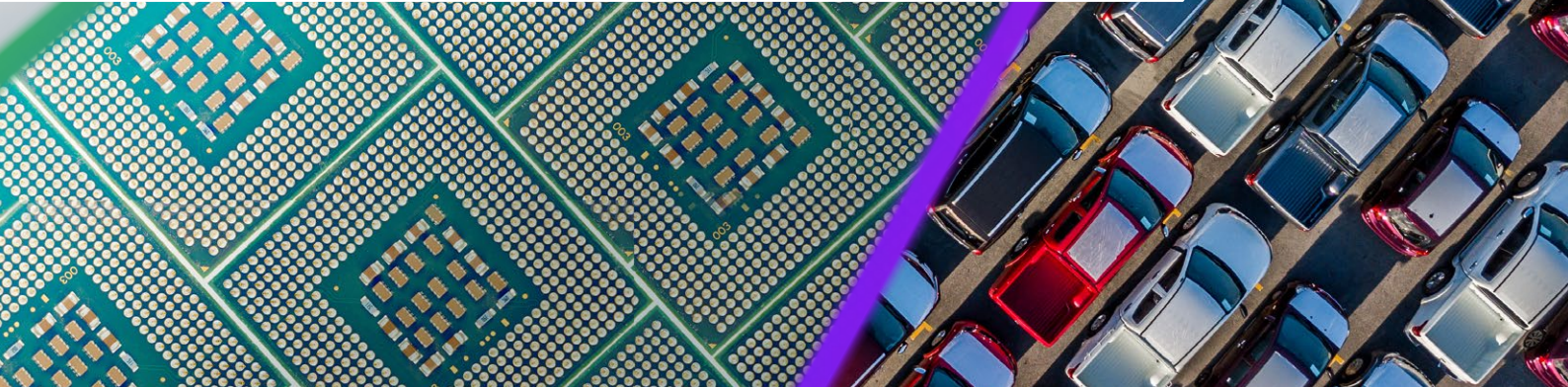


THE BETTER YOU MEASURE, THE BETTER YOUR BUSINESS

Improved product inspection and quality monitoring
through state-of-the-art optical sensor technology



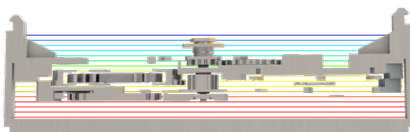
“WHAT GETS MEASURED GETS IMPROVED”

Management guru Peter F. Drucker said that measurement was the key to improvement. This is truer than ever in the Industry 4.0 age where manufacturing processes require automated measuring and quality control systems. Such processes need sensor-based monitoring to remain stable and enable any necessary adaptation. The ability to feed measured data back into a production process enables quality to be assured, improvements implemented, and rejects removed. In monitoring production processes, 3D optical technology offers many advantages: non-contact, ultra-fast measurement and ultra-precise, high-resolution data. It is particularly valuable in micro- and nanoscale metrology.

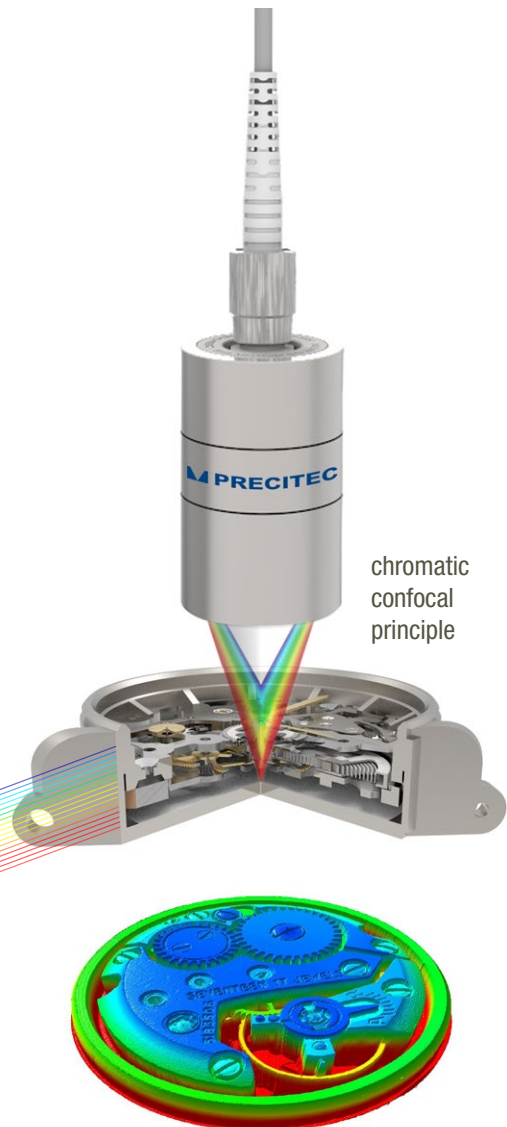
HOW YOU BENEFIT FROM 3D METROLOGY

Precitec's CHRocodile® optical sensors offer many benefits for your production process:

- ▶ Measurement possible on any kind of material – opaque or transparent, absorbent or colored, diffusive or reflective, rough or polished
- ▶ Shadowing effects avoided through coaxial measurement technology
- ▶ Very high slope acceptance and high numerical aperture – up to 45° on reflective surfaces and >80° on diffusive surfaces
- ▶ Ultra-high z-axis resolution and accuracy – no z scanning needed to obtain a measurement, with every measuring period delivering measurement values
- ▶ Parallel measurement of many points through multi-point line sensors
- ▶ High lateral resolution thanks to small and constant spot size
- ▶ High thermal stability, long-term repeatability, and no misalignment thanks to totally passive optical probe with no moving parts and no embedded electronics as a potential heat source



- ▶ Utmost precision under all operating conditions
- ▶ Wear-free durability through contact-free measurement
- ▶ Easy integration into your production process



chromatic confocal principle

topography of a watch measurement

WHAT OUR PRODUCTS DELIVER TODAY?

We offer you a wide range of chromatic confocal sensors for measuring thickness, distance, surface, topographies, etc. Our technology has major advantages over other technologies such as laser triangulation, as the table below shows:

ADVANTAGES OF CHROMATIC CONFOCAL TECHNOLOGY

Laser Triangulation Principle	versus	CHRomatic Confocal Technology
limited	shiny material	yes
no	reflective material	yes
limited	colored material	yes
limited	transparent material	yes
instable	Inclined or curved surface	stable
instable	smooth or rough surface	stable
limited	surface angle tolerance	excellent
limited	precision	submicron
low	lateral resolution	high
no	insensitive to heat and pollution	yes
no	simultaneous 3D and 2D display	yes

HOW YOU BENEFIT

In production processes the use of chromatic confocal measuring technology for computer-aided quality assurance in surface measurements brings multiple benefits:

- ▶ Utmost precision under all conditions
- ▶ High-speed real-time measuring and processing
- ▶ Enhanced speed through multi-point measurement – more than 1 million 3D points measured per second
- ▶ Wear-free durability
- ▶ Easy integration into production processes



LET OUR EXPERTISE OPTIMIZE YOUR PRODUCTION

Decades of 3D metrology expertise and experience enable us to enhance your production processes and make your business more competitive. The application areas outlined below are from industries where our optical sensors are frequently deployed. But they are also put to good use in the medical, pharmaceutical, machine tools, fine mechanics, aerospace and photovoltaic industries as well as in research work and academia. For more details of how you can benefit in all these industries please get in touch: info@.....

CONSUMER ELECTRONICS

For all phases of a consumer electronics product's life from R&D and component assembly to packaging and testing, we seamlessly stitch together different technologies to deliver the best possible measuring and evaluation results. Our optical non-contact sensors ensure that no parts are touched during measurement and all the different plastic, metal and glass parts are perfectly aligned during assembly. Working the coated, ultra-hardened screen glass in smartphones or tablets, for example, is an extremely demanding process where the cut edges have to be carefully inspected to ensure the strictest standards are met. In a single inline pass our optical sensors measure the dimensions, thickness and warp

of screen glass – and even the shape and depth of pits caused by grinding, cracks or laser ablation.

Besides our traditional focus on smartphones and tablets, we have expanded our range to include game consoles, laptops, readers, accessories (earbuds, chargers, cables), AR & VR glasses, and have added to our components' portfolio by including PCBs, lenses, FMMs, foldable displays, and sockets. Last but not least, we provide technical support, spares and training in situ across the globe. If required, we can modify both software and hardware to perfectly fit your needs because as an original equipment manufacturer we offer all the advantages of a one-stop shop.

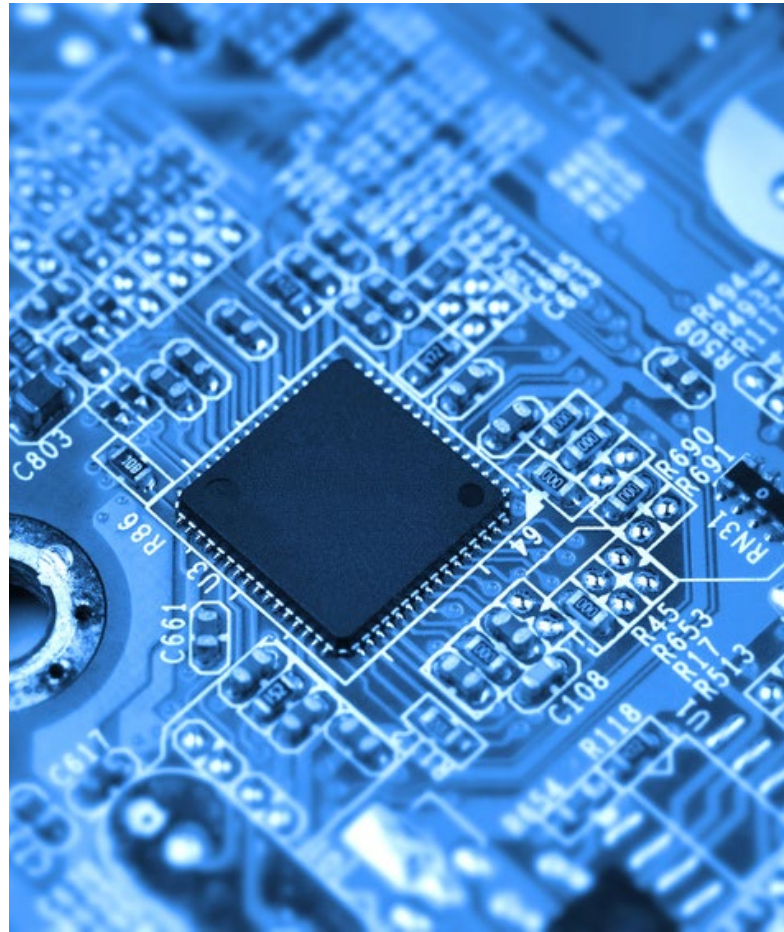


SEMI-CONDUCTORS – WAFER TOPOGRAPHY

Inline monitoring of wafer processing during thinning, metallization and bonding is a key application in chip manufacturing. Our interferometric point and chromatic confocal line sensors provide automated inspection solutions for bare and structured wafers while you benefit from shorter cycle times and simple integration into your production process.

Challenging tasks such as edge chipping detection, device-carrier misalignment, micro-cracks, adhesive residue at an edge, and delamination are no problem for our line sensors. They measure numerous points close to each other so the optical probe can cover a much larger area in a given time than a point sensor can. Our current generation of line sensors operates with 192 measuring points per line of 1-5 mm in length (depending on the probe), enabling robust, high-resolution measurement. These devices can reduce your overall process flow costs through detecting bonding voids and measuring the thickness of different layers in a single cycle.

Our optical measuring technology provides data with an extremely high lateral and axial resolution, as well as enabling topography height and depth measurements. The easily exchangeable optical probes allow a sensor to be flexibly adapted to your requirements, and the broad range of application and adjustment options makes our line sensors the ideal choice for chip manufacturing.





GLASS

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MEDICAL

CHRocodile optical sensors enable high-precision, non-contact distance and layer thickness measurements of medical components and naturally meet the medical industry's strict quality requirements. The Precitec EyeTracker enables successful refractive eye surgery through fast eye tracking in up to six dimensions. The CHRocodile CLS confocal line sensor measures the center thickness and curvature of intraocular lenses (IOLs) and allows comprehensive inspection of stents. The Chromatic Vision Camera detects defects on IOLs and contact lenses fast. The CHRocodile IT series accurately measures the wall thickness of medical balloons and the CHRocodile 2 S is a suitable sensor for semi-transparent balloons as it can be switched from chromatic to interferometric mode.





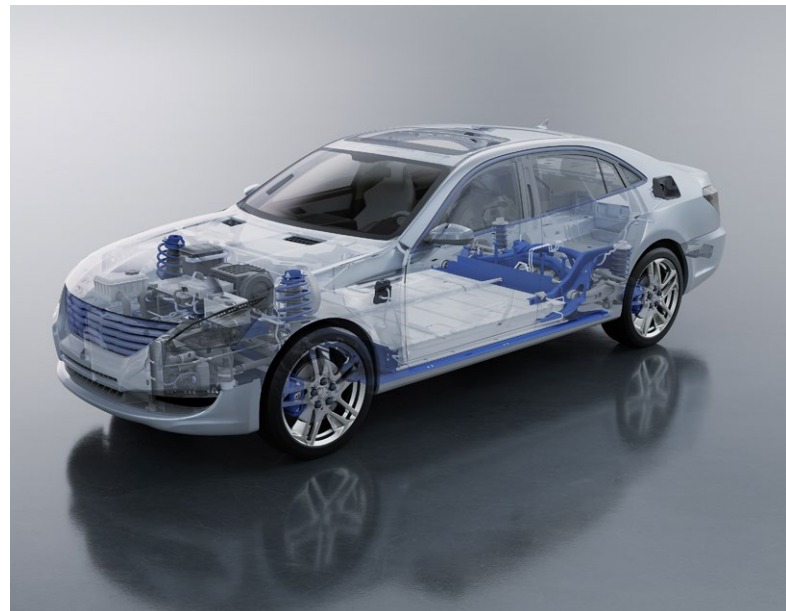
AUTOMOTIVE

Our chromatic point and line sensors tackle a wide variety of quality assurance tasks in car production. Their high measuring speed enables direct integration into a production line to allow 100% inline inspection and shorter cycle times for higher throughput. Typical applications include 3D shape inspection of complex assemblies, such as the structured surfaces of engine cylinders or the geometry and roughness of gears.

Our sensors are also used for measuring the protective and reflective coatings inside headlight housings and in rated break-point inspections for dashboard airbags. The dimensions of windcreens and panorama roofs can also be quantified as these sensors can measure the thickness and geometry of curved glass. The gap between the glass panes and the metal chassis can be measured inline with nanometer-range accuracy. Even the demanding material mix of metal, glass and plastic with its different surface properties is no problem for Precitec's optical measuring technologies.

E-MOBILITY

Vehicle powertrain electrification is paving the way for a mass market in high-capacity batteries. Early detection of production defects in electrode manufacturing is crucial for cost-efficient production. Our high-resolution sensors monitor product properties through inline measurement and detect process variants at an early stage, not least thanks to an axial resolution of $<1 \mu\text{m}$. The inspection possibilities include edge and start/stop quality control, superelevation of edges, thickness and roughness control of coatings, cutting burr inspection, waviness control of coatings over the foil width, foreign particle detection on electrode foils, laser-structured surface inspection, and wear control of rolls in calendar machines. We also offer solutions for electrode production, cell assembly, cell finishing and module/pack assembly. What's more, our high-speed optical inspection technology is ideal for inline measurement before or after drying.



WHY PRECITEC STANDS OUT

As the pioneer of chromatic confocal technology for non-contact measurements in industrial applications, we can point to more than 20 years of experience as an innovative market leader. With well over 25,000 of our systems now in the field, these industry-proven products are renowned for their precision, robustness, and customized applicability. Our worldwide application technology and sales and service networks ensure you always have a reliable partner at hand. And as a family-owned company, we place particular emphasis on close customer relationships built on trust, reliability, and the highly skilled nature of our R&D, sales, and service teams. Even by the standards of Germany's world-famous Mittelstand, our R&D budget is large at 14% of our annual turnover. We see that as an investment in our future – and our customers' future success..

KEY FIGURES

Over the past two decades, the Precitec Group has grown its annual turnover by an average of 17% – as organic growth in all operational fields. In 2019, for example, Precitec was operating in 22 countries and had a global workforce of 760. Precitec's technological leadership is underlined by a total of 245 patents and 13 cutting-edge innovations.

BROAD PRODUCT PORTFOLIO

Whatever your needs in high-precision optical metrology, you can find the ideal solution in our broad portfolio ranging from high-end devices to more favorably priced products such as the CHRcodile Mini or CHRcodile C. As a manufacturer of line, point and multi-point sensors and as an OEM sensor supplier, we will gladly work closely with you to develop any customized solution you need.

STANDARD-SETTING CUSTOMER SUPPORT

We are not just in the business of selling sensors. We want to sustainably support the business of each new customer. That is why we invest heavily in standard-setting customer support through our worldwide team of highly qualified and experienced technicians.

For us 360° customer service means:

- ▶ Finding solutions to your measurement needs through dedicated R&D
- ▶ Running free test measurements on your samples in our applications labs around the world
- ▶ Supporting you in tests conducted at your site
- ▶ Providing software and mechanical support to facilitate the integration of our sensors into your production process

OPTICAL MEASURING PROBES – BEST LATERAL RESOLUTION, HIGH NUMERICAL APERTURE

Chromatic confocal technology allows high-precision measurement in a wide variety of measuring tasks, e.g. topography, thickness, compositions, layers, surfaces under transparent materials, and complex geometries. But to achieve such precision you need the best optical measuring probes the market has to offer – from Precitec.

Our optical measuring probes are renowned for their best-in-class resolution and high numerical aperture and are ideal for non-contact distance and thickness measurements on all kinds of difficult materials, e.g. diffusive, rough, colored, polished or reflective surfaces.

With a measuring range that varies from a few microns to several millimeters, these systems are available in ultra-high vacuum, angled, and line sensor versions and include an ultra-thin 8 mm probe for measuring boreholes.

In response to market requirements, we have developed optical measuring probes for a wide range of production environments:

- ▶ Small probes where space is tight or even missing after machines have been retrofitted
- ▶ Ultra-high vacuum and vacuum probes for challenging environments
- ▶ Specially designed probes for rough and wet environments, e.g. in chemical mechanical polishing (CMP) and mechanical grinding applications for the semiconductor industry
- ▶ Line sensor versions for ultra-precise measurement of very fine contours
- ▶ Various optical probes with an angled design

Whatever your task, we will advise you on the best possible solution – with state-of-the-art chromatic confocal technology.



HOW YOU BENEFIT

- ▶ The right probe, resolution and measuring range for every measuring task
- ▶ High lateral resolution of up to 0.7 μm for measuring complex structures
- ▶ Numerical aperture of up to 45° on reflective surfaces and 80° on diffusive surfaces
- ▶ Accurate measurement of highly tilted, reflective and dispersive surfaces
- ▶ Small spot diameter
- ▶ Flexible working distance
- ▶ Compatible with all CHRcodile 2 sensors

CHROMATIC LINE SENSORS – IDEAL FOR ULTRA-PRECISE 3D INLINE INSPECTION

Our CHRcodile CLS line sensors are the ideal tools for precise 3D inline inspection in a wide range of manufacturing applications. They deliver ultra-precise distance and layer thickness data of a sample along a line, and their scanning speed allows a sample's 3D structure to be determined in a very short time. The data they supply is of extremely high lateral and axial resolution. Almost any kind of material can be measured – without shadowing effects, even for complex geometries. The typical applications include measuring topography in semiconductor applications or inspecting display glass in smartphone production.



CHROCODILE CLS2 PRO

The next-generation CHRcodile CLS2 Pro is a versatile workhorse offering the optimum combination of great speed (36,000 lines/sec), long line length (up to 20 mm) and high angle acceptance (up to 45°). Its combination of 8 mm line length and 38° angle acceptance is unmatched in the industry.

The typical semiconductor applications include wire bonding inspection, bump measurements, packaging wafer edge inspection, dicing groove inspection, defects, die cracks, and photomask lithography. It can also measure edge topography with a broader line, which enables faster line shape and free form measuring cycles.

CHROCODILE CLS2

The CHRcodile CLS2 combines high speed with utmost scanning precision at a high density of 21.6 million measuring points and up to 36,000 lines/sec at a high resolution on almost all materials. The typical semiconductor applications include wire bonding inspection, bump measurements, packaging wafer edge inspection, dicing groove inspection, defects, die cracks, and photomask lithography. In the consumer electronics field it is ideal for inspecting housing topography, slightly, medium or highly curved surfaces, chamfers and splines, and diameter/hole/stepped surfaces, as well as cosmetic inspection where additional height data is needed.



CHROCODILE CLS HS

As the CHRcodile CLS HS is equipped with a four times more powerful light source than the other models, it is ideal for measuring dark samples and surfaces at a measuring rate of up to 6,000 lines/sec.

The various probes available for this line sensor offer you the choice of an outstanding lateral resolution of 1 μm combined with a shorter line or a long line of 8 mm with a lower lateral resolution. The probes available include high numerical aperture (N/A) ones for measurements at angles of up to 44° for mirror-like surfaces and 80° on diffusive surfaces.

HOW YOU BENEFIT

- ▶ Economically attractive investment thanks to wide range of easily interchangeable probes
- ▶ Much shorter measurement cycles through high operational speeds
- ▶ High lateral resolution
- ▶ Measurement of almost any kind of material possible
- ▶ Wide range of quality control applications
- ▶ No shadowing thanks to coaxial technology
- ▶ Easy to integrate into production lines due to compact dimensions

CHROCODILE C & CHROCODILE MINI – THE ATTRACTIVE PRICE-PERFORMANCE ALTERNATIVE

These sensors deliver precise measurement data at various angles – 45° on specular surfaces and >80° on diffuse surfaces – and a range of geometries with no shadowing and on any kind of surface. Their price-performance ratio is superior to any laser triangulation device. The CHRcodile C is a fully integrated device, whereas the CHRcodile Mini has a separate probe and sensor, which is useful where space is limited.

CHROCODILE C

This ultra-compact sensor delivers high-precision distance and thickness measurements, is easily integratable into any kind of automatic inspection machine, and ideal for inline quality assurance applications. It integrates optoelectronics and optical probes in a single housing no bigger than a cigarette packet with an ultra-high dynamic range and great signal-to-noise ratio ensuring optimum results on any surface. Several easily interchangeable optical probes allow the system to be parameterized and easily adapted to each measurement assignment.



HOW YOU BENEFIT

- ▶ Compact design, low weight, low power consumption
- ▶ Distance and thickness measurements on all surfaces/ materials with interchangeable probes
- ▶ Maintenance-free and easy to integrate into production lines



CHROCODILE MINI/MINI+

These ultra-compact 3D confocal sensors combine maximum performance with minimal size – 95 x 106 x 95 mm and at the most 550 g. By enabling precise and stable non-contact thickness and distance measurements on any kind of material – even in confined production conditions – these sensors are ideal for determining positions and dimensions (e.g. for electronic components), topography, profile and roughness measurements (e.g. for tool surfaces) and measuring the thickness of glass or plastic coatings. Whatever the material to be measured, these sensors deliver highly precise measurements at up to 4,000 Hz – with a 10,000 Hz option. The three optical probes have a distance measurement range of 0.6-10 mm. The CHRcodile Mini has Ethernet and RS422 interfaces, the CHRcodile Mini+ three encoder ports, an analog output and digital in/out ports for integration into any kind of inspection equipment.

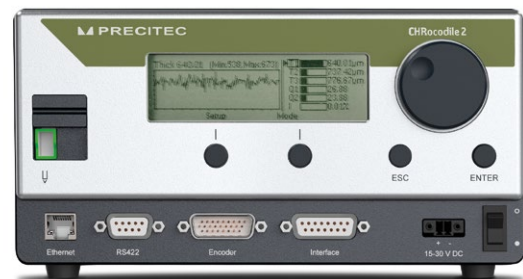
CHROCODILE 2 SENSORS – THE RIGHT PRODUCT FOR YOUR SPECIFIC TASKS

The CHRcodile 2 sensors feature a high-speed Ethernet connection, high-intensity white light LEDs, and ultra-sensitive detectors enabling measuring rates of up to 66 kHz with unprecedented measuring precision. These sensors are equipped with an automatic light control and perform non-contact distance, topography and thickness measurements, even for complex geometrical shapes and materials of differing reflectivity, roughness and refractive indices. The very stable, ultra-precise, and repeatable measurement data come from an environmentally robust technology. Additionally, these CHRcodile 2 sensors can easily switch between the chromatic confocal and interferometric operating modes to offer additional measuring possibilities, e.g. on transparent plastics and multilayer films. The CHRcodile 2 sensor family is made up of the following devices:

CHROCODILE 2S/2SE

HOW YOU BENEFIT

- ▶ All-rounder for non-contact distance and thickness measurements
- ▶ Fast: Up to 66,000 measurements per second
- ▶ Simple to integrate into production lines, maintenance-free, robust
- ▶ CHRcodile 2SE option designed for the use of high-intensity external light sources for high-speed measurements



CHROCODILE 2HS

HOW YOU BENEFIT

- ▶ Designed for a maximum signal-to-noise ratio
- ▶ Extraordinarily high dynamic response: 32-10,000 measurements per second
- ▶ Ideal for measuring surfaces of differing reflectivity and with large slopes
- ▶ Simple to integrate into production lines, maintenance-free and robust

CHROCODILE 2S HP

HOW YOU BENEFIT

- ▶ Particularly suitable for measurements on low reflective surfaces
- ▶ Extensive thickness measurement range: 100 μm -38.5 mm (leider eher weniger)
- ▶ Large graphic display

CHROCODILE 2DPS

HOW YOU BENEFIT

- ▶ Two-sided thickness measurement of non-transparent materials
- ▶ Step height measurement
- ▶ Referencing process included

CHROCODILE 2 LR

HOW YOU BENEFIT

- ▶ Ideal for non-contact measurement of topography and thickness
- ▶ Particularly high lateral resolution
- ▶ Interferometric measuring range 23 – 2,600 μm

CHROCODILE MULTI-POINT SENSORS – MAXIMUM FLEXIBILITY IN MEASUREMENT

The maximum measurement flexibility you enjoy from these multi-point sensors comes from their ability to carry out up to 24 simultaneous distance and thickness measurements. With up to 24 independent channels these sensors can utilize different chromatic probes and are thus perfectly suited to challenging measuring tasks, such as simultaneous non-contact measurement of topography and thickness.

CHROCODILE MPS 2L

With up to 24 measuring points you can resolve complex measuring tasks on surfaces of differing reflectivity and measure the wall thickness of complex-shaped and colored container glass. Two easily connectable line probes are particularly suitable for inline inspection of container glass at the cold end. They use up to 12 measuring points over a length of 12.5 mm to ensure efficient detection of defects, voids or thin areas in container glass. The robust and highly integrated design of this multi-point sensor enables easy in-tegration into inline inspection machines, even in harsh industrial environments. Its ultra-high dynamic response and outstanding signal-to-noise ratio ensure optimum measuring results on surfaces with differing reflectivity and from different angles.



HOW YOU BENEFIT

- ▶ Measurement of layer thickness and distance along a line, thus replacing up to 24 individual sensors
- ▶ Any combination of point and line measuring probes possible
- ▶ User-friendly and maintenance-free

CHROCODILE MPS 12E/24/96E

Besides all the advantages outlined above, this multi-point sensor makes ultra-short inspection times possible by measuring at up to 108,000 points per second.

HOW YOU BENEFIT

- ▶ Optimized measuring efficiency
- ▶ Replaces up to 96 individual sensors for simultaneous measurements
- ▶ Simple to integrate, maintenance-free and robust



ENOVASENSE PS – ANY COATING THICKNESS MEASURED PRECISELY

The Enovasense PS enables non-contact, non-destructive thickness measurements of virtually any kind of coating. This high-precision photothermal sensor is the ideal point sensor for inline inspection applications as it is light in weight (as little as 150 g), compact (35 x 35 x 64 mm) and thus easily integrated into any production environment. Thanks to its separate controller the sensor head will fit into almost any small space. The connecting cable can be up to 20 meters long. As the probe has no moving parts, maintenance-free integration is ensured.

HIGH-PRECISION MEASUREMENT OF ANY COATING LAYER

Precise and stable thickness measurements are possible on any kind of coating and substrate materials – diffusive or reflective, flat or curved, rough or polished – and on any surface, e.g. mirrored, unfinished metal, ceramic or adhesive surfaces. Thicknesses from μm to mm can be measured in the submicron range with constant, long-lasting stability.

DIFFERENT-SIZED SENSOR HEADS

The compact T033 and ultra-compact T060 sensor heads each have variants with an angled laser beam to measure perpendicularly to the head length. Moreover, various optical front lenses enable a wide range of working distances and laser spot diameters from 0.3-12 mm. A high-distance objective on the T033 measuring head increases the working distance to 200 mm and the distance tolerance to ± 50 mm.

EASILY INTEGRATABLE IN INDUSTRIAL ENVIRONMENTS

With an alignment tolerance of up to ± 10 mm around the nominal distance and an angle tolerance of up to $\pm 50^\circ$, the Enovasense PS is easily integratable. The sensor displays a high degree of stability to vibrations and changes in the part curvature and shape, can measure parts at very high temperatures and is suitable for ambient temperatures up to 50°C .

EASY-TO-USE, PLUG-AND-MEASURE APPLICATION SOFTWARE

Intuitive software enables the sensor to be quickly configured and calibrated for any coating application. A specific application enables a series of measurements to be performed while computing the statistics on them. The data flux can be collected by an external PLC through a Modbus Ethernet connection.



HOW YOU BENEFIT

- ▶ Coating thickness measurements on all substrates and surfaces
- ▶ Compact design, low weight
- ▶ Maintenance-free and easy to integrate into production lines

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