal solution. The machine uses alignment turning to eliminate the errors that occur during lens production. This not only rules out manual errors, but the subsequent assembly process does not require any further alignment and takes

significantly less time than manual alignment. ATS users confirm that the alignment time can be reduced from about one day when using the completely manual method to less than one hour in the ATS-supported process. And another advantage: In contrast to human operation, the system is always consistently efficient, and the automated centering is also ideally suited for higher quantities in series production, while still ensuring the quality of customized production.

Dr. Christian Buss, Product Manager of ATS: "The ATS machines utilize alignment turning, the most precise method to align the optical axis of a lens. In addition, a large range of different mount sizes can be machined. And last but not least, our high-precision turning machine achieves very good manufacturing accuracy with residual centering errors of less than 0.5 µm."

The system machines the workpiece comprised of the lens and mount, perfectly aligning the optical axis of the lens. The key advantage: Only the alignment turning method eliminates all errors occurring in the mounted lenses. The centration is automatic, and an intuitive, intelligent user interface guides the operator through the process without requiring in-depth previous knowledge.



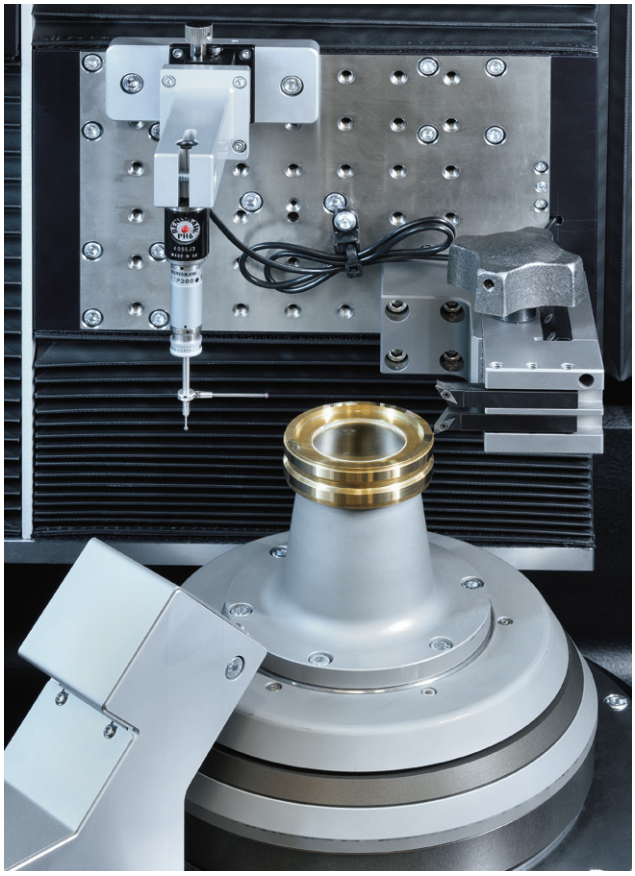
Top: Objective lens with conventionally manufactured sub-cells before their manual alignment

Bottom: Sub-cells machined with alignment turning show precisely aligned optical axes. Further manual alignment is not required.

The mount with the glued lens is fixed in an alignment chuck and the position of the optical axis of the lens to the spindle axis is measured with the proprietary and established OptiCentric® system. Using this alignment chuck, the lens is then aligned so that its two centers of curvature are located as closely as possible to the spindle's axis of rotation. The spindle is then rotated and the contact surfaces of the mount are machined with a sharp (diamond) turning tool; the system then checks the accuracy after each processing step. The result is a precisely finished cell surface and an optical axis perfectly aligned to the mount axis. In addition, the front and rear contact surfaces can also be machined during the turning process, thus allowing optimum adjustment of the air gaps between the lenses. High-precision turning with micrometer accuracy ensures that the alignment and distances between all lenses are optimal and that they can be mounted to an objective lens without any further alignment steps.

The core of the alignment turning machine is an ultra-precise turning device combined with the centration measurement system OptiCentric®, the alignment chuck, as well as tactile and optical sensors. This makes it possible to adjust and monitor all relevant parameters, such as the diameter of the mount or the distance between the lens and the mount's contact surfaces. In addition to these centering measurement devices, the tactile or optical sensors measure the front and rear contact surfaces of the mount. The automated alignment chuck is designed for applications where the speed of the alignment process is

important, for example in series production. The automated alignment largely eliminates operator error.



The automatic adjustment chuck aligns the optical axis of the workpiece precisely with the rotation axis of the turning station. After a tactile measurement of the flange surfaces and the external cell diameter, machining begins.

Experienced lens manufacturers can go one step further: The manufacturing tolerances of single lenses affect the image quality of the entire lens. Lenses that are supposedly identical therefore vary in their image quality. During production, the individual center thickness and lens radii are measured, the lenses are calculated again in their positioning, and the composition is optimized. The production in the ATS is optimized for each lens, so that although no two mounts are exactly the same, all of the finished lenses ultimately deliver the best quality in relation to the individual lens set.

The benchmark of alignment turning stations at TRIOPTICS is the ATS 200. It can be used to machine mounted lenses up to 200 mm in diameter. The maximum mounted lens weight is 5 kg. Thanks to TRIOPTICS' MultiLens® technology, multiple lens surfaces in one cell can also be centered with just one autocollimator. Also, multiple inner optical surfaces can be included to align the element with respect to a best-fit axis. To ensure the highest quality standards, the system features a stiff granite machine base, three high-precision aerostatic axes, and integrated vibration isolation. Highly flexible, the ATS 200 is ideal for implementing a wide range of customer projects. And due to its modular design, the system can be easily adapted and customized.

Melles Griot Optical Systems is one manufacturer that has already successfully integrated the ATS 200 into its production process for precision optics. Turan Erdogan, Site Leader at the company, confirms: "We can now offer custom microscope objectives from prototype to higher-volume production quantities at prices previously achieved by only very high-volume standard objectives. This capability is an ideal solution for life science and medical imaging applications like high-content-screening, digital pathology, and DNA sequencing, as well as for inspection and metrology applications in semiconductor and industrial markets".

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TRIOPTICS GmbH

Strandbaddamm 6
22880 Wedel
Germany

+49 4103 18006-0
sales@trioptics.com
www.trioptics.com

A member of the JENOPTIK Group

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