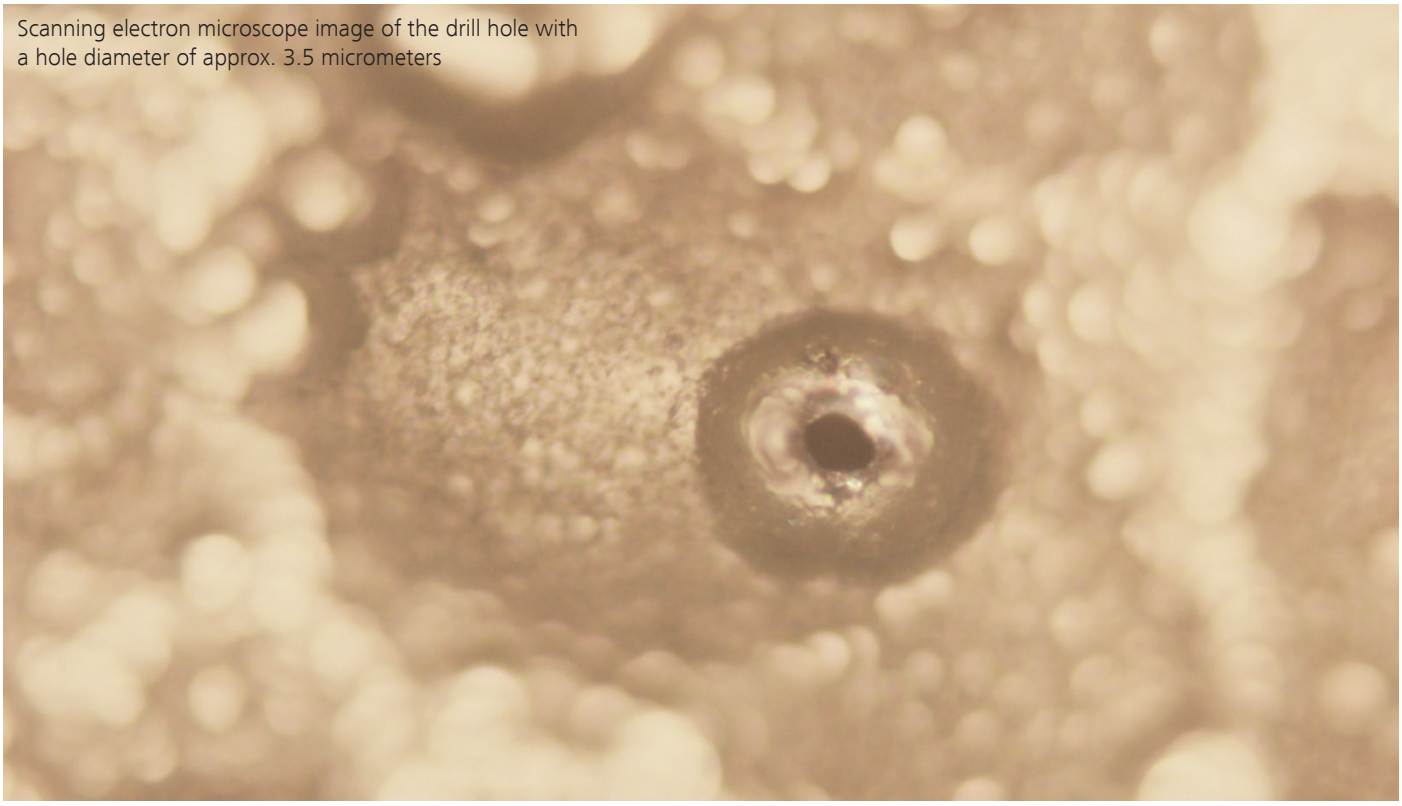


Scanning electron microscope image of the drill hole with a hole diameter of approx. 3.5 micrometers

Laser Drilling in Plastic – Successful Project with Micrometer Precision

Within the space of just six months, the machinery supplier Contexo and the photonics-specialist Jenoptik have successfully rolled out a laser-drilling machine for an innovative plastic product. Both partners combined their skills in the fields of custom-made automation solutions and integrated subsystems for laser applications.

This new machine is designed to "laser drill" microscopic holes that are less than 5 micrometers wide into a 0.1 millimeter sheet of plastic 30 times per minute – such are the challenges faced by manufacturers of production facilities today, and these challenges are growing with the manufacturing processes for new, mass-produced series products. Production should be both fast and cost-effective, and the result must always be the same and of outstanding quality.

The family-run company Contexo, which is based in the South German town of Winterbach, is taking on these challenges for its clients in its second generation and across the world. Reliable, high-performance machines for mass production are the pet project of the Swabian plant manufacturer.

Matthias Müller is one of the three sons of the company's founder and is responsible for Sales and Distribution on the company's board of management: "The machines we build for our clients assemble, print, join, stick, weld, and laser. We incorporate up to eighty work steps into a single machine and we personally ensure that our clients' projects are a success."

In mid-2018, the medium-sized company set itself the task of developing a complex automation solution for a big client in the drinks industry. The plant concept consisted of eight machines for assembling pressure tanks in sync. One of the eight machines was intended for drilling special plastic modules with an output of 16 million parts per year.

A key machining step in this is to drill a microhole into a valve component manufactured in a two-component injection-molding process. Despite its diminutive size, this hole has an important role to play, as the functionality of the entire system depends on it. When making the hole, it is vital that a narrow tolerance range is maintained. And the only technology that is capable of this is laser technology.

Furthermore, thermally stable, vibration-resistant high-precision optics that focus the laser beam and point it exactly at the workpiecewere also required. Contexo have dealt with this kind of task before, as they have been developing machine solutions that use lasers for many years now. Previous business connections and joint projects formed a solid foundation for the two partners in this project.

As Matthias Müller describes: "We have found a project partner who can provide us with integrated laser processes for this substantial machine concept. Jenoptik are specialists in the integration of optical modules. They have designed a special laser beam modulation system for the laser application "Microdrilling in Plastic" and they were able to assist us with application development. We were therefore able to focus on our core business, high-speed plastic item processing, and give our client their turnkey solution relatively quickly." And they do not just have short development time on their side: By integrating an already tested optical submodule, the machine supplier has eliminated possible risks, and by calling on Jenoptik, they have an experienced partner with special technological expertise.

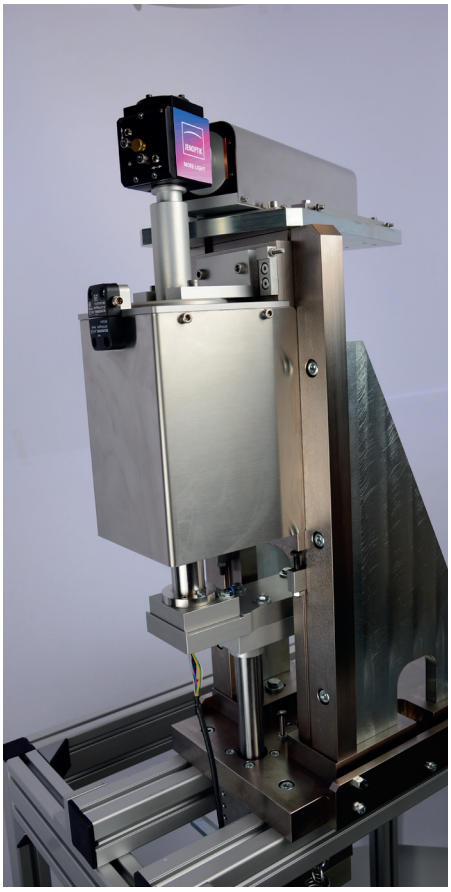
The optical system developed by Jenoptik consists of a beam expander for widening laser spots by up to four times their original size in collimated beams, a deflection unit with a dichroic mirror that reflects UV, lets visible light through, and deflects the laser beam by 90 degrees, as well as a lens for accurately focusing the laser beam on the workpiece. The optical components used are their own high-quality products.

Steffen Reinl has been part of the Jena-based company's project team from the very beginning: "We have set ourselves the task of developing and building an OEM module that is easy to integrate. We needed a detailed picture of the exact specifications in terms of installation space, laser type, drilling accuracy, working distance from the workpiece and adjustability within the optical system. The challenge lay in both the high bore diameter to bore depth aspect ratio and in ensuring reproducibility."

Challenging parameters for the process

The microholes had to be drilled to a diameter of 355 nanometers with a high-end picosecond laser that uses high pulse energy in the ultraviolet spectral range. The distance from the workpiece had to be exactly 10 centimeters, with a laser spot size of 3 micrometers and a depth of focus close to the material thickness – 100 to 150 micrometers.

An important criterion in the conception of the optical module was to ensure a uniform hole size in the workpiece, as this is crucial to the smooth operation of the end product. The solution was found in the residual light, which passes through the hole that is created during the drilling procedure and is detected, i.e., "measured", on the rear face of the component. The idea was implemented by Jenoptik using integrated image processing and the corresponding electronics.



The factory acceptance test of the optical Systems at Jenoptik

In this way, optical data can be evaluated and ultimately used to turn the laser energy off at exactly the right point in time and thus ensure a constant hole diameter with different material thicknesses. Steffen Reinl: "We were able to draw on an already established technology in our corporation and only had to make minor adjustments for this process."

integration after extensive test runs

The project started in August 2018 and was implemented successfully in the first quarter of 2019 after a development period of just six months. The exciting moment when their solution was integrated into the machine environment came in December 2018. The Thuringian photonics engineers had previously put the optical beam path “to the acid test” in their laboratory. Steffen Reinl: “We didn’t want to leave anything to chance. We got the picosecond laser for the ‘Factory Acceptance Test’ from our partners at Contexo. It is indispensable for confirming the functionality of the optical system and for giving it preliminary acceptance prior to installation. Everything went off without a hitch and we were able to send the system off to Winterbach with a clear conscience.”

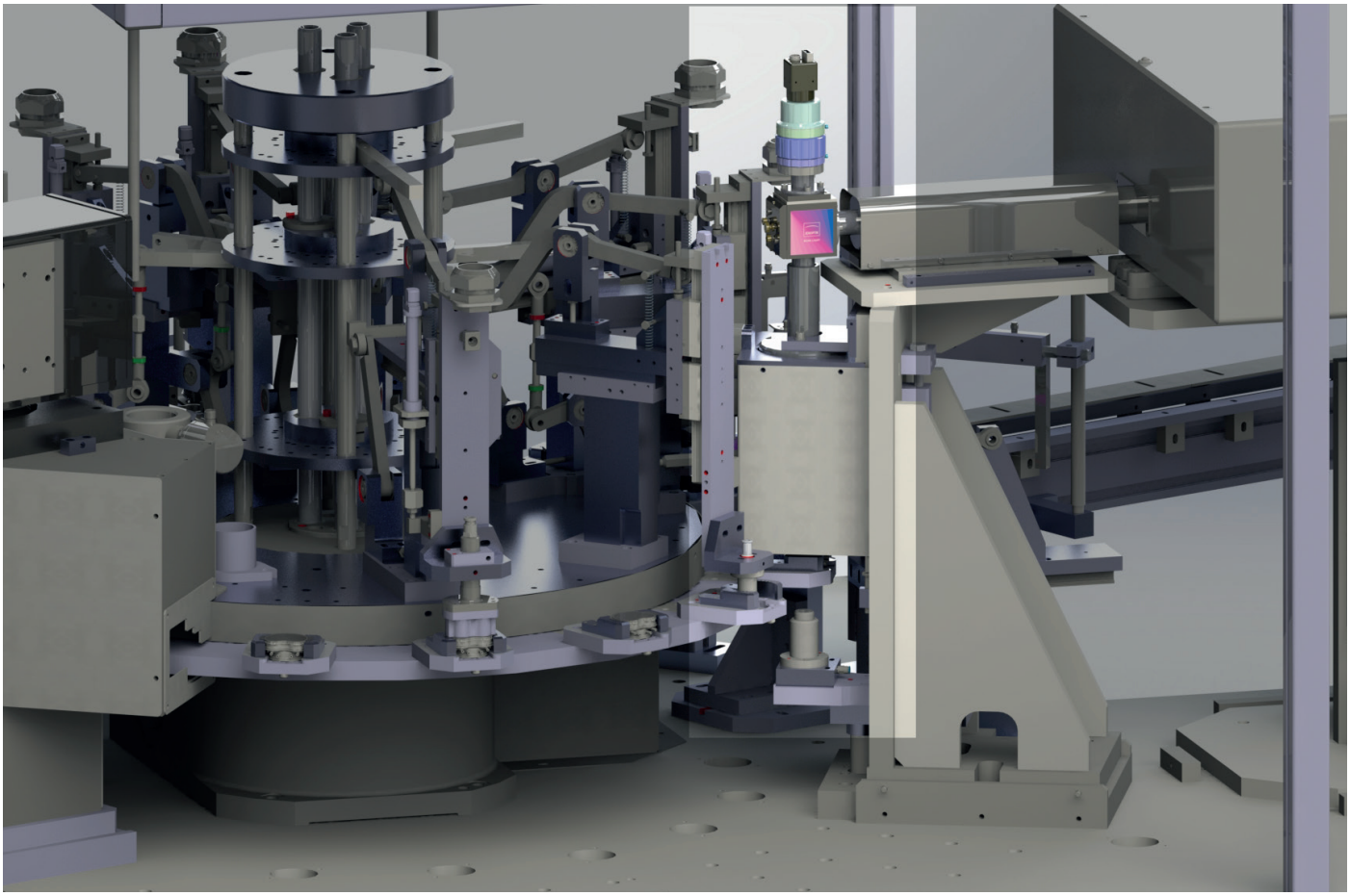
An adaptable camera was also installed in the machine as a digital positioning aid for the optical system. In this way, not only could the system be perfectly positioned, it also opened the door to long-term monitoring of the centering and offset of the optical path.

Mechanical engineers, optics engineers and assembly experts from both companies worked together in the project team to bring the project “Microdrilling in Plastic” to fruition. This project is a prime example of how core competencies from different disciplines complement one another and come together to form a greater whole. In the end, it is the client that benefits from a shorter delivery time and a faster project run.

Company Profiles

Contexo is a machinery supplier that operates internationally and takes on technical challenges for world-renowned brands and companies. The company specializes in constructing high-performance assembly machines for mass production.

Jenoptik combines crucial key technologies and meets the growing need for highly integrated optics solutions. The systems, modules and components used help clients master future challenges using photonics-based technologies.



View to the machine and the integrated optical system for automated drilling (CAD picture)