MEASURING AT THE LIMIT:

It (almost) doesn't get any smaller

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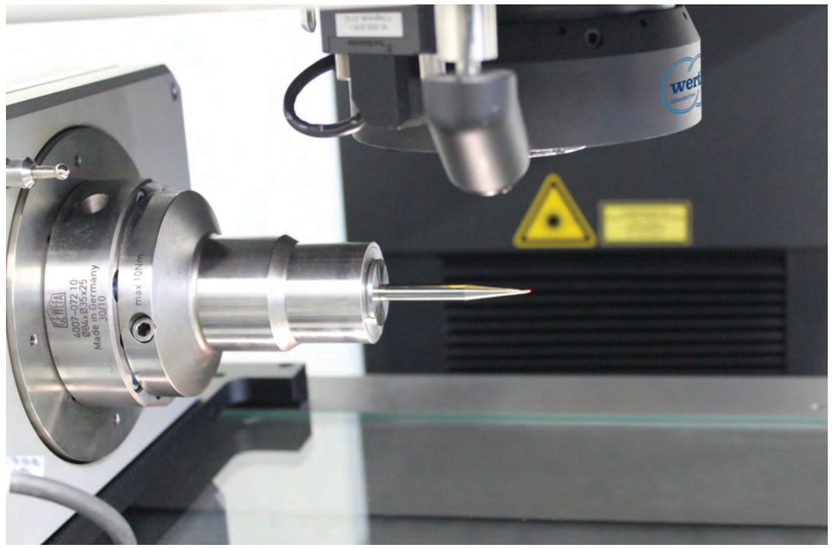
WORDS | **WOLFGANG KLINGAUF**



<< Figure: The A axis air bearing with tumbling compensation is also used for pitch measurements. >>

Production of micro tools requires special measurement technology. Where the eye can no longer detect geometric errors, high-end measuring machines are needed for both visual inspection and fully automated production monitoring.

In the world of tools, the name Zecha stands for precise cutting, punching, and forming tools, with diameters down to a few hundredths of a millimeter. Its partner for quality assurance is Werth Messtechnik.

Stefan Zecha, the managing shareholder of Zecha Hartmetall-Werkzeugfabrikation GmbH, described the focus of his company: “Our strength is in high-quality tools less than 6 mm big, especially when the diameter is less than 3 mm. Currently our smallest tool in the catalogue is a 0.03 mm mill, and our special line has a 0.02 mm mill with two cutting edges. It doesn’t get much smaller than that.” Starting back when the company was founded 50 years ago, Zecha has been focused on very small tools (figure 1), which were needed by the watchmaking and jewelry industry located in the area of Pforzheim. Over the years, other customer industries have joined them, such as micro mechanics, mould making and medical technology, which often require specialized solutions for their high quality requirements and materials that are very difficult to machine, such as titanium and cobalt chromium. Stefan Zecha and his tool specialists are happy to take on these challenges: “Customer-specific development is one of our strengths. This also moves our standard catalogue tools forward, and secures our competitive advantage in technology.”

Process Reliability and Traceability

The precision and quality of Zecha tools are defined by high dimensional and form accuracy. In order to guarantee these properties long term, the coatings are individually chosen for each series of tools. Stefan Zecha points out that “reliable production processes and traceability are indispensable, especially in medical technology. For us this means that we pay special attention to the consistent precision of our tools, and make sure they are traceable. Each tool is individually numbered and documented for this purpose (figure 2).”The effort that Zecha expends through the entire process chain for tool production is enormous. This becomes clear during a tour of the plant in Königsbach-Stein. The managing director points out that their partner company MPK Special Tools is similarly equipped with respect to production and measurement equipment. Cutting tools are produced there in Schwäbisch Gmünd, in addition to the production in Königsbach-Stein.

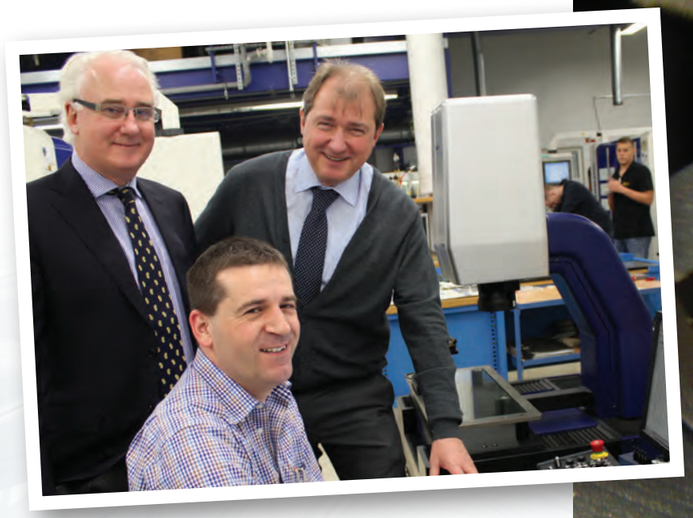
<< Figure 1: Micro tools from Zecha promise long tool life and maximum process reliability. They are manufactured with µm precision and the result is characterised by excellent coating adhesion, low friction, mechanical strength, and uniform quality. Images: Zecha/ Werth. >>

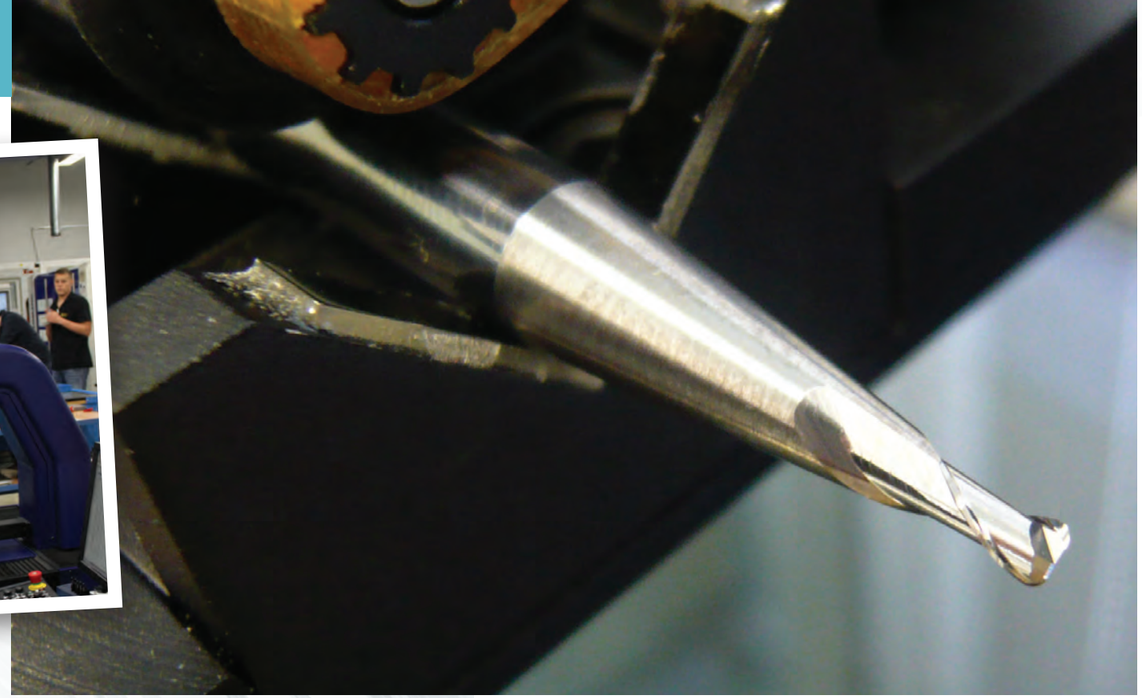
The focus at MPK, however, is on tools for punching and forming, which also require ultrahigh precision. Stefan Zecha provides an example: “A hole punch shaft must be round to within 1 µm, and its diameter must not deviate from the nominal value by more than 2 to 3 µm. Such precision is not necessarily required for the shafts of our cutting tools. But because we have the knowledge and technical prerequisites, we grind all of our shafts to this accuracy. This guarantees the ability to grind these micro tools during following process steps.”

Employees, Machines, and Measuring Technology Lead to Success

Three pillars form the basis for Zecha tools: employees, machines, and measuring technology. The employees, preferably trained in-house, are particularly valuable. “We have two to three apprentices at each location every school year,” says Stefan Zecha. He argues: “For products smaller than 3 mm, it is not enough to buy the machine and the associated measurement equipment. The employee must be able to work with the small dimensions, and this is not something you learn in every factory. Our people build up the required experience day after day. As a rule, they find a 12 mm mill harder to handle than a 1 mm tool.” The highly specialised employees are provided with equipment that is just as specialised, such as modern grinding machines, mostly from Rollomatic, whose temperature is held precisely to within ±1°C in climate-controlled surroundings. The newest laser system for producing PCD and CVD tools was acquired only recently. This ensures, among other things, that cutting edges have a sharpness between 0.5 and 2 µm for each cutting tool, depending on the application. The machine tools, however, are just half of the solution, as Stefan Zecha explained: “We also need high-quality measurement technology, so that the worker can monitor and correct the machine using the results of the machining process. The machine tools are able to provide results that are precise to the µm, but only if they are set up properly.”This insight is not new. Back in 2006, Zecha was using specialised measuring machines from Tool MT GmbH in

<< Figure 2: Detailed records of every work process mean that every tool can be uniquely identified by means of an individual number on the end of the shaft, and can be reproduced precisely, even years later. >>





<< Figure 3: Managing director Stefan Zecha (rear) and production manager Alexander Fabry, along with Christopher Morcom from Werth, celebrate the successful installation of the two measuring machines, a NanoMatic and a VideoCheck®, which are used in an identical configuration at the Königsbach-Stein and Schwäbisch Gmünd locations. >>

<< Figure 4: In order to meet the tough requirements for measuring microtools, the Werth NanoMatic and VideoCheck® measuring machines in use at Zecha have a so-called 'V block' for holding the tools. The tool rotates around its own axis in a rectangular prism, which prevents pendulum errors. >>

its manufacturing processes. In the meantime, the technical possibilities have advanced, so that Zecha upgraded to newer, more precise measurement technology almost two years ago. "Just as we upgraded the machine side with Rollomatic machines from the nano series, we also had to optimize our measurement technology in order to become faster and more precise," explained Alexander Fabry, Manager of Production/Quality Assurance. The tool specialists found suitable machines for the shop floor and the lab at Werth Messtechnik GmbH, to which Tool MT GmbH belongs since 2009. Werth Messtechnik is the leading company in coordinate measuring technology, with optical sensors, multisensors and X-ray tomography, as well as in the measurement of micro features.

Werth Multisensors Deliver Rapid, Precise Measurement Results

Alexander Fabry, who has known Werth for over 15 years, is excited about the merger. "The measuring machines provided by Tool MT before their cooperation with Werth Messtechnik were already very precise and provided absolutely repeatable results. These factors also have the highest priority at Werth, and the size of the Werth Group means that they can offer greater security and more flexible measurement technology. These coordinate measuring machines can be equipped with a wide variety of sensors — both optical and tactile — and offer a wide and interesting perspective for tool metrology with X-ray computed tomography as well." Zecha ultimately decided to install a Werth NanoMatic tool measuring machine with an image processing sensor and Werth Zoom in the production area, which is particularly well suited for measuring microtools in a shop floor environment (figure 3). Its special feature is that it uses the same technology as a grinding machine for clamping and guiding the tool. Christopher Morcom, managing director of Werth Tool MT GmbH, describes the principle: "We guide the tool in a prism, called a V-block, in which the tool rotates about its own axis (figure 4). This eliminates pendulum errors, i. e., there are no runout errors due to the rotary axis. This is indispensable if form accuracy of two micrometers is to be held out to the tip of the tool, both for grinding and for measurement. With the "V block", the tool rotates without any axial or radial movement, which is the key to a very precise measurement of the outer contour." Alexander Fabry agrees: "There are not many measurement equipment manufacturers who can meet our requirements for measuring micro tools. With the NanoMatic and the Werth VideoCheck® S 400, Werth had the best concept to cover all of our needs."The Werth VideoCheck® S 3D CNC multisensor coordinate measuring machine is located in Zecha's metrology lab, where it is used for final inspections. Its high precision, which is partly due to its zero-tension guide system, is used to verify measurement results from the manufacturing floor.

Flexible Coordinate Measuring Technology

Its high flexibility in terms of measurement tasks is also due to the two different chucking options that Zecha had installed in the VideoCheck® S. Just like the NanoMatic, it is equipped with a 'V block' for high-precision measurement of the external form. In addition, the A axis has an air bearing with integrated pendulum error compensation and is used for indexed measurements, such as determining rake angles.

The various sensors provide a number of measurement options. In addition to the image-processing sensor, the patented Werth Zoom with integrated laser sensor (WLP; Werth Laser Probe) is also available. Alexander Fabry explained: "You can't access all measurement points with the image processing sensor. We use the integrated laser, for example, to measure rake and clearance angles, i. e., when we need to measure differences in height." For micro tools, there are also dimensions that cannot be optically captured. The SP25 scanning probe is used for these, too. It can also be used to capture holes, cutouts, and relief areas. "The probe is also useful for us in punch manufacturing," explained Stefan Zecha. "We can use it to measure the wide variety of shapes for punches and how they are located rotationally relative to each other." Despite being equipped with different sensors, the two measuring machines installed at Zecha use the same WinWerth® software. The micro mills program is used for inspecting milling tools. It has a very simple, menu-driven interface. Shaped and stepped tools have more variety, so the microform program is also more complex. It can be used to measure special tools with contours that can be freely designed. In order to ensure reproducibility, the CAD data for the various tools are available on the network. The software accesses them in order to compare them with the measurement data. Zecha also provides its customers with measurement reports as needed. This allows them to see the dimensions down to a few microns in black and white.

Zecha Hartmetall-Werkzeugfabrikation GmbH
www.zecha.de

Werth Messtechnik GmbH
www.werth.de