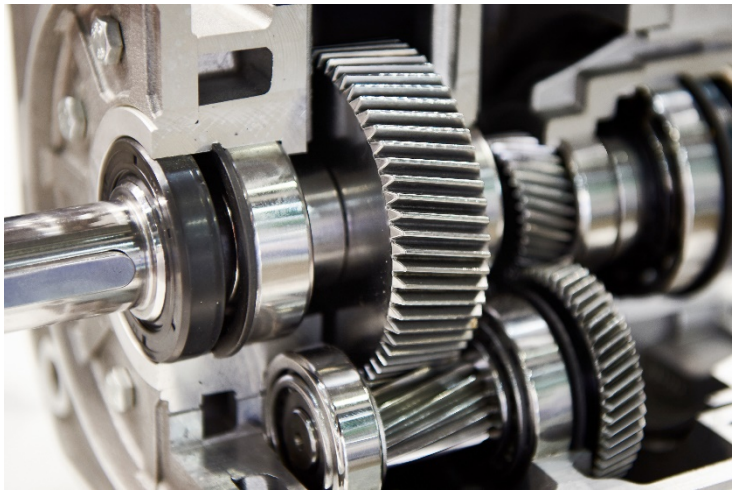
G Series Application Note

Application:

Gear Flank Measurement for gear noise reduction.



Bruker alicona

Bruker Alicona is a leading global supplier of optical metrology solutions based on the principle of Focus Variation.

Focus Variation works on the basis of moving a focal plane over a surface and collecting robust 3D data which can then be used to measure geometric form and surface finish from a single optical sensor.

Measurement processes can be fully automated and provide GD&T measurement capabilities across all industrial & medical sectors.

The systems are in use in Industry, Industrial Research, Universities and production facilities globally.

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Gear Flank Measurement for Noise Reduction

As motor vehicles have become quieter and electric versions becoming more common interior cabin noise, in terms of NVH (noise, vibration and harshness) has become a key driver regarding product quality.

One of the components that create unwanted sound are gears used in the drive chain. It is known that the waviness on a tooth flank can cause unpleasant noises in the interior of a motor vehicle and by controlling the waviness parameters this noise can be significantly reduced.

Filter roughness and waviness

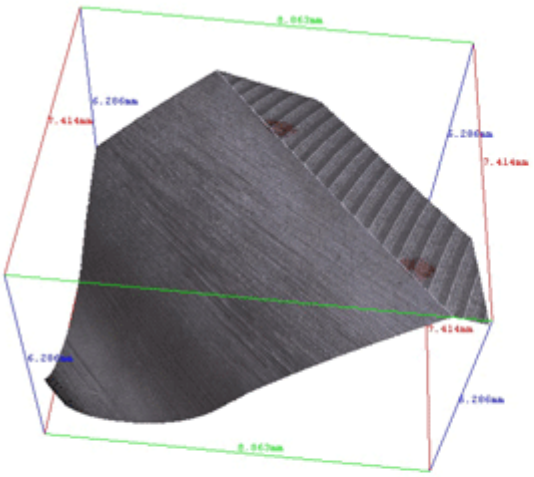
One of the biggest challenges in measuring waviness on gear flanks is to filter the waviness and roughness of the surface. For Honda, conventional 2D imaging techniques did not provide the required results. The waviness is often superimposed by tool marks caused by the machining process which makes it difficult to isolate them completely from the roughness. 2D surface profiling methods or tactile measuring systems, which only capture single profile lines, are only partly suitable for this purpose. Naoto Syukushima from the Powertrain Prototyping Department explains: "Ra values are not sufficient to verify the real surface state of flanks, as they only capture single profile lines. With area-based Sa-values we can map surface features over the entire surface and then completely isolate them from the waviness using various filtering methods.” The results of this analysis have enabled Honda to adapt the manufacturing process of hypoid gears and, consequently, to help prevent noise in the production of hypoid gears. Using high-resolution and area-based measurement technology, Honda has succeeded in isolating and quantifying the waviness from the roughness on a gear flank.

Using Bruker Alicona Optical Metrology and frequency analysis methods, the Research & Development team at Honda was able to identify and successfully reduce the cause of disturbing noises.

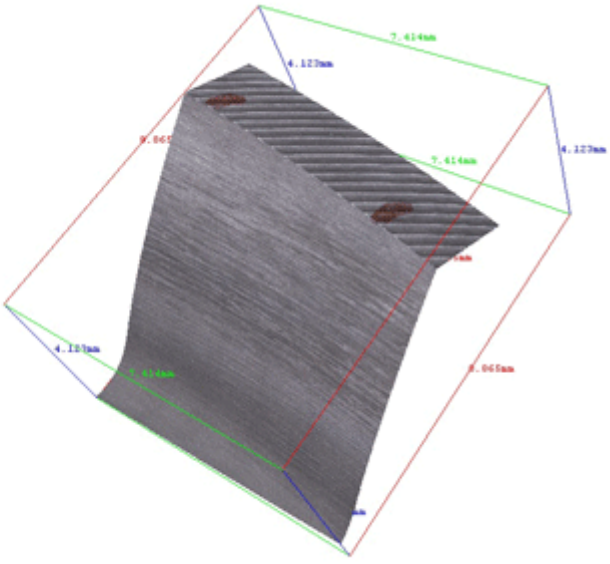
The measurement system used by Honda is the InfiniteFocusG5 system as illustrated below. As the gear components often measure 250 x 250mm the stage has been adapted to take both large and small components with a removeable platform.

In use the gears are placed on the measurement platform and orientated to expose the surface to be measured, this can be carried out manually using the XY platform and motorised “Z” or with an optional advanced real3D unit providing a 5 axis automated measurement system.

From this scan a 3D dataset of the tooth flank on either the pinion or ring as illustrated below.

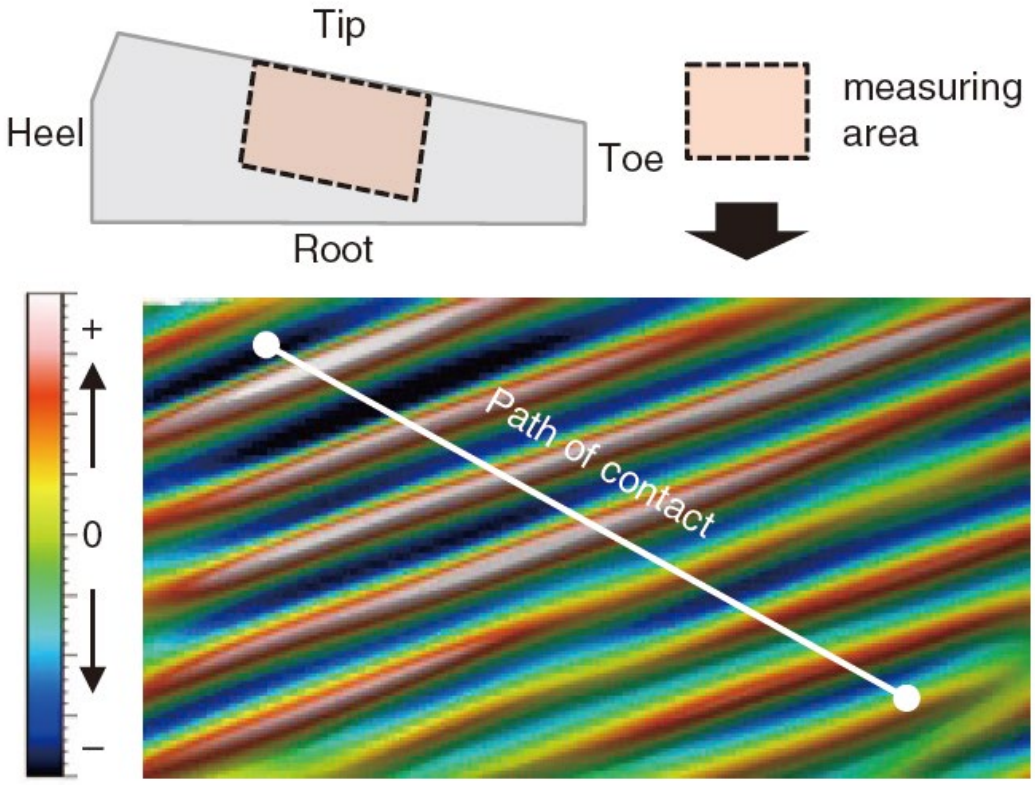


captured Area PINION



captured Area RING

The area selected for measurement is illustrated below with a line depicting the path of contact between the gears.



From this data the waviness function of the surface can be extracted, and comparisons made to establish the ideal parameters for noise reduction and exclusion.

Summary

High-resolution and repeatable measurements, even with difficult to access geometries such as steep flanks, is another benchmark that distinguishes InfiniteFocus from other metrology providers, according to Honda. This is what Naoto Syukushima says about the original need for a new measuring system: "The cooperation with Bruker Alicona started with the fact that we were looking for a measuring device that could also measure steep flanks." He continues: "The system we used before no longer met our requirements. With InfiniteFocus we measure faster and get much more meaningful information. We have become much more efficient!" According to Honda, other aspects that have also contributed to this increase in efficiency are the high level of user-friendliness of the 3D measuring system, the 3D color information for quick and easy identification of wear, and the high measuring performance for flanks with different surface finishes. The latter is due to wear or different stages of wear and the associated different reflection properties of the flank. Syukushima mentions yet another benefit: "Our components often measure 250mm x 250mm. Other measuring systems that we have tested could not be used for this measuring volume."

For Honda, there is one more decisive factor InfiniteFocus offers to successfully achieve the application of waviness analysis. "We can export the 3D and then apply our own analysis procedures. In our case, these are frequency analysis methods," explains Syukushima. Honda has thus set a new standard in the quantification of waviness on gear flanks. The patent on their process proves the major impact and leadership in this sector.

Our thanks go to Naoto Syukushima from the Powertrain Prototyping Department at Honda for his assistance with this application