optris
infrared measurements

Production

Quality Assurance

Research & Development

Test & Measurement

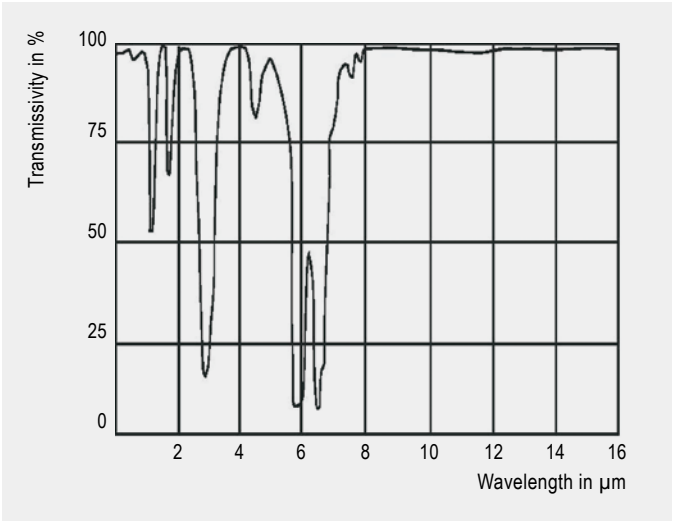
NON-CONTACT TEMPERATURE MEASUREMENT GLASS INDUSTRY

innovative infrared technology

Influence from the surroundings

The illustration shows that the transmissivity of air strongly depends on the wavelength. Strong flattening alternates with areas of high transmissivity – the so-called atmospheric windows. The transmissivity in the longwave atmospheric window (8 – 14 µm) is constantly high whereas there are measurable alleviations by the atmosphere in the shortwave area, which may lead to false results. Typical measuring windows are 1.1 … 1.7 µm, 2 … 2.5 µm and 3 … 5 µm.

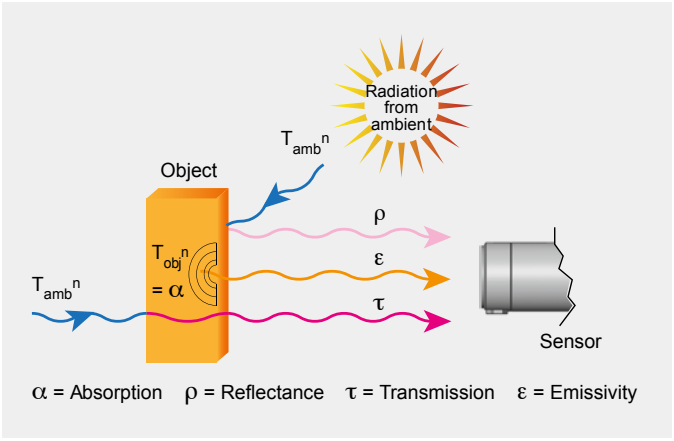
Additional influences can arise from heat sources in the environment of the measuring object. To prevent wrong measuring results due to increased ambient temperatures, an ambient temperature compensation can already be set in the infrared measuring device. This is especially helpful when measuring objects in closed chambers whereby the walls are hotter than the measuring object. A second temperature sensing head helps to generate accurate measuring results by automatically compensating the ambient temperatures and a correctly adjusted emissivity.



Spectral transmissivity of air (1 m, 32 °C, 75 % r. F.)

Dust, smoke and suspended matter in the atmosphere can pollute the optics and result in false measuring data. Here air purge collars (which are installed in front of the optics with compressed air) help to prevent deposition of suspended matter in front of the optics. Accessories for air and water cooling support the use of infrared thermometers even in hazardous surroundings.

The CoolingJacket Advanced enables an operation within an ambient temperature of up to 315 °C



Compensating ambient influences

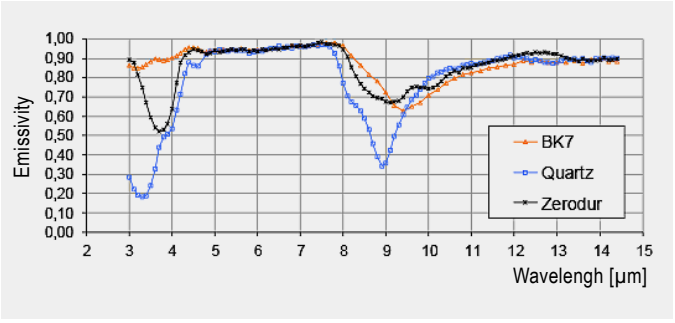
Emissivity and temperature measurement

For the accurate measurement of temperatures, emissivity is a key factor. It is dependent on various influences and must be adjusted according to the application.

Emissivity theoretically depends on the material, its surface quality, wavelength, the measuring angle and, in some cases, even the applied measuring configuration.

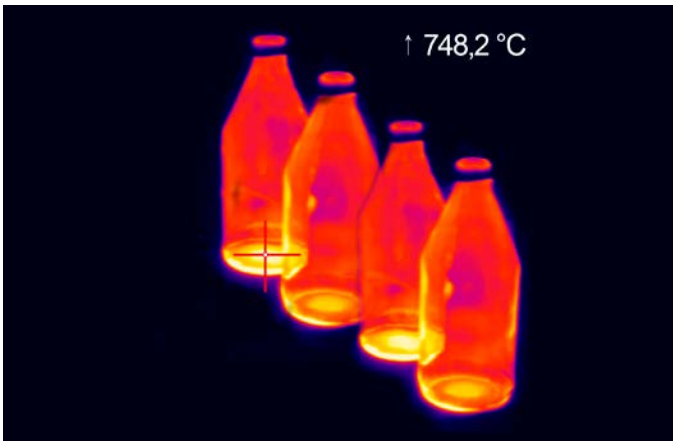
Uncoated glass usually exhibits an emissivity of 0.85 in the longwave range (8 – 14 µm). In processes with higher temperatures glass surfaces are measured with 5.0 µm or 7.9 µm because in those spectral ranges the emissivity is ≥0.95.

The main advantage of 7.9 µm is the lower angle dependency of the glass surface reflection in this wavelength range. This means that the surface temperature can be measured independently of the reflection even at an inclined viewing angle.



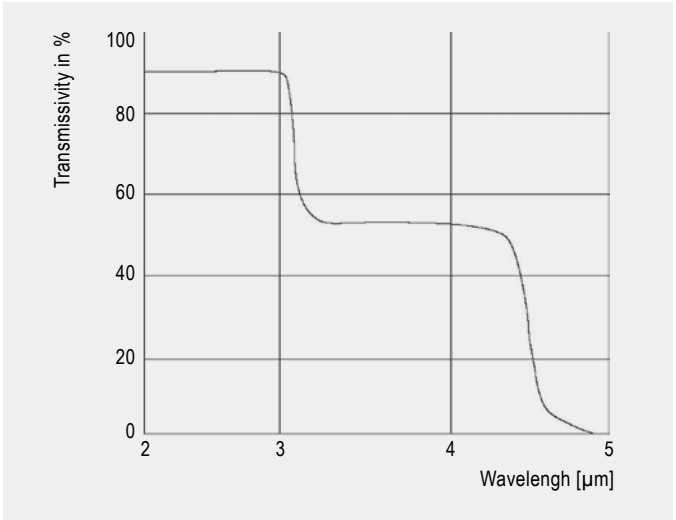
Spectral emissivity of glass

Temperature measurement of glass



Hot spot detection at glass bottle production

If you measure temperatures of glass with IR thermometers or the special IR camera optris PI G7 it implies that you take care of reflection and transmissivity. A careful selection of the wavelength facilitates measurements of the glass surface as well as of the deeper layers of the glass. Wavelengths of 1.0 µm, 2.2 µm or 3.9 µm are appropriate for measuring deeper layers whereas 5 µm are recommended for surface measurements. If temperatures are low, you should use wavelengths between 8 and 14 µm in combination with an emissivity of 0.85 in order to compensate reflection. For this purpose a thermometer with short response time should be used as glass is a bad heat conductor and can change its surface temperature quickly.



Spectral transmissivity of glass

Further informationen can be found in our IR basics brochure:
www.optris.global/downloads

Line scan with compact infrared camera

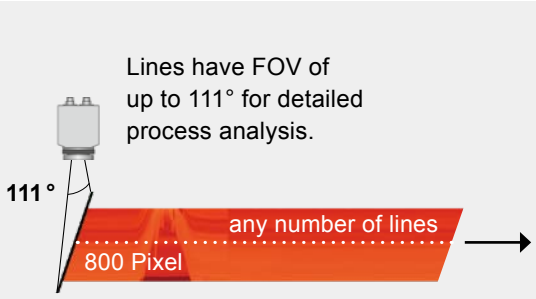
Optris infrared cameras are equipped with license-free PIX Connect software. The software enables the cameras to operate as line scan cameras.

Line scanners are traditionally used in the glass industry for various measurement procedures. In these devices, a point detector is coupled with a rotating mirror to consequently generate a linear optical scan of the object. These devices are bulky and expensive. Additionally, a high manual effort is required for setup.

When using an infrared camera as a line scanner, an arbitrary line is selected from the detector array. In addition to the more compact construction and the lower price, there are two significant benefits: the line to be scanned can be positioned and dimensioned anywhere using the software and the user receives a complete IR image quasi as additional information – these are important advantages, especially during system setup.

The cameras can accurately measure surface temperatures of moving measurement objects using minimal apertures. This function is of particular significance in the glass industry, since the glass temperature has a direct impact on the quality. Accordingly, temperatures are recorded at many points during the production process and transmitted directly to the process control system.

For example, the Optris PI 640 G7, a special IR camera for glass applications, can scan the complete glass width using in the float process (Up to 4 m) with an 90° lens using the diagonals as scan line at a height of 1.7 m.
Using a subframe mode of 640x120 pixels and the same optics, data can even be captured with 125 Hz and output to a thermal image in any resolution.

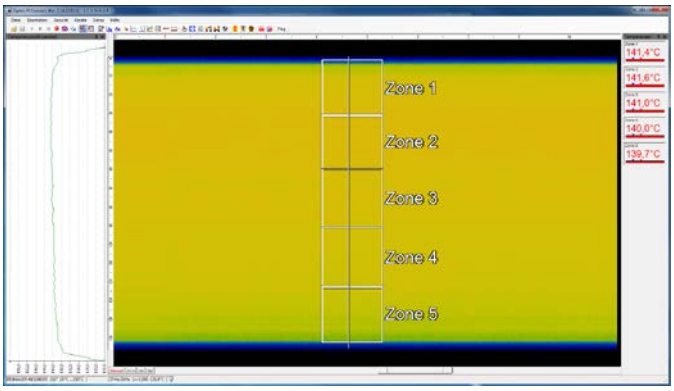


Applications of Temperature measurement technology

PRODUCTION OF GLASS

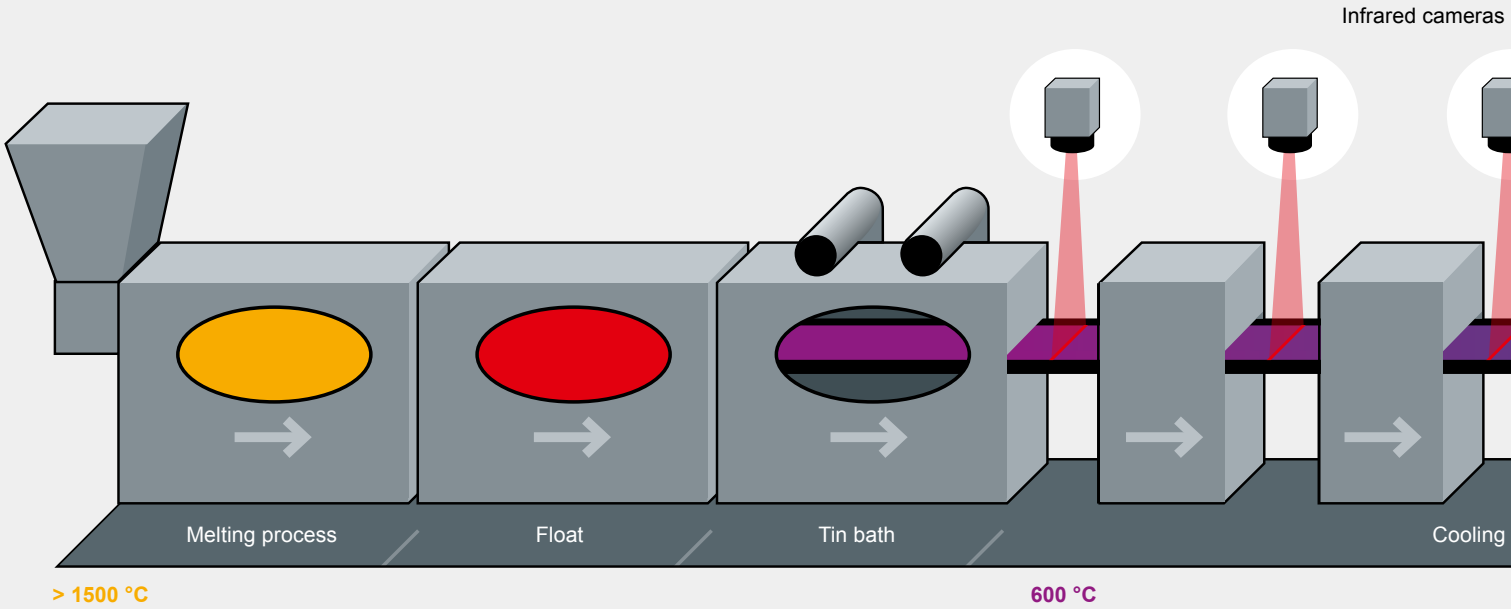
Production optimization in the float glass process

After the tin bath, the flat glass band has a temperature of about 600 °C; the first infrared camera in line-scan mode is applied for temperature monitoring at the transition to the cooling zone. The glass is transported through various cooling ranges in the cooling zone. Between the cooling ranges, infrared cameras are also installed in the cooling ranges for temperature monitoring, in order to guarantee optimal quality.



Software adjustments for line-scan process

Measurement areas at float glass production



Continuous control during the production of container glass

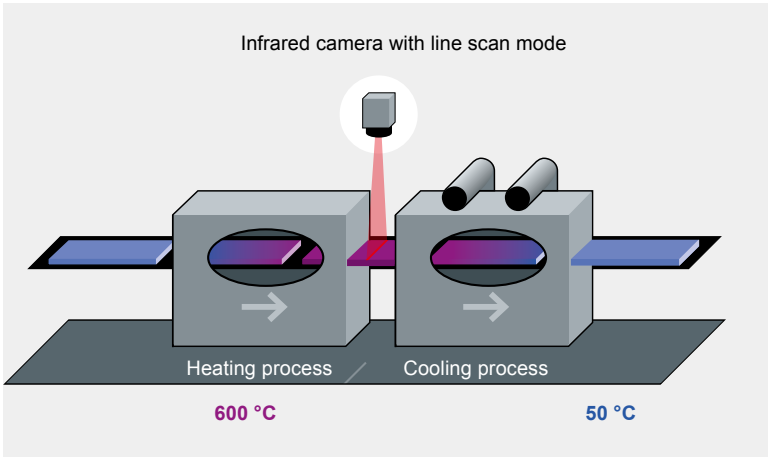
Container glass, meaning for example bottles in all sizes and forms, must be multiply monitored for its process-relevant temperature during the production process. When the molten glass exits through the feeder, the glass strand is cut. The thereby resulting **molten glass drops** must have a temperature of about 1000 °C to ensure quality. Temperature measurement was previously only possible with point-measuring infrared thermometers due to the high velocity. The innovative Optris PI 1M now also enables this measurement via surface measurement with an image rate of up to 1000 Hz.

During the **forming process**, which takes place at temperatures of over 500 °C, infrared sensors are also used for monitoring. Since the process only takes a few seconds, the reaction of the sensors is of critical importance here. The thermal measurement of the glass can be influenced by direct measurement of the glass surface or indirect measurement of the surface of the forming tool for both the forming of the parison shape as well as during finishing of the mould.

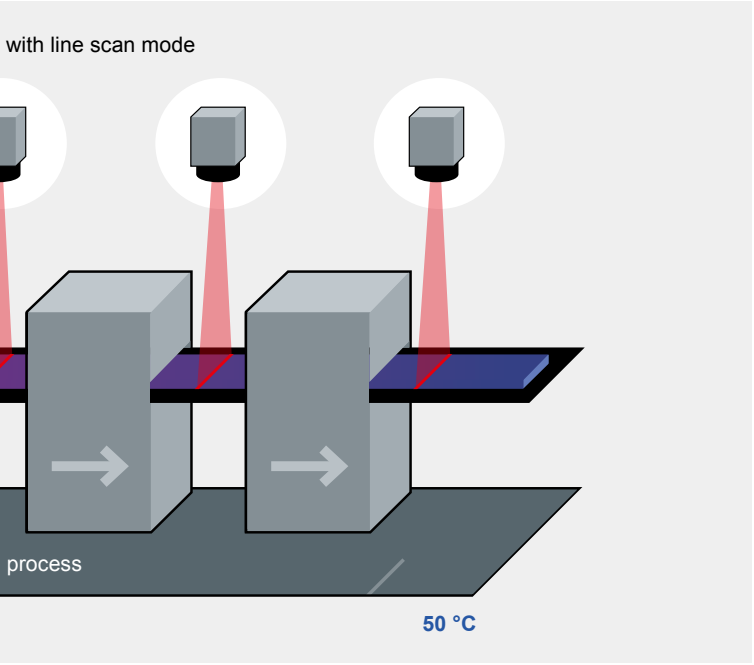
To complete the finishing process, another **temperature control to reduce tension** takes place in the containers. The glass is heated again and subsequently gradually cooled in a cooling tunnel over a period of up to 30 minutes. When the containers exit the heating zone, the cooling process is supported and controlled by temperature measurement.

Single-pane safety glass production with correct temperature measurement technology

For the production of single-pane safety glass (SPSG), the cut and processed flat glass is heated in a furnace under continuous movement at over 600 °C. During the transport of the heated glass in the pretension zone, an infrared camera monitors the temperature distribution on the glass surface in line-scan mode. During the pretension process, where the glass is shock-cooled, inhomogeneities can be compensated. The quality of the SPSG mainly depends on a homogeneous thermal treatment, which is ensured by the application of temperature measurement technology.

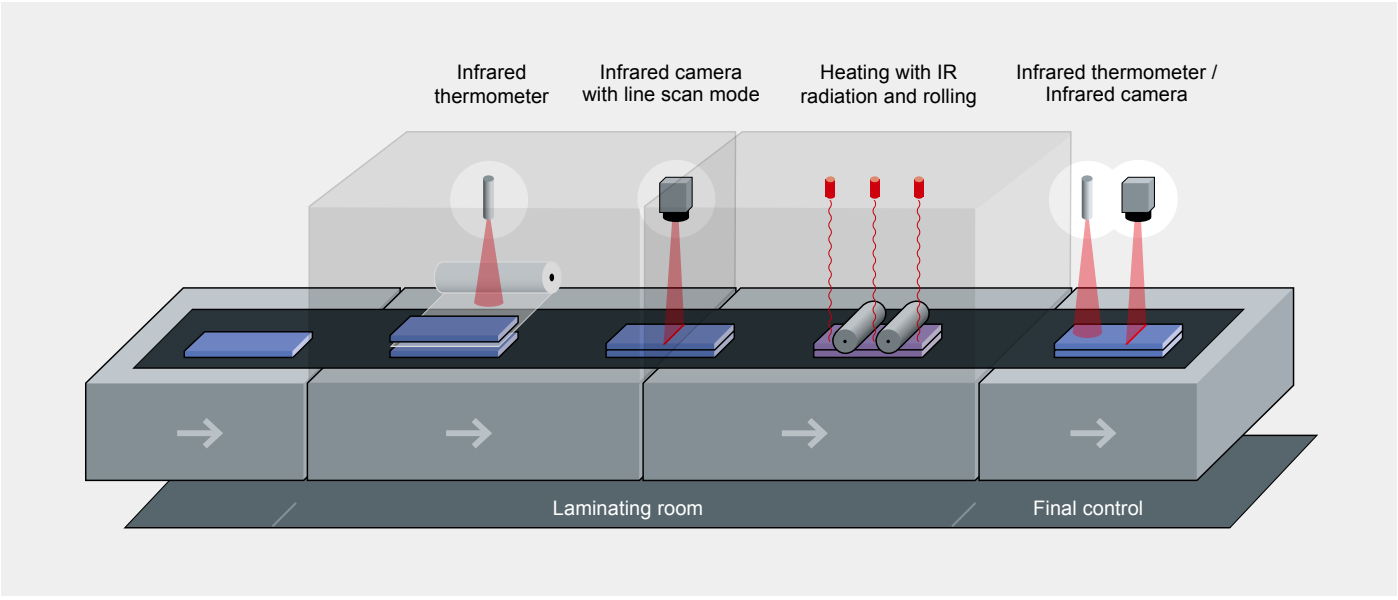


Measurement areas at SPSG production



Ensuring the quality of laminated safety glass

Laminated safety glass (LSG) consists of at least two f lat panes of glass, which are laminated in a clean room with a sheet of PVB film between them. The temperature of the film can be monitored with infrared thermometers. In the pre-lamination furnace, the glass panes are heated in order to melt the film and simultaneously press the “sandwich” together, to prevent air pockets. During the transition to the autoclaves, the temperature distribution is monitored with an infrared camera, in order to adjust the heating elements in the pre-lamination furnace for subsequent panes, when necessary.



Measurement areas at LSG production

Industry-specific measuring instruments

SPECIAL WAVELENGTH RANGES

The IR thermometer's stainless steel measuring head is **extremely small** and can be employed in ambient temperatures of up to 85 °C without additional cooling. A **multi-installation** of the pyrometers, e. g. in series as line scanner, is therefore **cost-efficient** and can be performed even in limited spaces. The temperature range is from 100 °C to 1650 °C.

optris® CT G5

Due to its special spectral range of 5.0 µm, the pyrometer optris® CT G5 is perfectly suited for the **measurement of glass temperatures**, e.g. during **container glass** production and **vehicle glass** production.

The infrared thermometer optris® CTlaser G5 allows for temperature measurement of **smallest objects of 1 mm** from a distance of 70 mm. Due to its **very short response time** of 10 ms it is often used for fast processes.

optris® CTlaser G5

With a spectral range of 5.0 µm, the two-part infrared thermometer optris® CTlaser G5 is especially designed in **precise measurement of glass surfaces**. The devices are employed for temperature measurement in e.g. manufacturing processes of **vehicle glass** and and **flat glass**.

Also in the manufacturing of **laboratory glass equipment** or the production of **glass bottles**, the pyrometer delivers excellent results and is thus employed for **quality assurance and process coordination**.

The infrared thermometer optris® CSlaser G5HF has been specifically designed for temperature measurement of glass. Its standardized two-wire interface provides a **reliable measuring data transmission** and allows for an easy integration of the temperature sensors into a PLC.

The IR thermometer is additionally equipped with an innovative double laser visor for a precise marking of the measuring spot. A variety of optics ensures high adaptability with diverse applications.

optris® CSlaser G5HF

The optris® CSlaser G5 is perfectly suited for temperature control of production processes of **flat glass and vehicle glass**. Also, the measurement during cooling and heating processes of **single-pane safety glass** and **laminated sheets safety glass** is important.

The infrared cameras optris® PI 450 G7 and PI 640 G7 are industry specific models within the PI series. They are **especially developed for the glass industry,** working with a spectral range of 7.9 µm.

The temperature range of 200 °C to 1500 °C allows the implementation in diverse applications in **production, dressing and further processing** of glass.

optris® PI 450 G7 / PI 640 G7

These infrared cameras should be used when **temperature values within a field** are to be detected. In due to the low price an infrared camera could be the better solution in comparison to rows of infrared thermometers.

The infrared thermometer optris CTlaser MT offers a special measuring wavelength for precise temperature measurement through flames of 200°C to 1650°C.

optris® CTlaser MT

It is thus perfectly suited for surveillance of work pieces in ovens, for measurements in chemical reactors and for testing of refractory linings in kilns. The stainless steel measuring head with its highly precise double laser visor allows for exact marking of measurement spots in any distance at any time.

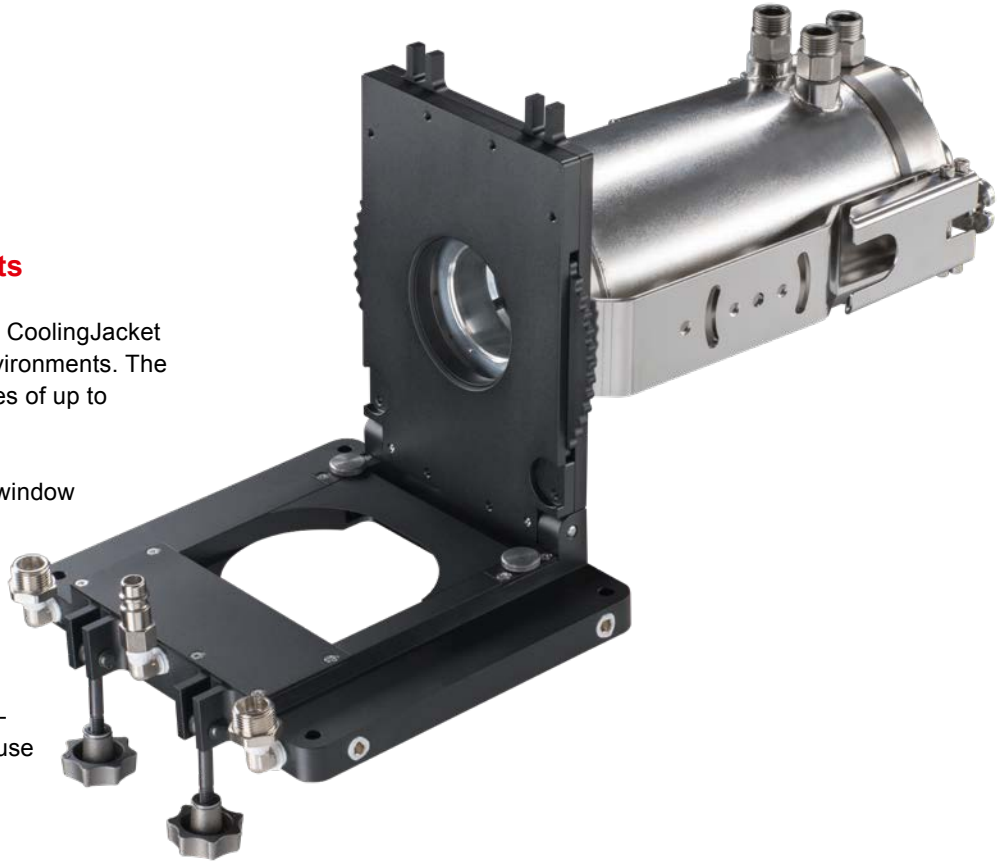
The innovative pyrometer with its special spectral range of 7.9 µm is particularly suitable for temperature measurements of thin plastic materials.

optris® CT P7

The optris CT P7 is used in the production of laminated safety glass as it detects and secures the temperature of the elastic and tear-resistant high polymer film.

Glass industry

LAMINAR AIR PURGE



Air purge for rugged environments

The air purge unit complements the reliable CoolingJacket (water cooling housing) for use in harsh environments. The system can be used at ambient temperatures of up to 315 °C.

An integrated, infrared-transparent special window protects the optics of the camera or sensor on the one hand and, on the other hand, enables an optimal laminar air flow. This is particularly important because turbulence directly in front of the optics leads to dirt deposits. The Optris development engineers designed, extensively tested and optimized the air purge attachment in the in-house test center.

Variety of options

Two models of the Optris air purge are available:

- Large sighting window
  For applications in need of the infrared camera's whole detection field.

- Inspection slit
  For applications using only a scan line, thus offering an even better protection of the sensor. This option is quite common in the glass industry.

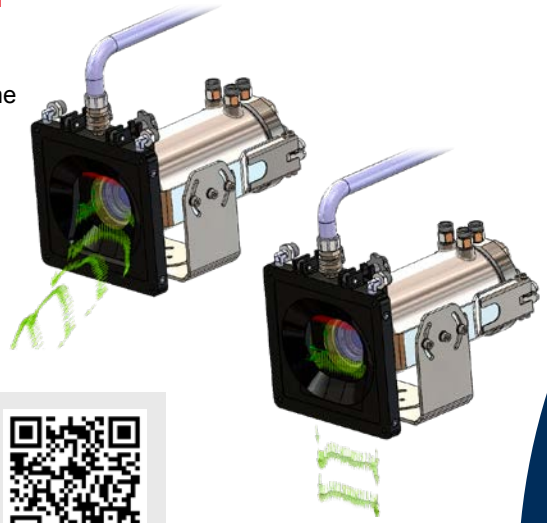
Installation and maintenance friendly inspection clap

The focus of the installed infrared camera can be adjusted from the outside through the gear ring without changing the position of the camera. The cost- and license-free software allows for an uncomplicated parameterization, for example the definition of the LineScan line, from the computer. Installation at the installation site is thus reduced to a minimum.

The folding mechanism of the air purge enables the inspection of the protective window and the camera optics without disassembly. The manual focus through the integrated ring remains unchanged.

Flexible air purge for the protection from dirt

In harsh environments, the airflow in front of the CoolingJacket has proven to be just as critical for reliable and accurate temperature measurement as the cooling itself. The air purge unit optimizes this airflow and allows both orthogonal (left) and parallel (right) airflow.



Forther information an technical details on the Air Purge as well as the CoolingJacket are available at

www.optris.global/accessories-infrared-cameras

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