Fraunhofer IPM

HoloGear
Comprehensive tooth flank inspection

HoloGear captures tooth flanks fast and with great precision, identifying geometrical deviations within seconds.

Fast, precise, optical – thanks to digital holography

Modern gear geometry must meet very high standards for dimensional accuracy to ensure optimal functioning , maximum efficiency, and minimal noise emissions. However, conventional measuring methods are often not up to the task when it comes to fully inspecting all functional surfaces on gears, racks, pinions and worms, to check for geometrical deviations.

Today's standard: measuring single points

Standard measurements using tactile coordinate measuring machines or gear measuring machines are highly precise and place each point of the gear in absolute reference to each other and the axis. However, using these tactile measuring methods, each single point must be brought into direct contact with the measuring probe. As a result, a complete measurement of the entire functional surface is extremely time-consuming and is only done in individual cases. This is where digital holography can show its strength in terms of comprehensive measurement.

100 percent inspection of tooth flanks

Within just a matter of seconds, the HoloGear measurement system comprehensively detects any deviations on the entire flank with high precision. HoloGear works contact-free, capturing around 20 million 3D points every second and generating a comprehensive dataset of the tooth flank. The reproducibility of the deviation data is less than a micrometer, which is precise enough even for the highest quality requirements.

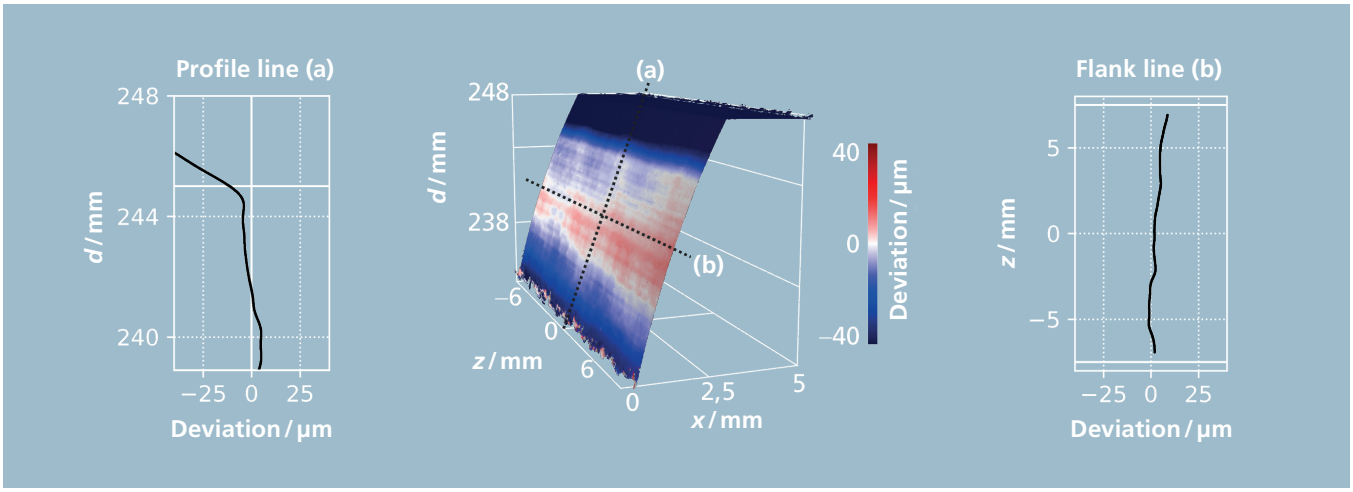
Thanks to these unique features, HoloGear has the potential to revolutionize quality control for gears. Comprehensive flank measurement marks the beginning of this process.

HoloGear: optical instead of tactile

In measurement technology, optical methods have several advantages over tactile methods: They measure faster, often produce more precise results, and are usually easier to handle. Until now, optical methods have failed in the

Advantages

- **Fast:** Capturing an entire tooth flank in a single shot
- **Comprehensive:** Reliable detection of geometrical deviations
- **Highly precise:** Reproducibility better than 1 µm
- **Non-contact:** optical measurement



HoloGear captures the entire tooth flank of an involute gear (incl. the addendum circle) in a single shot in less than 200 ms. The picture shows an example gear with 248 mm outer diameter, module 4 and a tooth width of 15 mm. 3.6 million 3D points are captured on one flank.

task of gear measurement due to steep flanks, very little reflected light, deep structures, and multiple reflections – all of which make measurements impossible. By using digital multiwavelength holography, Fraunhofer IPM succeeded in combining the precision of tactile technology with the speed of optical methods. HoloGear is the first system to enable comprehensive quality control of each tooth flank, both quickly and precisely.

Precise inspection of tooth flanks

HoloGear is designed to inspect tooth flanks as they are being produced, and capture the entire flank (including the addendum circle and root circle) in a single shot – without scanning. The system is able to cover an area of 15 × 15 mm² with around 10 million 3D points in just a single measurement. The 3D shape is reconstructed numerically, visualized, and evaluated. Depending on the customer's needs, it is possible to extract hundreds of profile and flank lines. By rotating the gear, all flanks can be consecutively measured and evaluated. Even generally hard-to-detect periodic structural defects can be spotted this way. Furthermore, this data allows high-quality noise analyses and simulations to be carried out.

Digital multiwavelength holography

In recent years, Fraunhofer IPM has introduced digital multiwavelength holography as a tool for other measuring tasks in industrial production. Thanks to the latest developments in the field, it is now possible to apply the advantages of the laser-based method to gear measurement. By using multiple narrow-band lasers, various synthetic wavelengths can be generated. This opens up a wide potential measurement spectrum which, depending on surface roughness, can extend from the (sub)micrometer to the millimeter range. It is even possible to take measurements when there is little backscattered light. In addition, the use of two sensors enables the right and the left tooth flank to be measured simultaneously.

Another advantage: With holographic measurement data, it is possible to numerically focus depth-extended objects that lie outside the focus range of the imaging optics. This allows a sharp image of the tooth flank to be captured in a single shot, from the root circle to the addendum circle.

By adjusting the optical design, the measurement field can be individually adapted to the desired gear geometries, as with all systems in the Holotop family.

Contact

Dr. Alexander Bertz
Group Manager Geometrical Inline Measurement Systems
Phone +49 761 8857-362
alexander.bertz@ipm.fraunhofer.de

Dr. Annelie Schiller
Project Manager
Phone +49 761 8857-303
annelie.schiller@ipm.fraunhofer.de

Fraunhofer Institute for Physical Measurement Techniques IPM
Georges-Köhler-Allee 301
D-79110 Freiburg
www.ipm.fraunhofer.de/en