Fizeau interferometers for surfaces with different reflectivity

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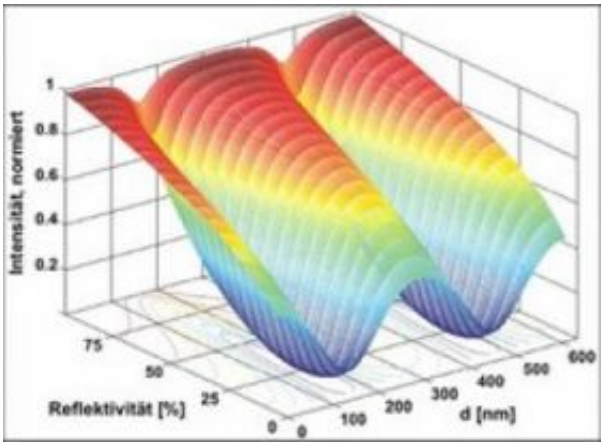

Intensities of the interferences of common Fizeau interferometers, in this example calculated for a reference surface with a reflectivity of 0.5 and test sample surfaces with varying reflectivity between 0 and 100% and a variation of the distance d between test sample and reference piece over a wavelength (λ = 633 nm). The new method avoids the strong dependence of the intensity profile and the contrast on the reflectivity of the test sample's surface. Credit: PTB

Due to their stable design, Fizeau interferometers are used to determine the topography of surfaces such as, e.g., plane surfaces. PTB (Physikalisch-Technische Bundesanstalt, Germany) has now developed a method which makes it possible to analyse surfaces with different reflectivities in a simple way. This method can also be extended to dynamic measurements.

Fizeau interferometers generate an interference between the surface of a test sample and a reference surface that is brought close to the test sample. The interference image is recorded and analysed by an imaging optics system. The contrast and the shape of the interference signals depend, however, on the reflectivity of the test samples. The time and effort required for measuring and analysing the topographies of differently reflecting test pieces is therefore significantly increased.

The method of separating the wavefronts of the reference surface and the test sample surface in the plane of the reference surface – for which a patent has been applied for – uses a new generation of commercially available beam splitters, also called "on-axis beam splitters", which cause a separation of the polarisation directions of the incident light along the optical axis.

In comparison with common Fizeau interferometers, this has various advantages. On the one hand, through the generation of polarised light, the measurement can be traced back to a pure two-beam interference. The analysis of the signal is thus significantly facilitated and improved. Classic Fizeau interferometers, however, are based on the analysis of the multiple-beam interference.

On the other hand, by varying the direction of polarisation, a maximum contrast can be set, independent of the reflectivity of the test sample. In contrast to this, in conventional Fizeau interferometers, different reference surfaces with adapted reflectivity must be held available in case the reflectivity of the test samples varies strongly.

In order to increase the accuracy of analysis of common Fizeau interferometers, a variable phase is generated by varying mechanically the distance between the test sample and the reference surface (phase-shifter interferometry). Another advantage of the new method is that such a phase shifting becomes possible through the use of electro-optical

components and thus without using mobile parts. Thanks to the increased measuring dynamics achieved in this way, it is, for example, possible to carry out topographical measurements in environments which are subjected to vibrational strain.

The new method allows a facilitated and improved analysis of the measurement data, requires only one calibrated reference surface instead of several, and opens up new possibilities of application in the field of dynamic interferometry. It is particularly suited for measurements on structured or unstructured surfaces with different reflectivities – especially in the optical and semiconductor industry.

Source: Physikalisch-Technische Bundesanstalt (PTB)