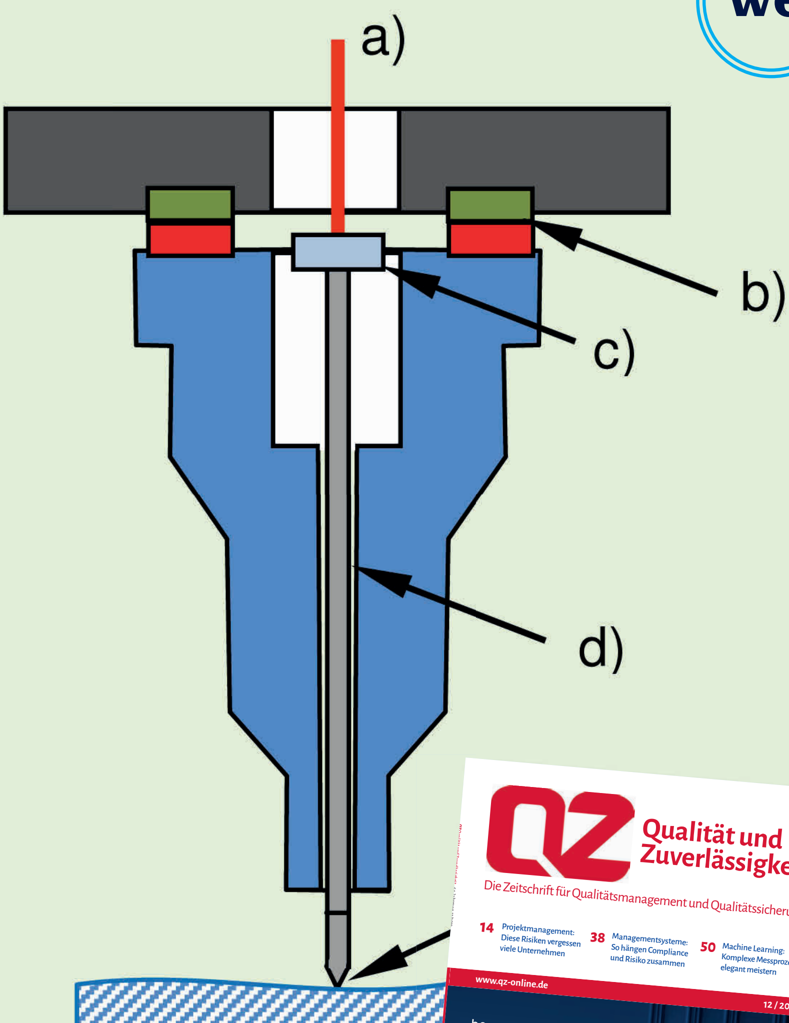

Special Print 12/2019

Flexible and surface independent

Tactile sensor technology in coordinate metrology

Werth Messtechnik GmbH

www.werth.de

Flexible and surface independent

Tactile sensor technology in coordinate metrology

BASICS PART 2 In coordinate metrology, mainly tactile and optical sensors, as well as X-ray computed tomography, are used. Tactile sensors differ in their functional principle and structure consisting of mechanics, optics, electronics, and software, and thus in their characteristics, whose basic understanding is helpful for an optimal application. The tactile measurement is largely independent of the surface properties of the objects to be measured.

The operating principle of all tactile sensors is based on mechanical contact with the measured object. From this, the electrical signals for further processing are derived. A distinction is made between trigger and scanning touch probes. The measurement result includes both the geometry (= shape and size) of the probing form element (sphere) and the spatial position and geometric shape of the object surface to be measured. The position of the probing point during tactile scanning is determined by a mathematical correction from the known coordinates of the center of the probe sphere, taking into account the workpiece geometry.

Tactile measurement corresponds to the traditional manual measuring methods (caliper dial gauge) and is largely independent of the surface properties of the objects to be measured. With "star probes" and corresponding change racks, an object can be measured three-dimensionally from all directions with relatively little effort.

Tactile electrical sensors

With touch trigger probes, a signal (trigger) for reading out the scale systems of the coordinate measuring machine is generated as soon as the probe tip touches the measuring object. The measuring point results from the coordinates of the measuring device and refers to the center of the probe sphere. The common disadvantage of all touch trigger probes is that the coordinate measuring machine is brought into contact with the measuring object to determine a measuring point, and then has to be moved out of contact again.

In a scanning probe system, the sensor has its own displacement measuring systems (scales, inductive sensors, optical measuring systems). If the probe tip is deflected in any direction when touching the measuring object, the magnitude of this deflection can be determined from the information of these displacement measuring systems. The measuring point is obtained by superimposing the sensor deflection on the sensor position in the coordinate system of the machine.

For the measurement of single points, the measuring principle of the scanning probe system makes it possible to continuously record measuring points during the entire probing process (deflection and return). From this, averaged and thus reproducible measuring points can be determined. The complete course of the probing process can also be recorded and the probing point for an assumed deflection of zero (probing with O N probing force) can be extrapolated from this. This is useful, for example, when measuring flexible workpieces.

In combination with an appropriate control system, measuring touch probes can also be used for automatic scanning of the surfaces. With this method many surface points can be measured in a relatively short

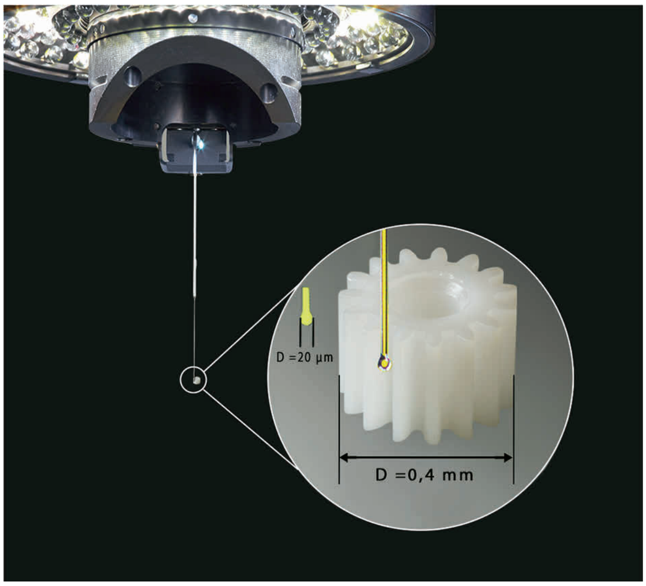

Figure 1: Measurement of a micro gear with the Werth Fiber Probe – the fiber is guided in a metal tube. (© Werth)

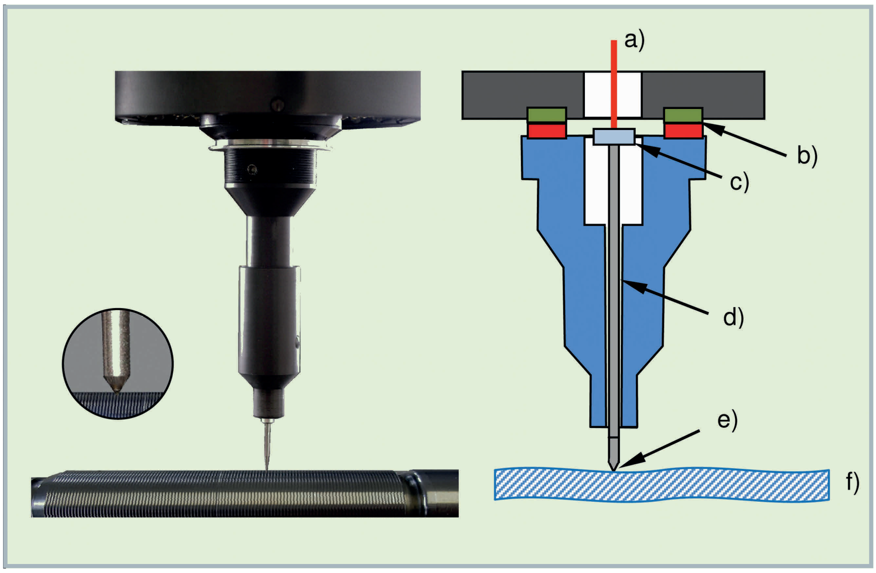

Figure 2. Werth Contour Probe (WCP): additional equipment for tactile contour measurement with distance sensors: a) Measurement beam, b) Magnetic interface, c) Mirror, d) Guide, e) Probe tip, f) Workpiece (© Werth)

time. The scanning can also be performed on unknown three-dimensional surfaces or by taking into account given paths (e.g. from CAD data). This makes it possible to scan much faster, because the control process after probe deflection becomes easier or can be omitted completely. The use of measuring probe systems is universally possible, provided that the workpiece properties allow it (sensitivity, feature size).

Tactile-optical micro probe

Conventional tactile sensors have in common that the signal is transmitted from the probing sphere via a rigid shaft to the actual sensor (switch, piezo element). Since any flexing of the stylus affects the measurement result, the aim is to use the stiffest possible stylus shafts. In connection with the sensor technology used, this leads to relatively large dimensions and probing forces.

These disadvantages are avoided with scanning tactile-optical sensors by using the stylus shaft only for positioning the tip. For the Werth Fiber Probe, the determination of the deflection of the tip in lateral direction to the shaft (x, y) is carried out with an image processing sensor. Due to the scanning sensor principle, single point measurements as well as scanning procedures can be achieved. Typical applications for the fiber probe are bores and slots with dimensions from less than 0.5 mm up to several 10 µm, fiber optic connectors, micro gears (module approx. 0.1 mm, see Fig. 1), and fuel injection nozzles. The fiber probe is also suitable for roughness measurements. By integrating an additional optical distance sensor, the probe deflection in shaft direction can also be measured. The Werth Fiber Probe 3D can be used in all operating modes that are also available for conventional measuring probes. Applications include the measurement of micro-optics (lenses for cell phones) and molded rubber parts, as well as the scanning of micro-gears.

Due to the small dimensions and probing forces, the fiber probe can be used on particularly touch-sensitive or easily deformable measurement objects. A further advantage is that the image processing and the distance sensor can also be used for direct optical measurement of the workpiece geometry. A device equipped in this way can be used as an optical-tactile multisensor coordinate measuring machine without additional sensors. Due to its principle of operation, the fiber probe is currently one of the most accurate sensors for coordinate measuring machines, other than the image processing sensor.

Tactile-optical contour sensor

The tactile-optical contour sensor (Werth Contour Probe) combines the stylus known from contour measuring devices with a laser distance sensor and image processing (Fig. 2). With this contour sensor, roughness and contour measurements can be performed with high accuracy in the coordinate measuring machine. By placing the contour probe in a change rack, it is possible to measure directly with the laser sensor or image processing alternatively. The integration of the tactile-optical contour sensor in a coordinate measuring machine allows the measurement in the workpiece coordinates in any scanning direction. Application examples are profile measurements on gear segments and roughness measurements of stamped and bent parts. ■

Translated by Werth Messtechnik GmbH

Masthead

Publisher: Carl Hanser Verlag GmbH & Co. KG, Kolbergerstr. 22, 81679 Munich; © Licensed edition authorised by Carl Hanser Verlag, Munich. All rights reserved, including reprinting, photographic or electronic reproduction as well as translation.

INFORMATION & SERVICE

ARTICLE SERIES

Extract from the specialist book „Multisensor Coordinate Metrology“, for further information see literature reference.

LITERATURE REFERENCE

1 Christoph, R.; Neumann, H.J.: Multisensor Coordinate Metrology. „Die Bibliothek der Technik“, Volume 352. Second, revised edition, SZ Scala GmbH, Munich 2019

AUTHORS

Dr.-Ing. habil. Ralf Christoph is owner and managing director of Werth Messtechnik GmbH, Gießen, and head of development.
Dipl.-Ing. (FH) Hans Joachim Neumann Hans Joachim Neumann was a coordinate measuring pioneer in the early days of his career at Zeiss and was actively involved in standardization work for decades. He is an honorary member of the VDI.
Dr.-Ing. Schirin Heidari Bateni the technical editor of Werth Messtechnik GmbH, Gießen.

CONTACT

Werth Messtechnik GmbH
T 0641 7938-0
marketing@werth.de
www.werth.de

Werth Messtechnik GmbH
Siemensstraße 19
35394 Gießen
Telefon: +49 641 7938-0
Fax: +49 641 7938-719
Internet: www.werth.de
E-Mail: mail@werth.de