Contact-Free Thickness Measurement of Container Glass

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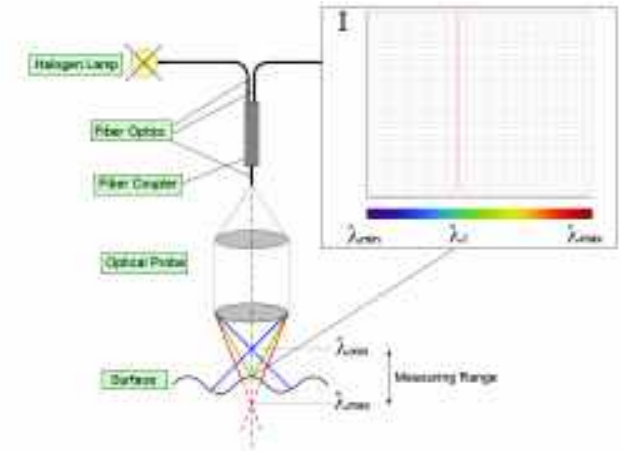
Contact-free thickness measurement is already established in many container glass production plants. With the CHRocodile M4 sensor, Precitec Optronik is now presenting a new sensor that boasts a very high measuring rate, a small compact size and a modular design. Its optical measuring principle is ideally suited to the inline inspection of glass in all colours.

The superiority of the optical measuring process

Optical, capacitive and tactile measuring methods are possible for inline thickness measurement. However, there is a risk of inaccurate measurements when capacitive measuring systems are used on uneven surfaces, while the use of probes in the vicinity of stampings is problematical. Optical methods avoid these problems and achieve a high degree of precision and measuring certainty. Contact-free measuring methods without moving parts, such as chromatic aberration, are unsurpassed in terms of robustness. If suitably configured, optical measuring systems are almost universally useable.

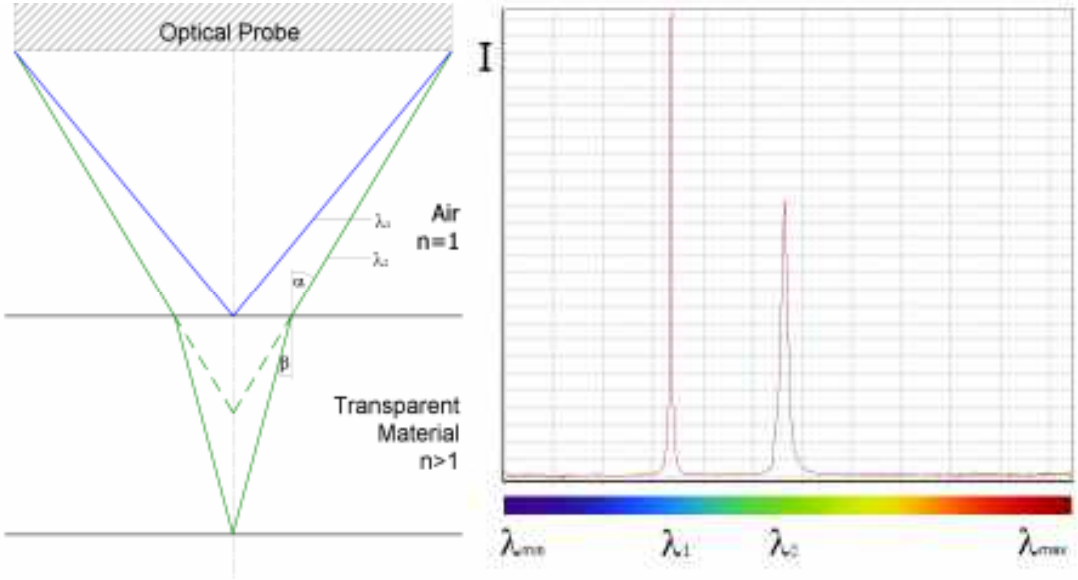
How the confocal chromatic wall thickness measurement works

The wall thickness of container glass is measured using the chromatic length aberration of a special lens. To do this, white light is launched into an optical fibre and directed into the measuring head. The optical probe consists of a lens with a well-defined colour length error and focuses the light leaving the fibre onto the glass surface being measured according to the wavelength. This means that there is always only one wavelength in focus on the surface. Finally, the spectrometer analyses the reflected light. The spectrum shows a sharp peak for the wavelength focussed on the glass surface.



Principle of chromatically coded confocal measurement

The calibration performed at the factory unambiguously determines the distance from the optical probe to the glass surface from the wavelength found. In the wall thickness measurement, the front and rear side of the bottle glass are in the measuring range. Correspondingly, two peaks can also be observed in the spectrum, from which the distances to the front and rear sides of the glass are determined. The glass thickness is calculated from the difference. Here, the sensor automatically makes allowance for the refraction index of the glass.



Beam path and spectrum in a glass thickness measurement. This also enables statements to be made about the object's roundness.

Structure of the CHRocodile M4 sensor

The new CHRocodile M4 sensor uses the measuring principle described above. The CHRocodile M4 is of a modular design and offers up to 4 independent measuring points. This enables the unit to be configured as required. Every module consists of an evaluation unit and a measuring head. A robust glass fibre (length 2 m – 25 m) carries the light to the measuring head, which is of a very compact design and is in the form of a purely passive lens without electronic or moving parts. This simplifies integration of the optical probe into inspection systems in the glass industry and allows measurements even under difficult ambient conditions, such as when glass is glowing hot.

Modular sensor CHRocodile M4 with four measuring heads

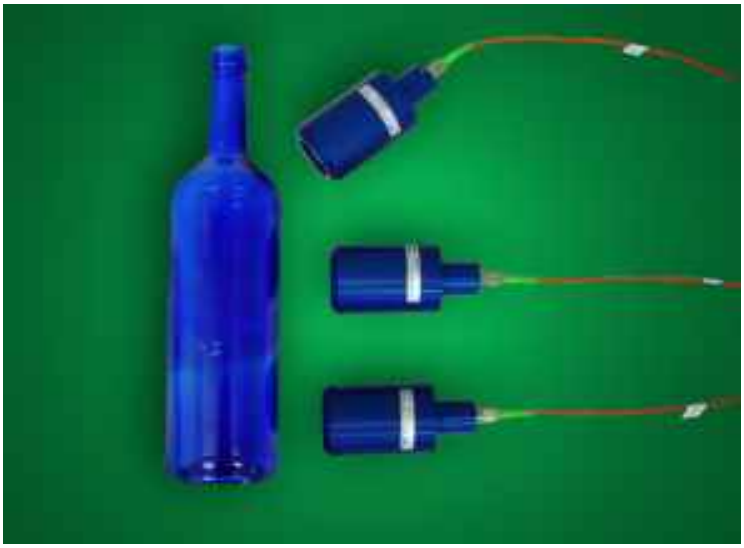
Use of the CHRocodile M4 in the glass industry

Every module of the CHRocodile M4 supplies the distance from the outside and the inside, as well as the glass thickness, 4000 times per second. Since the measuring spot has a diameter of only a few hundredths of a millimetre, even the smallest flaws do not remain undetected. In an inline thickness measurement, a new independent measured value for distance and thickness is obtained every millimetre at a glass speed of 4 m/s.

The special design of the measuring heads brings further advantages. For example, it is possible to measure slanted surfaces in an angle range of ± 25^0 to the optical axis. In measurements performed on glowing glass surfaces, the hot ambient air caused wavy effects as a result of density fluctuations. These cause major measuring errors in other optical methods such as laser triangulation. With the chromatic sensor, the streaking effect is negligible thanks to the high numerical aperture of the measuring heads.

Streaking effects on glowing glass bottles have no influence on the measurement

Another excellent property of the CHRocodile M4 is its wide optical dynamic range: Since a reflection from the rear wall is also evaluated in thickness measurements, the absorption of the wall material can prevent the use of optical sensors with a narrow dynamic range in the case of dark-tinted glasses. The CHRocodile M4 is suitable for measurements on dark sunglasses, brown beer bottles and almost opaque small cosmetics bottles.



Coloured glasses are no problem: The arrangement of the measuring heads for a wall thickness measurement is shown here.

Glass thicknesses of between 2µm and 35mm can be measured, depending on the measuring head. In this case, a optical probe covers a wall thickness range of between 0.2 mm and 15 mm.

At the same time as the thickness measurement, the distance values for the surfaces are also obtained. This means that measurement of rotation-symmetrical bodies also delivers a statement on the body's ovality. The only prerequisite is that it is fixed concentrically to the axis of rotation. The wobble error is also determined at the same time.

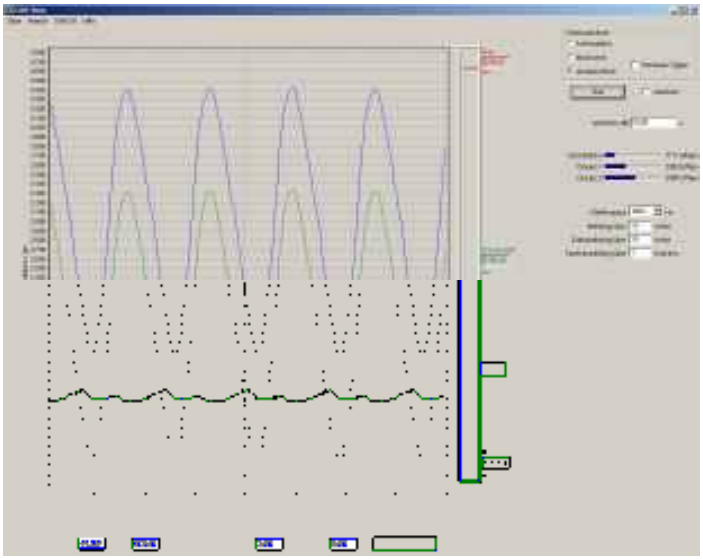
The CHRocodile M4 is therefore extremely well suited to the following measuring tasks:

- On round bottles wall thickness and shape (e.g. ovality), also around engravings and textures
- Determining the wobble error when measuring on the bottle neck, eccentricity
- On rectangular bottles the shape and wall thickness of the side surfaces, as well as the thicknesses of the corners
- Thickness and evenness deviation on flat glass

And all of that inline during production or on a random sample basis in the testing laboratory!

Simple integration and handling

The CHRocodile M4 stands out by virtue of the fact that it can integrated into existing systems with particular ease, since it can be completely configured via RS 232 and RS 422 interfaces. The data is also output digitally via these interfaces. An analog output is also available for control purposes.



The comprehensive software package evaluates the measured data conveniently. The example here shows simultaneous evaluation of wall thickness and roundness on a glass bottle

There is a comprehensive software package for automatic measured data evaluation. This is based on the experience gained from several hundred installations of the proven CHR sensors series. The sensor's complete set of commands and DLLs are available to system constructors. This allows the CHRocodile M4 with its 19" housing to be easily incorporated into existing glass testing stations.
The sensors have been calibrated at the factory and require no additional monitoring using external testing equipment. The sensor is designed for many years of maintenance-free operation. Only the light source (a halogen lamp) must be replaced approximately once annually. This change can be made in a few seconds and without tools or specialist knowledge.

The chromatic sensors from Precitec Optronik have been in use in the glass industry worldwide for many years. Previously, the emphasis was on high-accuracy measurement of optical glasses. Now, the modular CHRocodile M4 is targeted especially at the container glass market. This is an area in which it offers many advantages, particularly with its tailor-made combination of accuracy, speed and robustness.

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