

Sensors & Applications

Battery production



More Precision



Coating

Drying

Calendering

Cutting

Assembly

Filling

Formation

Energy storage devices such as lithium-ion batteries play a crucial role for electromobility and energy transition. The growing demand is met by Gigafactories which are equipped with efficient and highly automated production technologies.

As demand for electricity storage media increases, quality control is becoming increasingly important. High quality from the raw materials to the finished memory cell must be guaranteed without interruption in electrode and cell production. Inline inspection of production deviations during the process contributes significantly to the economic efficiency and environmental compatibility of production processes.

Micro-Epsilon offers reliable solutions from high precision distance sensors to infrared temperature measurement technology and 2D/3D profile sensors for multiple measurement tasks involved in battery production. These sensors are used at every production stage from electrode manufacturing to assembly and forming processes.

Micro-Epsilon's extensive and diverse product portfolio offers you the right measurement method with the right sensor for every type of coating and all measuring objects.

Why Micro-Epsilon?

- Increasing economic efficiency, resource conservation and quality
- Highest precision down to the nanometer range
- Bundled sensor and system expertise from a single source
- A broad technology portfolio for the optimal solution of your application
- Decades of experiences in strip and belt processes



combiSENSOR

Sensor for precise thickness measurement of coatings

Target thickness: 40 μm to max. 6 mm

High accuracy

Ease of use via web interface

Analog interfaces, Ethernet, EtherCAT



capaNCDT

Capacitive sensor systems for high precision distance and thickness measurements

Measuring ranges from 0.05 to 10 mm

Submicron resolution

High temperature stability, ideal for fluctuating ambient temperatures

Multi-channel controller and measuring bracket for multi-track applications



confocalDT

Confocal chromatic sensors for high precision distance measurement

High signal stability on all surfaces

Synchronous 2-channel measurement with only one controller

Ideal for dynamic measurement tasks due to high measuring rate



thicknessCONTROL

Turnkey measuring systems for thickness measurement

Measurement of thickness and thickness profile

No consequential costs for radiation protection due to isotope and X-ray free measuring principle

Easy integration into processing lines

High accuracy thanks to application-specific measuring methods

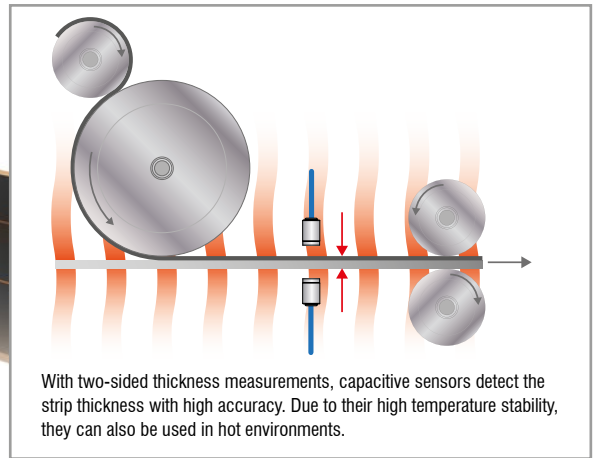
Stable thickness measurement with electromagnetic sensors

Push

- High-precision measurements even with high ambient temperatures
- Multi-channel controller for multi-track measurements
- Large measurement spot compensates for inhomogeneous structures



Measuring bracket with capacitive sensors for strip and coating thickness



With two-sided thickness measurements, capacitive sensors detect the strip thickness with high accuracy. Due to their high temperature stability, they can also be used in hot environments.

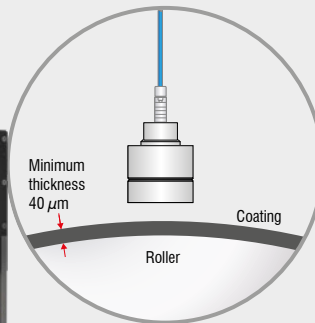
Electromagnetic sensors from Micro-Epsilon offer numerous advantages in thickness measurement. The sensors have a relatively large measuring spot that compensates for inhomogeneous structures. In addition, they can also be used at high temperatures. Thanks to integrated temperature compensation, the electromagnetic sensors provide stable measurement values in the submicrometer range and are also used in dry processes.

Thickness measurement using capacitive sensors

Two capacitive sensors mounted opposite each other enable two-sided thickness measurement of electrically conductive materials. Strip thicknesses in the μm range can be measured using this method. Each of the two capacitive displacement sensors provides a linear distance signal which is calculated by the controller as a thickness measurement value. The measuring spot of the sensors is larger than that of the optical methods, which averages out any structures and anomalies on the surface. Using the capaNCDT multi-channel controllers enables processing of several sensor pairs with just one controller.

Sensor: *capaNCDT 6200*

thicknessGAUGE O.EC:
One-sided thickness measurement of coatings



Sensor system for thickness measurement of electrode coatings

For stable thickness measurement in soiled areas with high ambient temperatures, the thicknessGAUGE O.EC is used. The system is designed as an O-frame and uses a combiSENSOR that traverses over the battery film. Thanks to the innovative technology, the thickness measurement is contactless from only one side. The guide roller serves as a reference target for the integrated eddy current sensor, while the integrated capacitive sensor determines the distance to the material surface. The difference between the two signals is calculated by the controller as a thickness value and output as a measured value.

Measuring system : *thicknessGAUGE O.EC*

High-resolution thickness measurement using optical sensors

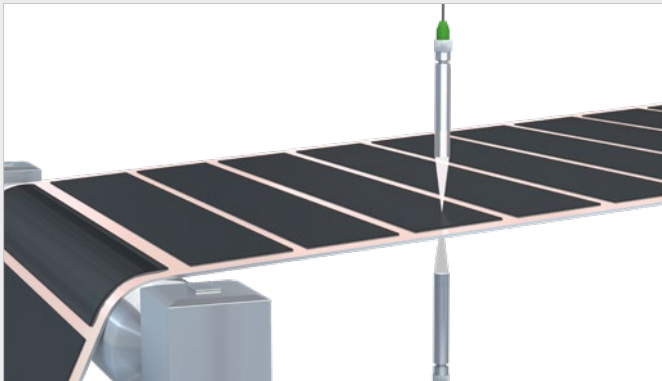
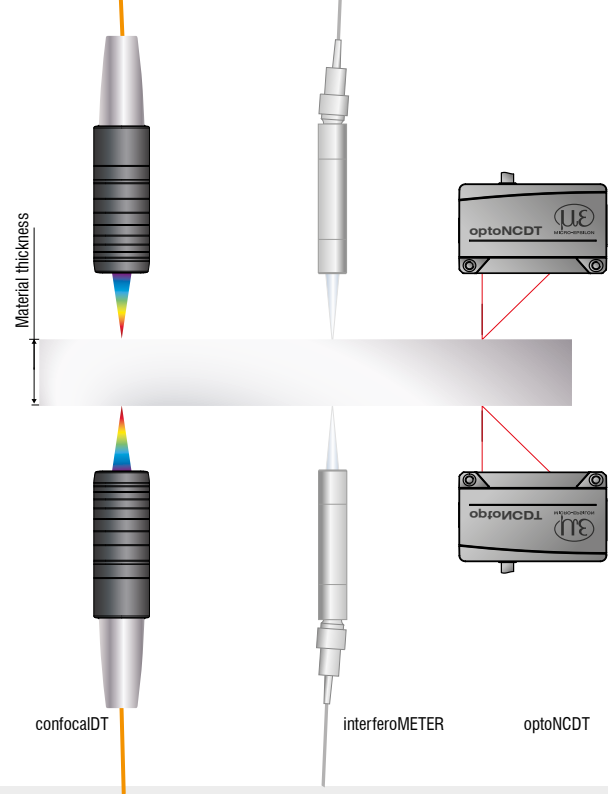
The background image shows a large industrial roll of metal being processed in a factory. A bright light source is visible, and a green laser line is projected onto the surface of the metal. The scene is set in a modern industrial environment with various machinery and structures.

- Reliable measurement methods for all coating processes
- Non-contact measurement with high accuracy and high measuring rate
- Ideal for dynamic process control

High precision optical sensors for two-sided thickness measurement

With double-sided thickness measurements, two sensors are arranged opposite each other and measure the distance to the battery film. This arrangement allows extremely high resolution to be achieved.

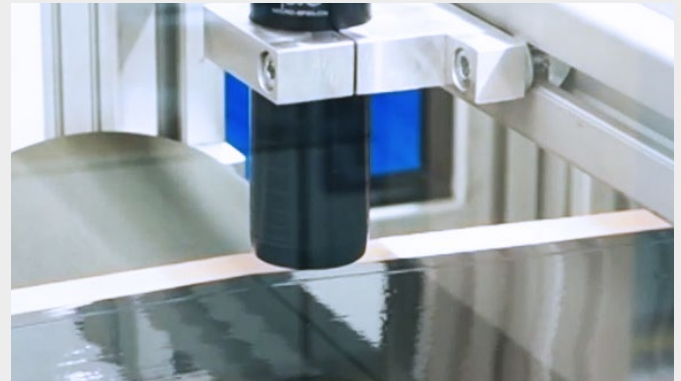
In addition to confocal chromatic sensors, laser triangulation sensors and white light interferometers are particularly suitable. These are selected depending on accuracy requirements, surface type and coating type (uncoated/coated). The sensors are typically used to monitor and control wet coating processes, but are also suitable for dry coating processes.



Thickness measurement of electrode coatings

Two opposing white light interferometers measure the thickness of coated electrodes using the differential thickness method. At a constant distance from each other, the two sensors each detect the distance to the film. The white light interferometers enable a measurement resolution in the nanometer range. The thickness values are used to control the application of the coating and for quality assurance purposes.

Sensor: *interferoMETER IMS5400*



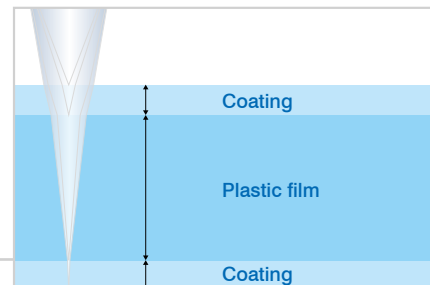
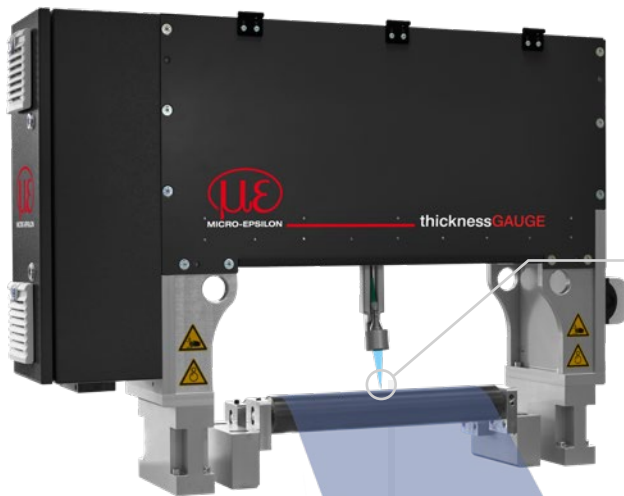
Measuring the thickness of wet layers

Confocal chromatic sensors from Micro-Epsilon monitor the coating thickness of wet materials. These sensors provide both extremely high resolution and high measuring rates. Installing several sensors next to each other enables concurrent determination of the homogeneity of the coating over the complete strip width.

Sensor: *confocalDT*

Inline system for strip thickness measurement

- Reliable measurement methods for all coating processes
- Ideal for fluctuating high ambient temperatures
- Process reliability in multi-track and fixed track measurements



Compact measuring system for inline thickness measurement of separator films

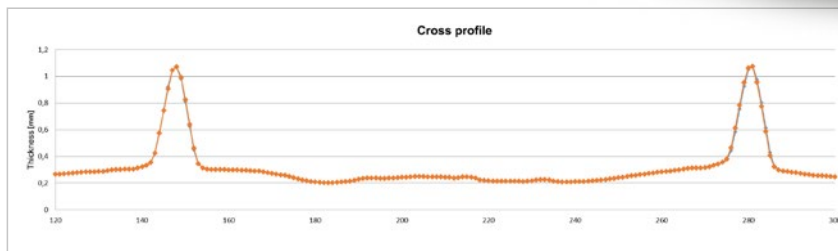
The compact thicknessGAUGE sensor system is used for coating thickness measurement of separator film. Equipped with a white light interferometer, the sensor system detects both the film thickness and the coating from 10 μm thickness.

Measuring system: thicknessGAUGE O.I.M.S

Thickness measurement with high precision

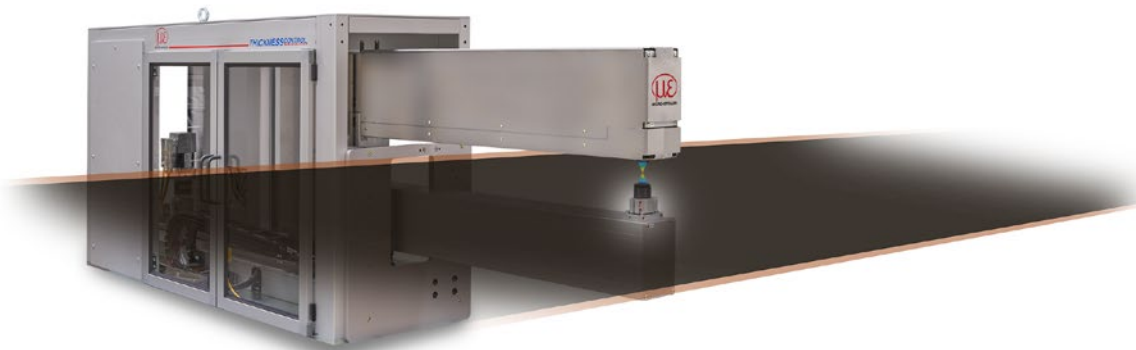
thicknessGAUGE sensor systems are used for inline thickness measurements of strip materials. Several models with different sensor types, measuring ranges and measuring widths enable inline thickness measurements of different materials and surfaces. The system uses two optical or electromagnetic distance sensors to detect the strip thickness. The sensors are precisely aligned to each other and calibrated. Furthermore, thickness calibration at the factory ensures high precision. By means of a linear axis, the thicknessGAUGE sensor systems can be moved to measure the thickness over the entire strip width.

Measuring system: thicknessGAUGE



Thickness profile evaluation

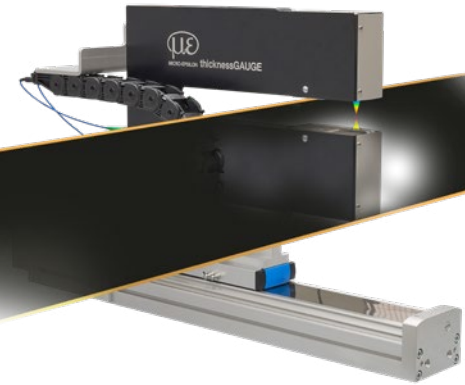
If the sensor is moved over the strip material by means of a linear axis, transverse thickness profiles can be evaluated.



High precision inline thickness measurement of battery film

The thicknessCONTROL Quad measuring system consists of two robust measuring frames, each containing eight confocal sensors. The system is used for high-precision inline thickness measurement of coated battery film and impresses with long-term stable measurements.

Measuring system: thicknessCONTROL



The thicknessGAUGE sensor systems combine high-precision sensors with a coordinated mechanical system including a traversing axis. Thanks to a comprehensive software and interface package, the sensor systems can be integrated into production lines in a process-safe manner.

thicknessCONTROL UTS

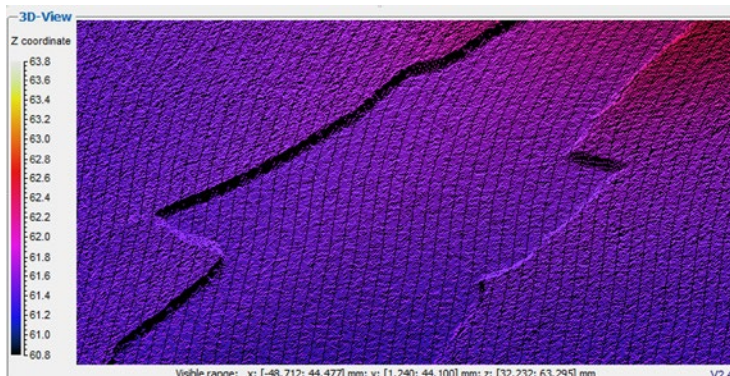
High precision thickness measuring system for coated anode and cathode films

Robust design with temperature compensation

Measuring range (thickness) <6 mm

System accuracy $\pm 0.3 \mu\text{m}$

2D/3D Profile measurement



3D surface inspection

The scanCONTROL sensors enable stable measurement with high resolution in the 3D inspection of coated films. Defects with the smallest geometries – e.g. spalling and inclusions – are reliably recognized and output by the scanners.

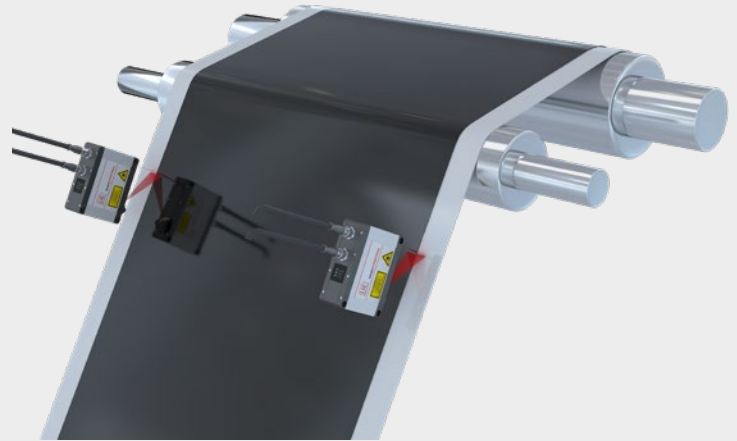
Sensor: scanCONTROL



Inspection of adhesive beading and applied sealants

scanCONTROL laser scanners inspect the presence and dimension of adhesive beading. They are mounted on the dispenser and control the quantity applied and the distance from the dispenser. Their high resolution enables them to reliably detect even the finest of beads. This is how breaks and flaws can be detected regardless of the type of application or the color applied.

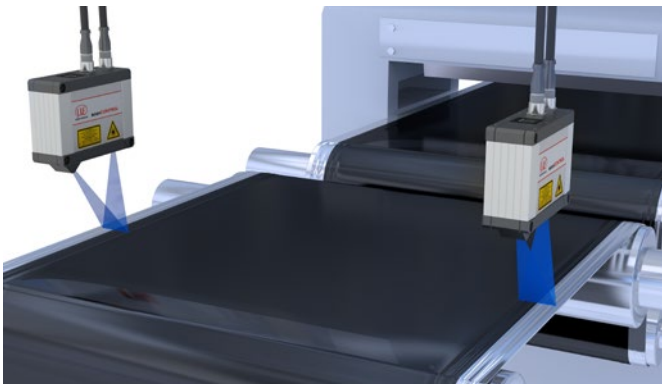
Sensor: scanCONTROL



Coating application on edges

Electrodes must be coated with extreme precision. Therefore, laser scanners from Micro-Epsilon inspect the coating profile on the edge. This is how anomalies of the coating and undulations are detected.

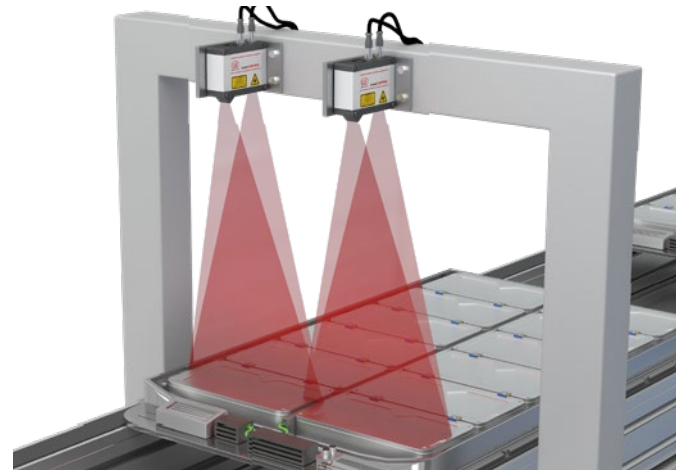
Sensor: scanCONTROL



Detection of curved edges after cutting

Films may have curvatures and deformations after longitudinal cutting. In order to detect these deviations reliably, laser profile sensors from Micro-Epsilon are used. Due to their extremely high resolution and insensitivity to reflecting surfaces, these sensors provide stable measurement results.

Sensor: scanCONTROL



Position control of battery cells

After the battery cells have been assembled, laser scanners from Micro-Epsilon inspect their completeness and position. These precise profile sensors generate a 3D-image which is then compared with the CAD data.

Sensor: scanCONTROL



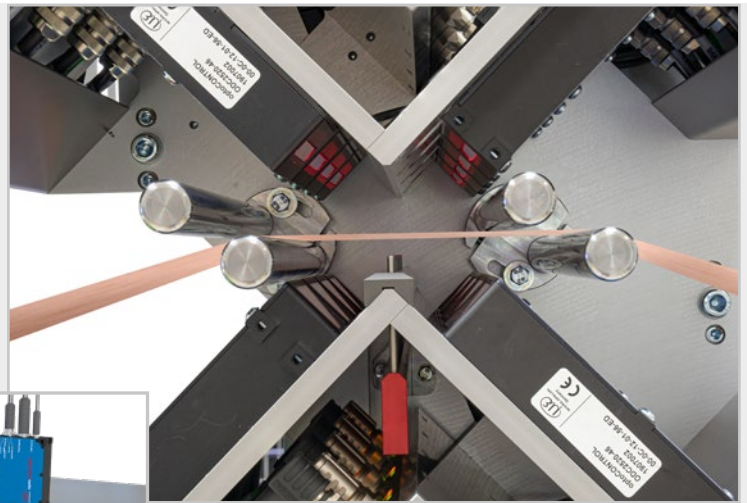
Non-contact measurement of temperature and edges

- Non-contact process monitoring
- Measuring procedure for all process stages
- Ideal for automated production monitoring

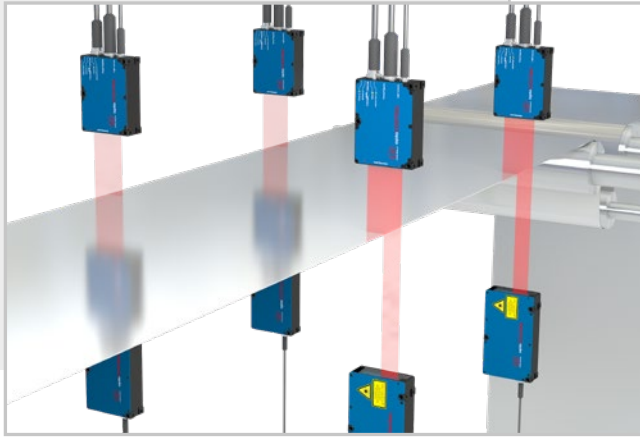
Web edge control of electrode film

During the production of battery cells, electrode and separator films must be guided reliably. Optical optoCONTROL micrometers detect the required edge position for web edge control with high accuracy. Operating several micrometers enables the concurrent detection of the web width.

Sensor: *optoCONTROL 2520*



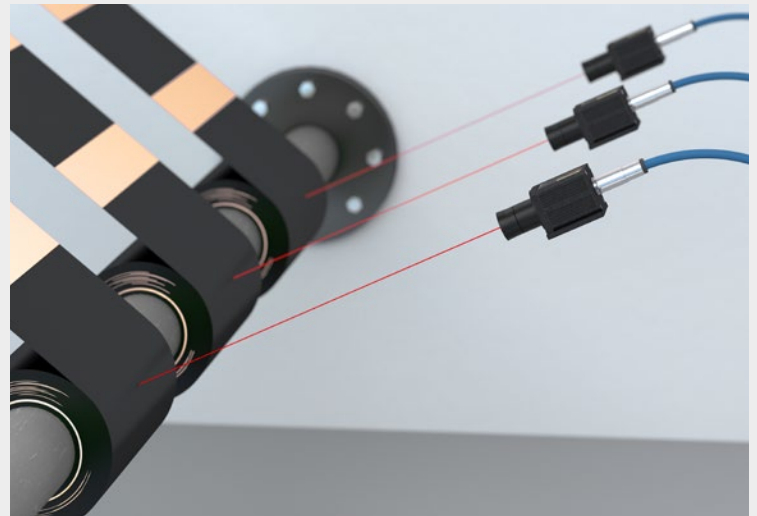
Detection of web edges and width measurement



Monitoring the coil unwinding process

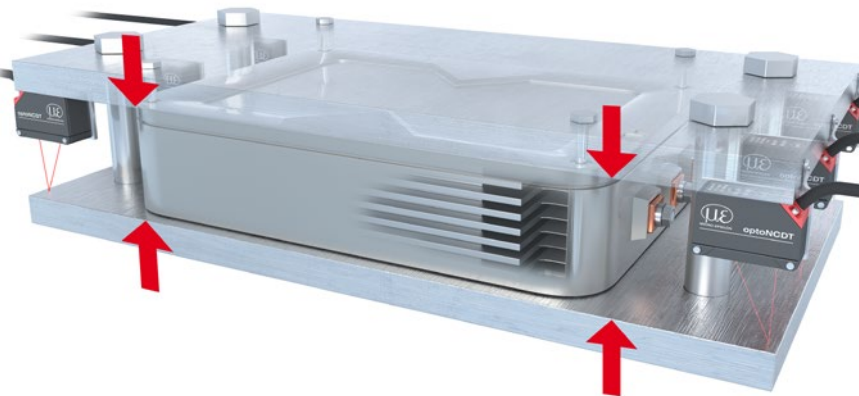
optoNCDT ILR2250-100 laser distance sensors monitor the unwinding and winding of coils. As the diameter continuously increases or decreases respectively, the distance between the coil and the sensor changes. This distance change is reliably and precisely monitored by the sensors. The integrated AUTO measurement mode enables reliable detection even on reflective surfaces and mat coatings.

Sensor: *optoNCDT ILR2250*



Non-contact sensors for machine monitoring

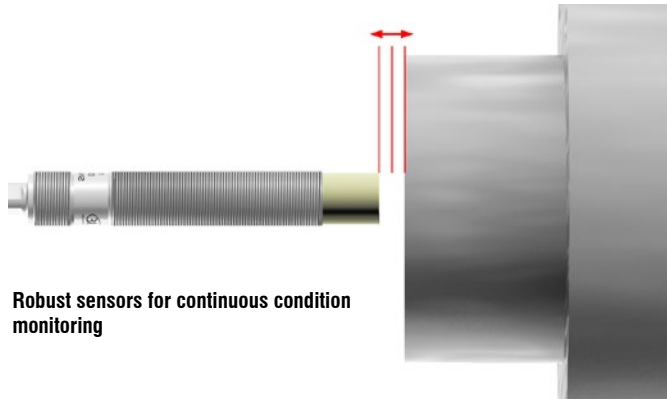
- Robust sensors for integration into plant and machinery
- High accuracy and temperature stability
- Ideal for machine monitoring



Measurement of battery expansion during charging

When the battery is first charged, the battery cell expands. To detect the critical point before rupture and to interrupt the charging process, the battery is installed in a test stand. Laser sensors from Micro-Epsilon check the vertical expansion in several charge and discharge cycles. The compact sensors can also be accommodated in confined spaces and deliver high measurement accuracy.

Sensor: *optoNCDT 1420*

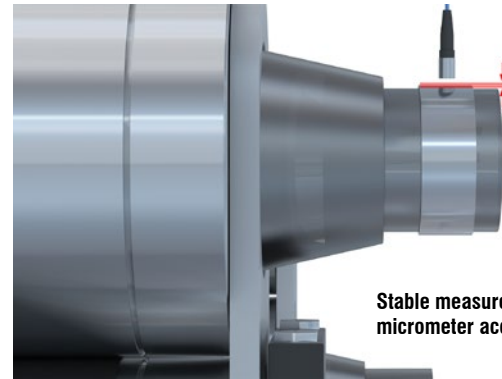


Robust sensors for continuous condition monitoring

Precise measurement of the axial roll runout

In order to enable the guide or coating rolls to operate at the highest precision, the axial roll runout is continuously measured. For this purpose, eddy current displacement sensors detect the axial movement of the roll by determining the distance to the roll. In addition to the compact design, the advantage of the eddy current sensors used is their resistance to harsh environments: the sensors provide precise measurement results even when oil, dirt, temperatures or pressure act on the sensor. The compact eddyNCDT 3001 sensors also have an integrated controller, which further facilitates integration.

Sensor: eddyNCDT 3001

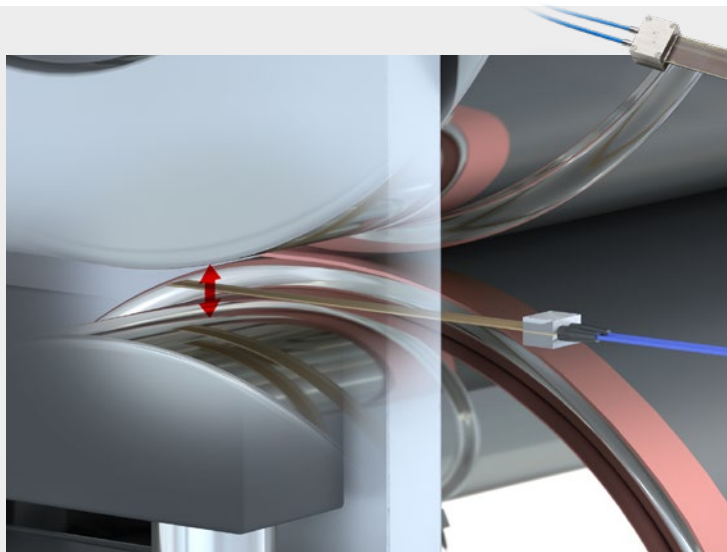


Stable measurement with micrometer accuracy

Measurement of roll wear via the bearing gap

Capacitive displacement sensors are used to determine the wear of rollers. The roll wear is measured indirectly via the change in the bearing gap of the drive shaft. Thanks to the capacitive sensors, the measurement is continuous and with high precision. As a result, wear is permanently determined and detected at an early stage, which means that maintenance intervals can be scheduled in a targeted manner. The capacitive sensors can also be used with strong temperature fluctuations and provide a high signal stability.

Sensor: capaNCDT



Capacitive flat sensors for precise measurement of the roller gap

Monitoring the roller gap

Capacitive flat sensors are used for monitoring and controlling calender and coating rolls. These are available in various designs and detect the roller gap with micrometer accuracy. These compact sensors can be integrated into confined installation spaces to measure directly against the rollers or the roller suspension and to readjust the roller gap. As the sensors are temperature-compensated, they can also be used at high ambient temperatures.

Sensor: capaNCDT

Sensors and Systems from Micro-Epsilon



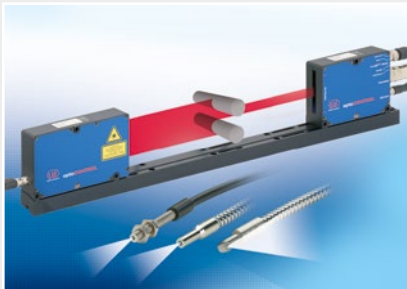
Sensors and systems for displacement, distance and position



Sensors and measurement devices for non-contact temperature measurement



Measuring and inspection systems for metal strips, plastics and rubber



Optical micrometers and fiber optics, measuring and test amplifiers



Color recognition sensors, LED analyzers and inline color spectrometers



3D measurement technology for dimensional testing and surface inspection

More Precision

Whether it is for quality assurance, predictive maintenance, process and machine monitoring, automation or R&D – sensors from Micro-Epsilon make a vital contribution to the improvement of products and processes. High precision sensors and measuring systems solve measurement tasks in all core industries – from machine building to automated production lines and integrated OEM solutions.



MICRO-EPSILON

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