



GLASS INDUSTRY SOLUTIONS

Non-Contact Temperature Sensors for Improved Process Monitoring and Greater Efficiency

IMPAC Pyrometers & MIKRON Thermal Imagers

LumaSense offers a broad selection of solutions for glass production:

- Solar glass and flat glass
- Container glassware
- Glass wool
- Technical glass

Successful process optimization through non-contact temperature measurements

Temperature measurement is key to the monitoring and optimization of energy-intensive glass production processes. Careful monitoring of glass temperatures and of production equipment and machinery is the only way to ensure that product quality will meet the stringent marketplace requirements.

Temperatures during the various production stages are mostly measured without contact, e.g. in the glass melting furnace, in the working tank, in the feeder or in the gob.

The principal advantages of non-contact measurements are:

- Easy handling
- Increased throughput rates
- Fast response
- High flexibility
- Prolonged service lives
- No contamination of the molten glass

Digital measuring equipment with compact electronic components guarantees fast and precise temperature measurements and excellent repeatability.

LumaSense Technologies, Inc., offers more than 50 years of experience in non-contact measuring technologies with two product lines:

- IMPAC for pyrometry
- MIKRON for thermal imaging

Choose from a wide range of non-contact thermometers whose ruggedness and precision are tailored to the specific needs of the glass industry.

Whether it be for flat glass or solar glass, container glassware, utility glassware, or technical glass, all of our products deliver fast and accurate temperature readings. Customers receive optimum solutions to their specific challenges through intensive consultation with our sales and application engineers.

We deliver promptly to ensure swift integration with your production process.



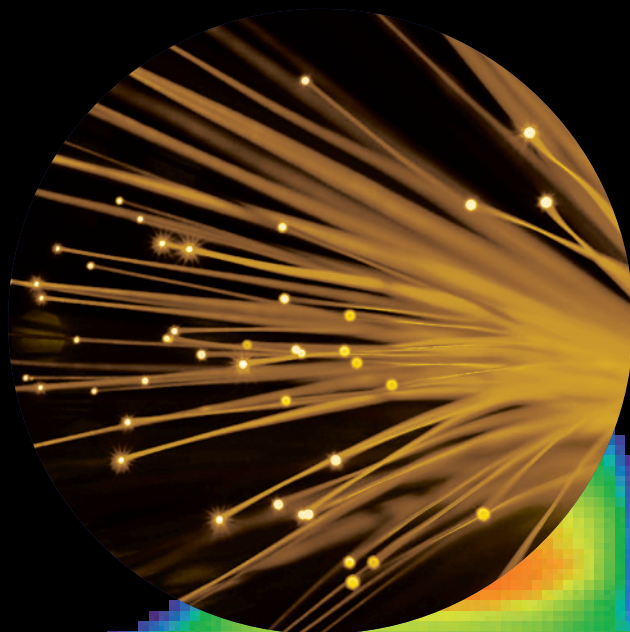
Solutions for

Flat glass and solar glass

e.g. for the architectural and automotive sectors

Thin and thinnest sheet glass

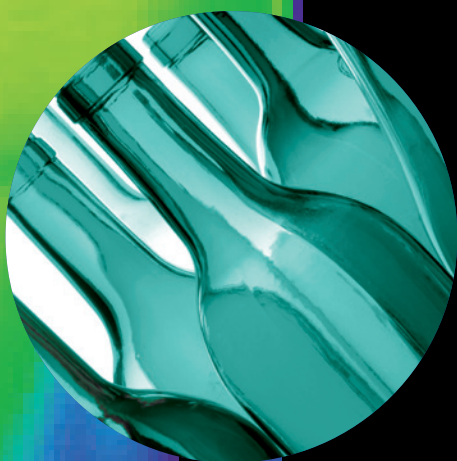
e.g. for smart phones, tablets, flat panel displays, solar panels and safety glass



Solutions for

Technical glass

e.g. lamps, lightbulbs, energy saving lamps and tubes, optical glass fiber, glass wool, and optical instruments



Solutions for

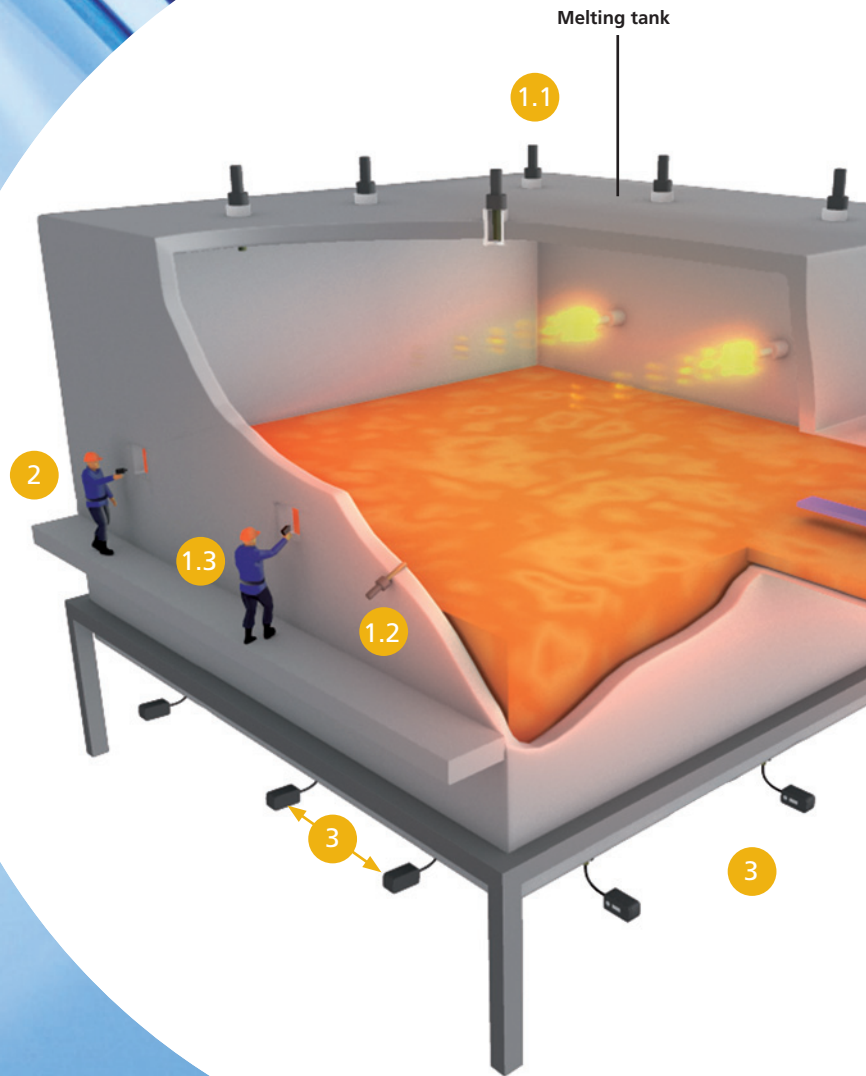
Container and utility glassware

e.g. for bottles, containers and drinking glasses

Reliable temperature measurement in the melting tank

Materials and measuring equipment in melting tanks are exposed to exceedingly high temperatures and are subject to heavy wear.

LumaSense's product lines include highly ruggedized sensors with appropriate high temperature accessories, made from sturdy ceramic or inonel materials, for example, to offer optimum temperature monitoring in the harshest conditions.



1

Process stage

Checking the roof temperature

Challenges

Ensure the stability of the roof through temperature measurements in this area.

Wear-resistant temperature measuring systems delivering continuous, reliable data.

LumaSense's solution

Rugged fixed-installation instrument with closed ceramic or inonel tube or a handheld precision instrument.

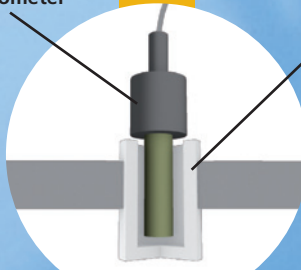
See set-ups 1.1) - 1.3)

Customer benefits

Avoiding glass runout due to refractory failure and high costs resulting from loss of production.

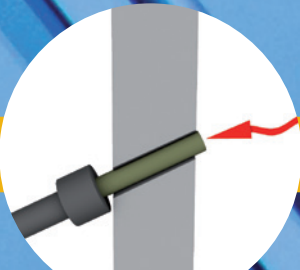
Pyrometer

Closed ceramic or inonel tube



1.1

Set-up 1.1) Roof-mounting, Ref.*: Series 6 or Series 50-LO plus with closed ceramic or inonel tube



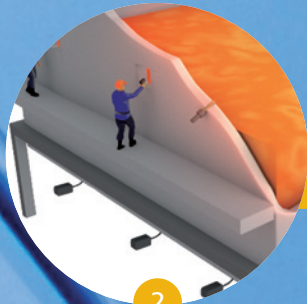
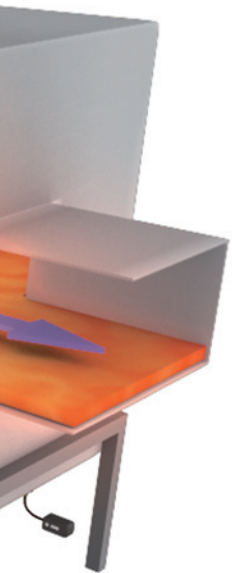
1.2

Set-up 1.2) Fixed installation pyrometer Ref.*: Series 50-LO plus with open-ended ceramic or inonel tube



1.3

Set-up 1.3) Mobile inspection, Ref.*: Series 8



2

Set-up 2) Mobile inspections by service staff, Ref.*: Series 8 for end-wall temperature

2

Process stage

Monitoring of end-wall temperature

Challenges

Continuous measurement of end-wall temperatures for early detection of potential refractory failures.

LumaSense's solution

Robust handheld instrument with through-the-lens sighting for direct readings, high grade optics for detection of contours, and ultra-small measuring spots.

See set-up 2)

Customer benefits

Flexible inspection capabilities to monitor critical areas and prevent dangerous refractory failures at the end wall.

3

Process stage

Monitoring of tank bottom temperature

Challenges

Early detection of elevated temperatures in the bottom area of the melting tank caused by erosion of the refractory lining.

LumaSense's solution

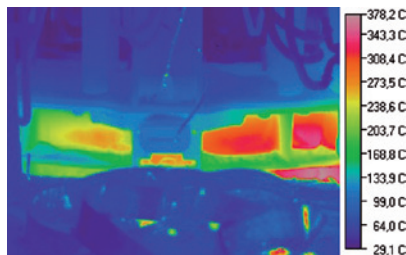
Thermal imager for inspection of the melting tank bottom. By continuously monitoring surface temperature, the condition of the bottom refractory can be calculated and monitored, which enables the prevention of unexpected early failure.

See set-up 3)

Customer benefits

Early detection of wear in insulation materials allows you to schedule corrective maintenance activities.

Prevention of glass runouts through the tank bottom and of resulting stops in production with the high costs they entail.



Thermal image example

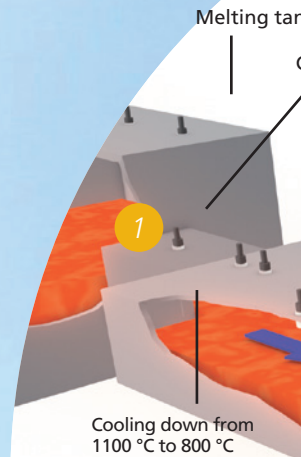


3

Set-up 3) Fixed-installation instruments at multiple locations, Ref.*: thermal imaging, Series 520

Homogenous temperature distribution in flat glass production

Considerable mechanical stresses may develop in the glass as it cools down. LumaSense supplies proven pyrometers and thermal imagers which enable optimum monitoring and control of the cooling rate of flat glass.



1

Process stage

Review of the glass temperature in the canal

Challenges

The glass discharged by the melting furnace must have a minimum temperature of 1100 °C before it enters the glass bath.

LumaSense's solution

A configuration with a long fiber optic cable and open-ended ceramic or inconel tube as radiation shield.

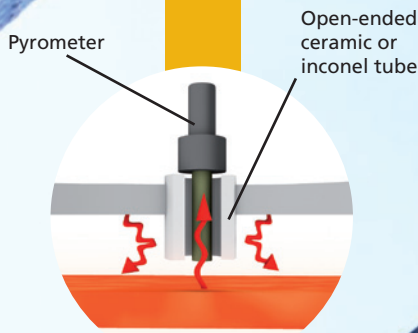
See set-up 1)

Customer benefits

Reliable adjustment of correct starting temperature for the complete downstream process.

Adjustment of glass flow rate via its viscosity.

Cost reductions through closed-loop temperature control within tight tolerances.



1

Set-up 1) Ref.*: Series 50-LO/GL with open-ended ceramic or inconel tube

2

Process stage

Measuring temperature distribution in the heating zone of the tin bath

Challenges

Ensure the requisite temperature distribution in the molten glass contained in the tin bath.

LumaSense's solution

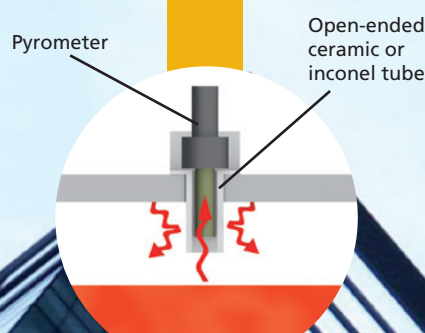
a configuration with an open-ended ceramic or inconel tube to shield the sensor against interfering radiation and to ensure the repeatability of readings.

See set-up 2)

Customer benefits

Reliable implementation of correct cooling rates and closed-loop control of heat input.

Cost reductions through optimized use of energy.



2

Set-up 2 Ref.*: IPE 140/39

3

Process stage

Measuring surface temperatures in the annealing lehr

Challenges

Relieve all mechanical stresses induced in the glass before further processing and packing.

Process optimization through closed-loop control of the heating elements in the annealing lehr.

LumaSense's solution

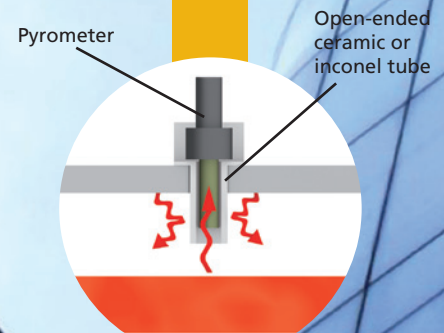
Proven pyrometers with rugged sensors and a flat glass calibration feature tailored to the specific mounting conditions and ambient radiation.

See set-up 3)

Customer benefits

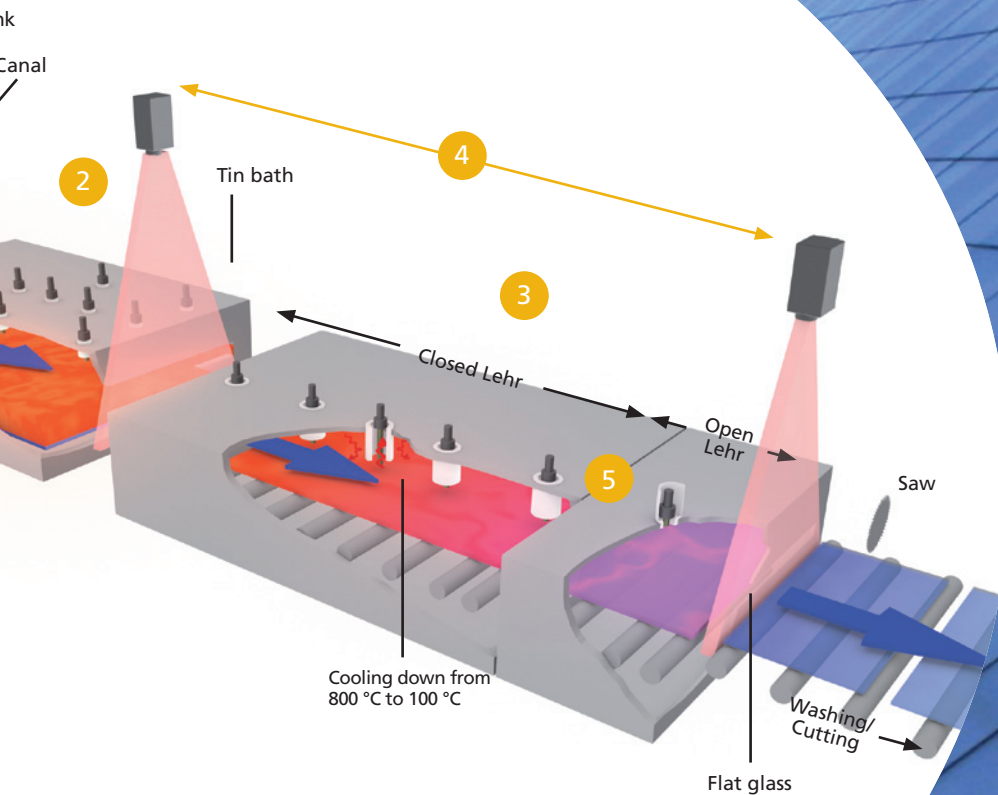
Closed-loop control of heating elements with accurate acquisition of flat glass temperature.

Quality assurance and efficient use of energy.



3

Set-up 3) Ref.*: Series 5/5 and 210/5 incl. special flat glass calibration and for ultra-thin glass sheets: IN 6/78-L



Process stage

Measuring the temperature distribution across the flat glass ribbon

Challenges

Ensure homogeneous temperature distribution in the ribbon as the flat glass leaves the working tank.

LumaSense solution

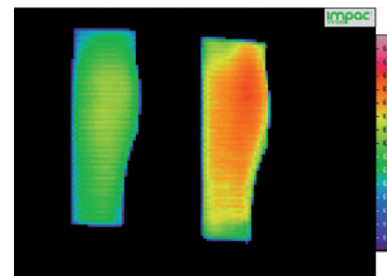
Thermal imagers for fast and full coverage temperature acquisition across the entire width of the flat glass ribbon.

See set-up 4)

Customer benefits

Rapid visualization of temperature distribution by means of thermal imaging software for easy, manual readjustment of heat input.

Automatic alarming when limit values are exceeded.



Thermal image of two glass panes

Process stage

Monitoring of annealing lehr discharge temperature

Challenges

Ensure the requisite glass temperature after the cooling phase.

LumaSense's solution

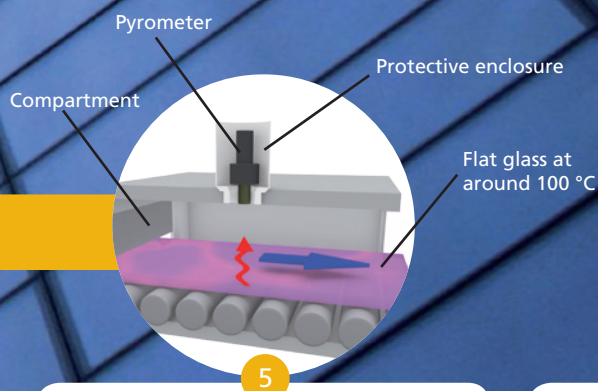
A reliable low-temperature pyrometer in a stainless steel protective enclosure. Rugged two-wire system with analog signal transmission.

See set-up 5)

Customer benefits

Observance of correct material cooling rate for production of flat glass with few internal stresses.

Prevention of glass breakage due to thermal shock on entry into normal atmosphere.

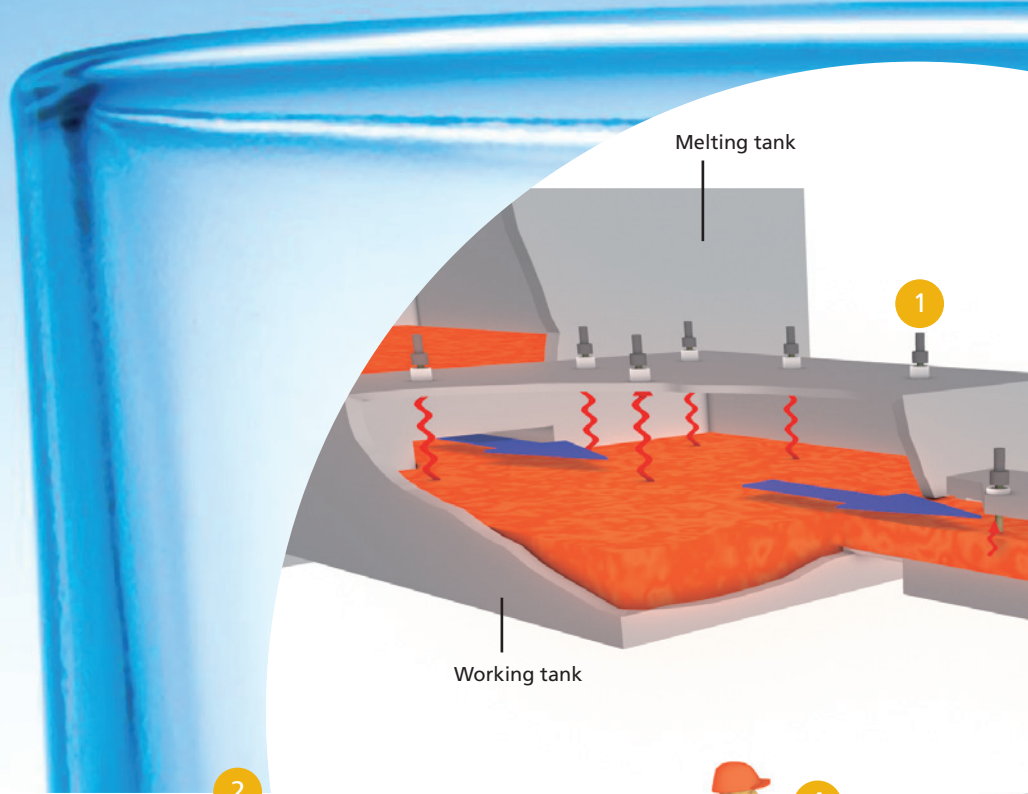


Set-up 5) Ref.*: Series 5/5 incl. special flat glass calibration and protective enclosure

Set-up 4) Ref.*: Thermal imaging

Optimized forming and energy efficiency in container glass production

In the production of container glassware, closely controlled temperatures are key to shaping the glassware and to achieving energy savings. LumaSense's pyrometers and thermal imagers facilitate the adjustment of the temperature distribution and closed-loop control of the feeder temperature.



1

Process stage

Measuring the temperature distribution in the working tank

Challenges

Ensure homogeneous temperature distribution in the molten glass exiting the working tank.

Optimum adjustment of the temperature profiles in material flow direction.

LumaSense solution

A configuration with an open-ended ceramic or inconel tube to shield the sensor against interfering radiation and to ensure the repeatability of readings.

See set-up 1)

Customer benefits

Reliable implementation of correct cooling rates.

Adjustment of glass flow rate via its viscosity.

Cost reductions through optimized use of energy.

2

Process stage

Measuring the temperature gradient in the feeder

Challenges

Continuous measurement and control of the material flow.

Minimized energy costs in the heating process.

LumaSense solution

Proven application packages featuring high measuring accuracy, excellent repeatability and long service lives.

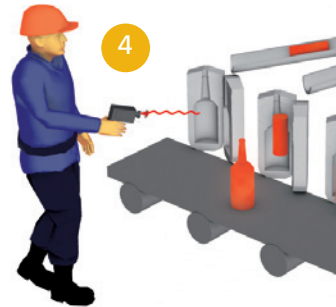
See set-up 2)

Customer benefits

Quick installation thanks to easy and reliable integration of components.

Optimized use of energy and adjustment of glass flow rate.

4



3

Process stage

Measuring the gob temperature

Challenges

Ensure the desired container wall thickness via the core temperature of the gob.

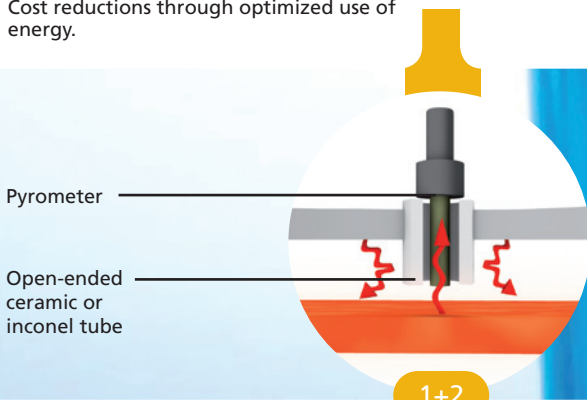
LumaSense solution

Rapid ratio pyrometer with small measuring spots.

See set-up 3)

Customer benefits

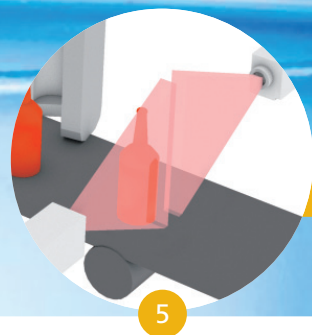
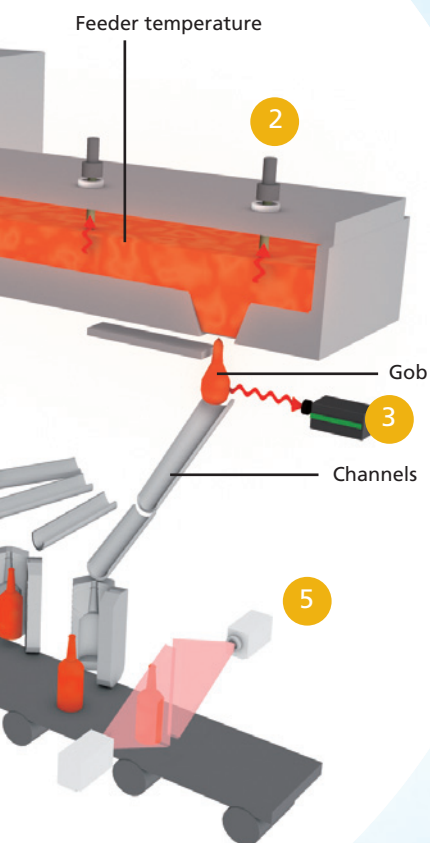
Reliably achieving the correct gob temperature prior to the next step in the process (IS machine).



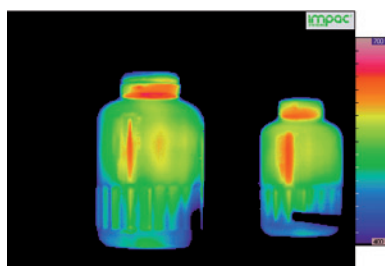
1+2

Set-up 1) Ref.*: Series 50-LO/GL with open-ended ceramic or inconel tube

Set-up 2) Ref.*: Series 50-LO/GL with ceramic or inconel tube



Set-up 5) Ref.*: Thermal imaging



Process stage

Final check and control of material distribution

Challenges

Save raw materials with a view to optimizing energy efficiency throughout the complete forming process.

LumaSense solution

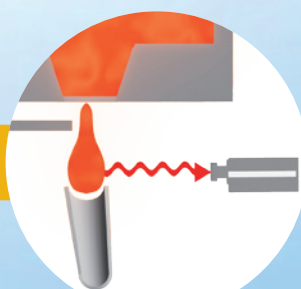
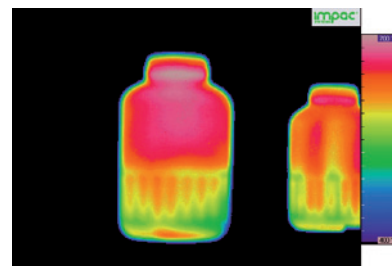
High resolution thermal imager with a spectral filter for glass surfaces and image processing software for automatic detection of defects.

See set-up 5)

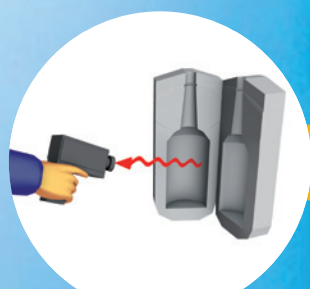
Customer benefits

General optimization of moulds through visualization of glass wall thicknesses and localization of thin container walls.

Automated mould parameter set-up through optional coupling of the system to the PLC for data correlation.



Set-up 3) Ref.*: Series 6 including protective enclosure



Set-up 4) Ref.*: Series 15 (portable) or Series 6 (stationary)

Process stage

Measuring the mould temperature inside the IS machine

Challenges

Precise control of the air flow rate used for blowing and adjustment of the temperature distribution in the water-cooled mould. This forms the gob of glass into the desired shape with the requisite wall thickness.

LumaSense solution

Portable pyrometer for mobile inspections or fixed installed pyrometer.

See set-up 4)

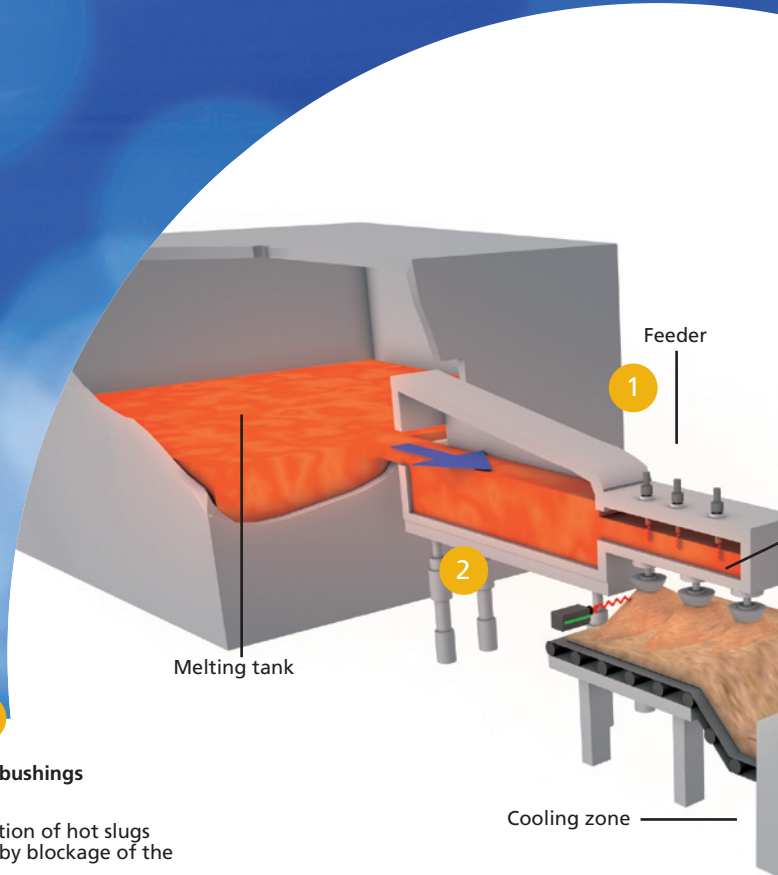
Customer benefits

Optimum uniformity of container wall thickness.

Optimum adjustment of coolants.

Glass wool manufacture

In the manufacture of glass wool, slugs may be produced in the spinning and rotating processes which are then embedded in the glass wool. Such hot slugs may ignite spontaneously in unfavourable conditions, for example during shipping from the production plant to a warehouse.



1

Process stage

Measuring the temperature distribution in the forehearth

Challenges

Ensure optimum properties of the molten glass for the subsequent process steps.

LumaSense solution

A configuration with an open-ended ceramic or inconel tube to shield the sensor against interfering radiation and to ensure the repeatability of readings.

See set-up 1)

Customer benefits

The correct cool-down rate is ensured.

Adjustment of glass flow rate via its viscosity.

Cost reduction through optimized use of energy.

2

Process stage

Checking the spinner bushings

Challenges

Detection and prevention of hot slugs which may be caused by blockage of the bushings.

LumaSense solution

A high speed pyrometer for detection of hot lumps. High-grade optics provide for a small measuring spot at large distances.

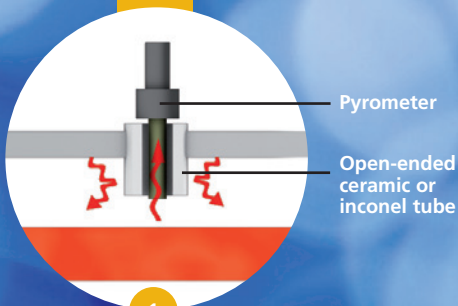
See set-up 2)

Customer benefits

Increased productivity.

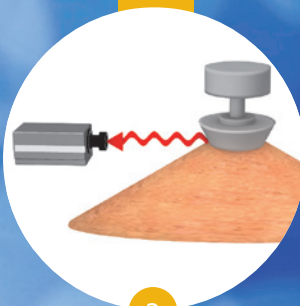
Improved reliability of the production process.

Prevention of costly complaints and returns of deficient batches.



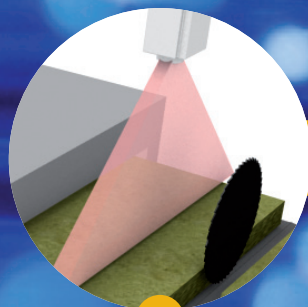
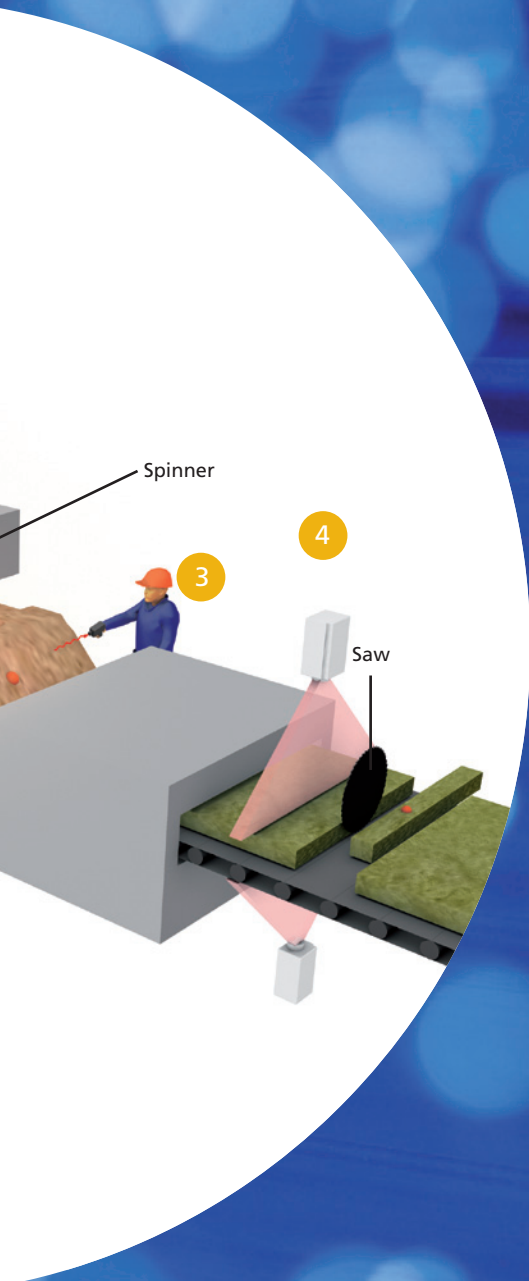
1

Set-up 1) Series 50-LO/GL with open-ended ceramic or inconel tube



2

Set-up 2) Ref.*: Series 12 or Series 140



Set-up 4) Ref.*: Thermal imaging

3+4

Process stage

Detection of slugs at the exit of the curing oven

Challenges

Protection of the products by detection of hot glass slugs and resulting smouldering pockets.

LumaSense solution

Fixed-installation thermal imagers for detection of glass slugs as hot spots.

See set-up 4)

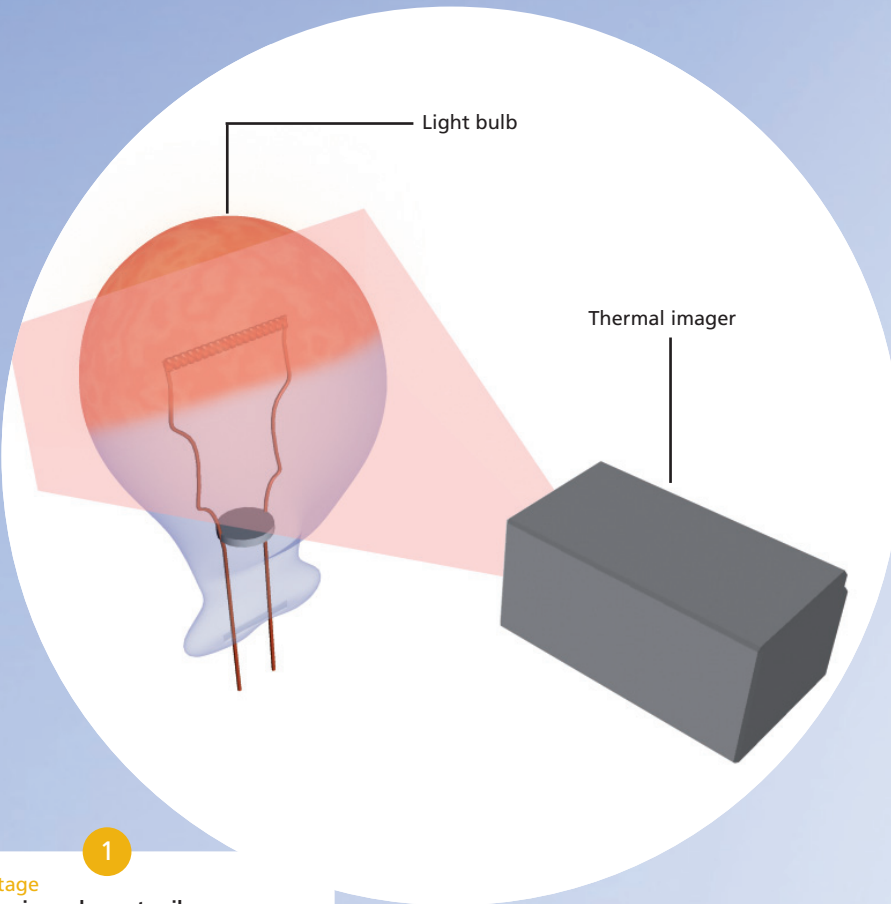
Customer benefits

Potential compactions in the material are detected early to ensure safe storage and shipment of the goods.

Quality assurance in the production of technical glass

The manufacture of technical glass is subject to particularly stringent quality requirements. The only way to achieve the desired quality and required service life of the product is to observe very close tolerances with regard to material temperatures throughout the entire process.

Pyrometers and heat imagers from LumaSense Technologies are highly accurate temperature sensors and fulfil all prerequisites for successful compliance with quality requirements.



1

Process stage Measuring incandescent coils

Challenges

Optimization of temperature distribution in the incandescent coil.

LumaSense solution

A fixed-installation thermal imaging system designed to measure very high temperatures on metals.

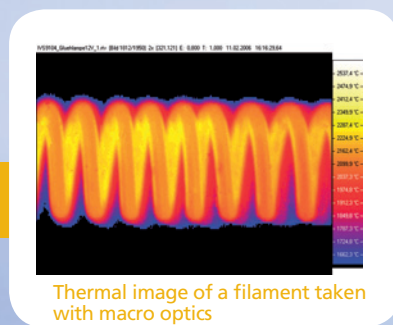
Real-time thermal imagery of temperature distribution and comprehensive data analysis and reporting features.

See set-up 1) Ref.*: Thermal imaging

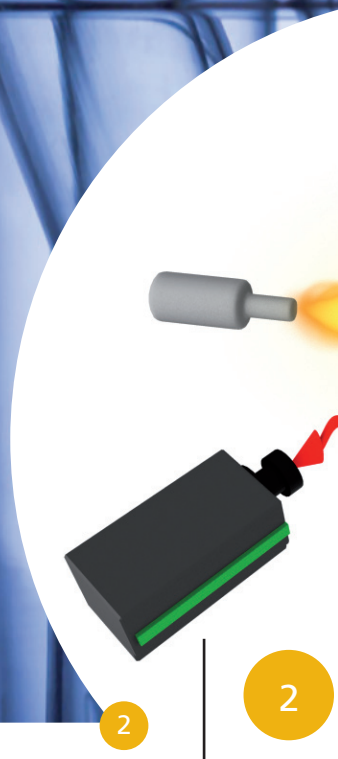
Customer benefits

Precise temperature measurements during the development phases of lamps and luminaires enable you to optimize material properties and performance parameters.

This helps to considerably improve the service lives of series production articles.



Thermal image of a filament taken with macro optics



2

Process stage Rotary blow-moulding machine

Challenges

Optimized efficiency of gas burners and reliable adjustment of requisite material temperature.

LumaSense solution

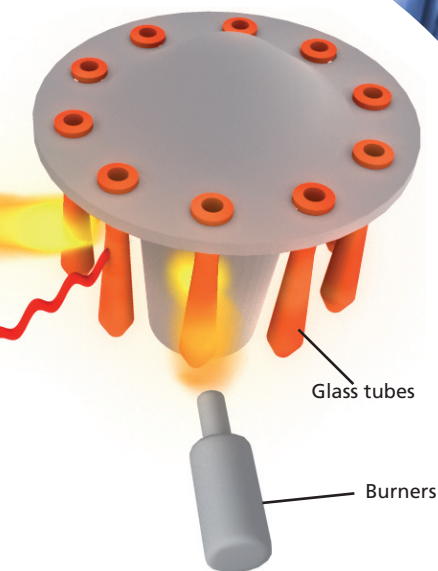
Measuring the glass temperatures between the heating stages.

See set-up 2) Ref.*: Series 140

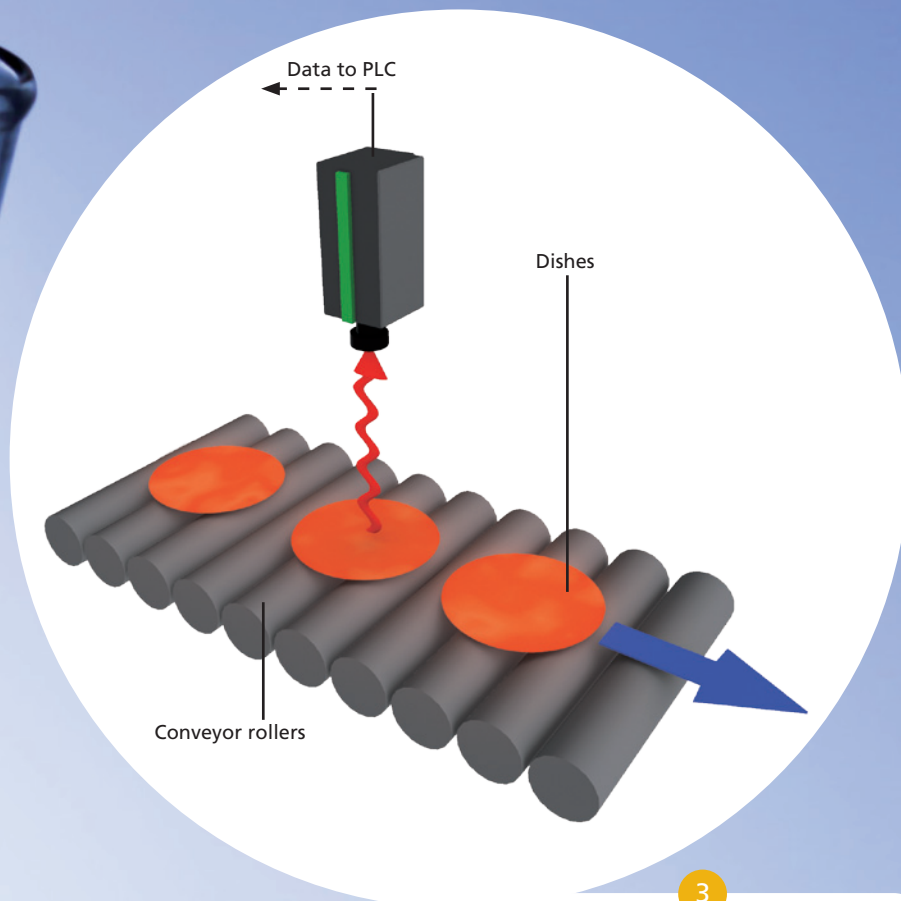
Customer benefits

Indirect measurements for optimized burner efficiency and precise closed-loop control of glass temperatures.

One key aspect of this solution is that gas consumption is optimized and energy costs are cut.



-- ➔ Data to PLC



3

Process stage

Measuring the temperature of glass dishes before entering the cooling lehr

Challenges

The temperature of the dishes must be measured to guarantee the desired material properties.

LumaSense solution

Pyrometers for rapid data acquisition with small measuring spot and reliable data transfer. The use of a fast measuring instrument allows you to scan a large number of measuring points on the dish as it passes on the conveyor.

See set-up 1) Ref. *: Series 140

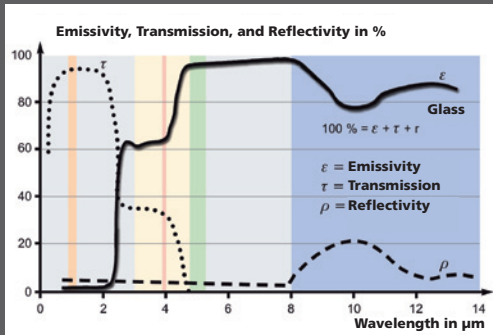
Customer benefits

Optimized use of energy in the forming process and monitoring of dish temperatures.

Featured Products

Our product lines include virtually hundreds of different non-contact temperature measuring instruments to suit nearly every industrial application. On the basis of our long-standing experience in this field we have developed a wide range of high-end products specifically for the glass industry.

Emissivity of Glass in the Infrared Spectrum



Spectral filters for glass surfaces

The emissivity of glass is determined by wavelength regions in which electromagnetic radiation:

- mostly passes through the material (transmission)
- is almost totally absorbed (absorption)

The temperature is best measured inside the absorption bands, as glass is impenetrable to infrared radiation in these regions.

Wavelength region for surface temperature measurements:

- 5.14 μm for glass thicknesses of 1 mm and more, at medium to high temperatures
- 7.75 μm for glass thicknesses less than 1 mm at low to medium temperatures

Spectral responses around 3.9 μm and 1 μm will enable you to measure temperatures with a glass-specific penetration depth (depending on material).



Series 5/5

Robust, compact pyrometer series for glass surface temperature measurements

- Available temperature ranges from 100 to 2500 °C
- Available with special calibration for Flat Glass
- Laser aiming (plus versions)



Series 50-LO/GL

Digital infrared thermometer with fiber optic cable for industrial use

- Measuring ranges between 600 and 1800 °C (adjustable on the instrument)
- High measuring accuracy and repeatability
- Comprehensive accessories and extremely rugged versions with integrated air purge available
- Fiber-optic cable with add-on optics rated and dimensioned for ambient temperatures up to 250 °C
- Laser aiming installed as a standard feature



Series 6

Robust digital pyrometer series for various materials and processes

- Available temperature ranges from 50 to 3000 °C (depending on model)
- 2-color ratio pyrometer for temperature measurements widely independent of emissivity (ISR 6 Advanced)
- Optional through lens sighting, laser targeting or integrated color TV module (depending on model)
- Special model for measurement of ultra thin glass sheets available (IN 6/78-L)



Series 50-LO plus

Pyrometer with fiber optics for medium to high temperatures

- Very fast and accurate measurements
- Various optical heads available
- Extremely small spot sizes (min. 0.45 mm)
- Fiber optic cable and optics designed for ambient temperatures up to 250 °C
- Laser aiming installed as a standard feature



Series 520

Digital infrared pyrometers with temperature-resistant miniature sensor head (for up to 180 °C)

- Parameter set-up on the instrument or via PC
- Measuring ranges between -40 and 700 °C
- Optics with wide measuring spots for short distances
- Optional close up lens for small objects
- Sensor head replaceable without need for re-calibration
- Integrated analog output, switching contact and interface for data exchange with PC



Series 8

Rugged, high-end handheld units for medium to high temperatures

- Easy to use
- Very fast and accurate measurements, including maximum value storage
- Measuring ranges between 250 and 2500 °C
- Very small measuring spots, even at large distances
- Integrated through-lens sighting with projection of temperature or emissivity reading
- Data memory and PC interface



Series 15

Portable, low-cost pyrometers for measuring tasks involving low to medium temperatures

- Easy to use
- Fast and accurate measurements
- Add-on optics for different measuring spot sizes
- Measuring ranges between 250 and 1800 °C
- Laser aiming and illuminated display
- Integrated data memory and PC interface



Series 140

Compact, highly accurate, fast digital pyrometers with variable focusing optics and integrated display

- Parameter set-up on the instrument or via PC
- Very fast and accurate measurements
- Measuring ranges between 5 and 3300 °C
- Very small measuring spots, even at large distances
- Integrated through-lens sighting or laser aiming or TV module (depending on model)
- Integrated real-time data interface
- Special versions available for glass production



Series 12

Extremely rugged industrial pyrometer for fixed installation in harsh environments

- Parameter set-up on the instrument or via PC
- Very fast and accurate measurements
- Measuring ranges between 200 and 3500 °C
- Very small measuring spots, even at large distances
- LED display, through-lens sighting and optional laser aiming light
- Integrated real-time data interface
- Special versions with integrated scanner available



Thermal imager series

Thermal imagers for fixed-installation cameras for process quality monitoring

- Temperature ranges between 40 and 500 °C, optionally up to 3000 °C
- Application-specific wavelength
- 5 to 60 frames per second, depending on the model
- User-friendly analysis programs and report generators (offline) as well as analysis and process software (online)

Harnessing the Power of Your 6th Sense

Six Simple Steps to the 6th Sense

LumaSense LS⁶ Systems equip our customers in Global Energy, Industrial Materials, and Advanced Technologies with "predictable efficiency" using our LS⁶ Systems, LumaSpec™ software, and purpose-driven 6th Sense Process Methodology.

LumaSense illuminates our customers' core generation, materials, and manufacturing processes with an invaluable 6th Sense to help detect, reduce, and ultimately prevent inefficiencies and unnecessary waste of energy,

materials, and human capital. Utilizing this 6th Sense, resource-intensive global companies can hone their competitive edge at massive scale and directly improve their bottom line.

The 6th Sense is the power of perception beyond the five senses. Some refer to it as intuition, others say it is the ability to understand the subtle cause and effect relationship behind many events. LumaSense Technologies provides the sensors and solutions that awaken this 6th Sense in customers to allow them to efficiently optimize their processes.

OUR UNIQUE 6TH SENSE METHODOLOGY



Upon completion, LumaSense customers gain an inexorable "6th Sense" that delivers immediate gains and progressive performance.

LumaSense Technologies

Americas and Australia
Sales & Service
Santa Clara, CA
Ph: +1 800 631 0176
Fax: +1 408 727 1677

info@lumasenseinc.com

LumaSense Technologies, Inc., reserves the right to change the information in this publication at any time.

Europe, Middle East, Africa
Sales & Service
Frankfurt, Germany
Ph: +49 69 97373 0
Fax: +49 69 97373 167

India
Sales & Support Center
Mumbai, India
Ph: +91 22 67419203
Fax: +91 22 67419201

China
Sales & Support Center
Shanghai, China
Ph: +86 133 1182 7766
Fax: +86 21 5877 2383

Awakening Your 6th Sense

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