



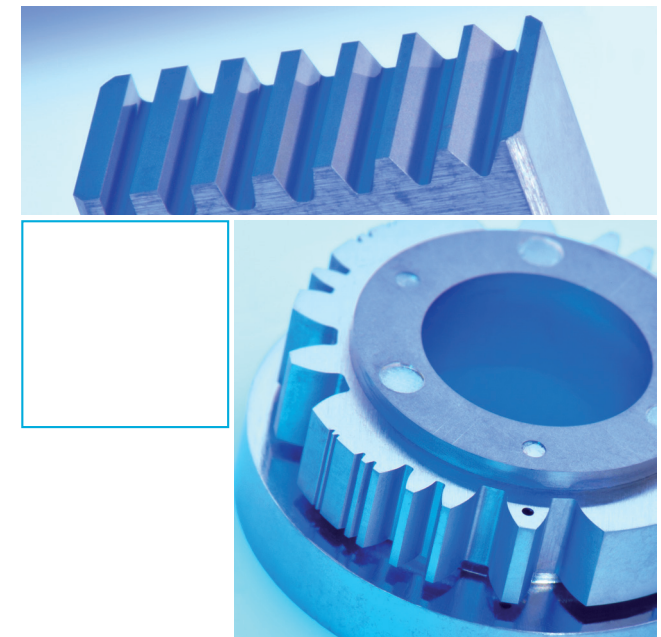


For the measurement of micro gears, sensors are increasingly used which are based on physically different principles. These comprise, in addition to the tactile sensors, also optical probing procedures and computer tomography. A quantitative and comparable statement about their suitability for the measurement of micro gears can be made only on the basis of comparison measurements on standards.

Measurement procedure	Current principles	Examples of applications
Tactile	 Piezoelectric microprobe Ultrasound microprobe	<ul style="list-style-type: none"> Tactile coordinate measuring machines Gear measuring instruments
Optical laminar	 Focus variation Confocal microscopy Fringe projection White-light interferometry	<ul style="list-style-type: none"> Optical surface measuring systems
Optical-tactile	 Fiber sensor Tactile-opt. microprobe Video sensor	<ul style="list-style-type: none"> Multisensor coordinate measuring machines
Volume-like	 Computer tomography	<ul style="list-style-type: none"> Industrial computer tomography machines

Possible measurement technologies for micro gears

Micro Gear Measurement Standards



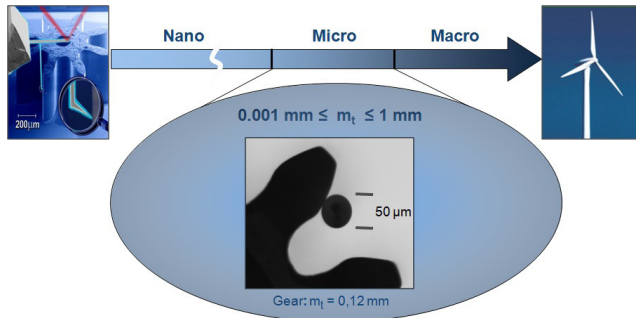


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Motivation

Micro gears with transverse modules between 1 μm and 1 mm have become an indispensable part of modern production. They are used in medical devices, in semi-conductor manufacture, microrobotics and precision engineering and are, thus, increasingly gaining in economic relevance. For these gears, a minimum of material and simultaneous a maximum of precision and efficiency are required. For the implementation of these requirements, reliable quality assurance and, thus, reliable measurement technology are indispensable. However, suitable micro measurement standards and comparison concepts, with the aid of which the measurements are reliably traceable to the SI unit of length “meter” have been lacking so far.

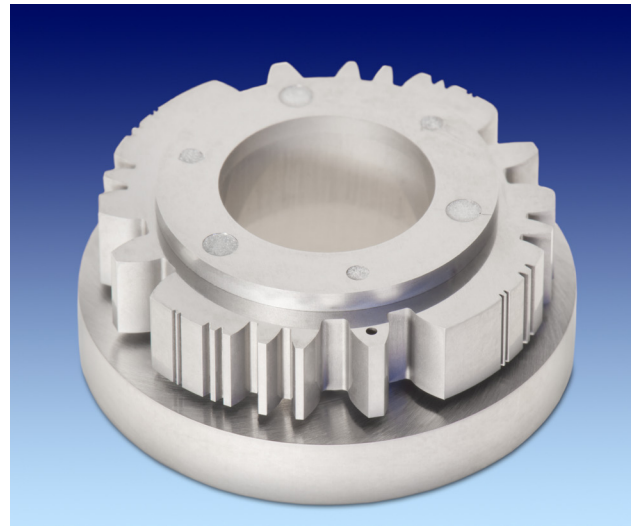


With the development of micro gear measurement standards at PTB, calibrated standards are, for the first time, available for the performance of comparison measurements¹. In addition, the suitability of the most diverse measuring instruments, sensors and measurement procedures for micro gear measurements can, in future, be quantitatively assessed.

¹ The respective activities were carried out within the scope of a project with the Forschungsvereinigung Antriebstechnik e.V. (FVA) and funded by the Arbeitsgemeinschaft industrieller Forschungsvereinigungen e.V. (AiF).

Product-like measurement standard

The product-like micro gear standard, which has been developed at PTB, embodies different gear geometries on one component. The module range has been adapted to the requirements of industry. The design allows measurements with tactile and optical sensors as well as computer-tomographic procedures to be carried out.



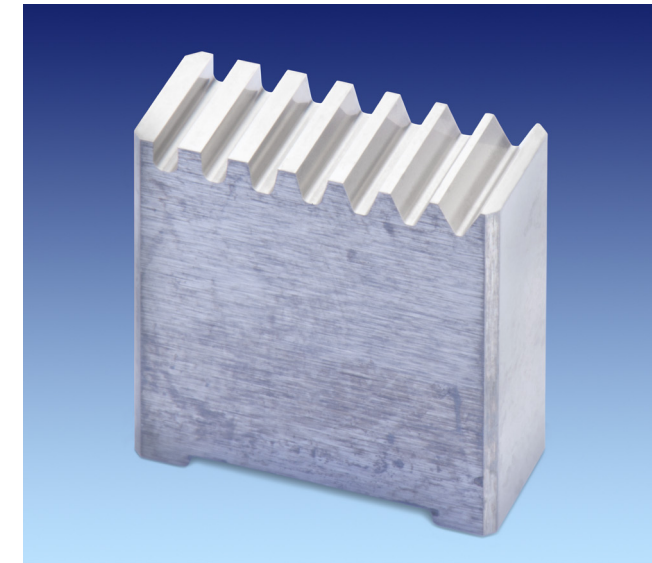
Product-like micro gear measurement standard of PTB (lower reference cylinder \varnothing 24 mm)

Parameter	Description
Type	external gear
Helix angle β	0°
Addendum modification x	0
Number of teeth z	198 / 99 / 38 / 18
Normal module m_n	0.1 mm / 0.2 mm / 0.5 mm / 1 mm
Pressure angle α_n	20°
Tooth depth h_a	0.2 mm / 0.3 mm / 1 mm / 1.5 mm
Tip diameter d_a	20 mm
Material	Hard metal or titan

Design of the micro gear measurement standard

Profile angle measurement standard

This standard, which has also been developed at PTB, serves to furnish proof of the fundamental suitability of optical sensors for the measurement of micro gears. The focal point thereby lays on the measurability of different space width structures along the gap depth as a function of different aperture angles.



Profile angle measurement standard of PTB (width 11.8 mm)

Parameter	Description
Normal module m_n	0.5 mm
Profile angle	0° / 5° / 10° / 15° / 20° / 25° / 30°
Tooth depth h_a	1 mm
Fillet radius	0.3 mm / 0.2 mm / 0.15 mm
Total geometry (w/h/d)	11.8 mm / 20 mm / 5 mm
Material	Hard metal

Design of the profile angle measurement standard