White Paper

How to optimize measurement performance of infrared pyrometers and thermal imaging cameras

There are many factors to consider when selecting a non-contact thermal measurement device. While emissivity and wavelength are crucial when measuring the temperature of specific materials or objects, other factors such as ease of set up, integration capabilities and compactness are equally important.

Thermal imaging cameras and infrared pyrometers measure the temperature of an object without touching it. It is therefore possible to perform fast, reliable temperature measurements of moving objects or components that cannot be touched. Not only are these infrared measurement devices now relatively inexpensive, they also offer numerous features and options, including software tools to simplify integration for process control and high speed recording for R&D environments. It is now also possible to select sensors and imagers that operate at specific wavelengths for particular materials, such as metals, ceramics and glass.

Infrared sensors are available with various options: laser aiming, video interface or compact design with integrated controller

The Infrared Temperature Measurement System

Each body with a temperature above the absolute zero (-273.15°C = 0 Kelvin) emits an electromagnetic radiation from its surface, which is proportional to its intrinsic temperature. A part of this so-called intrinsic radiation is infrared radiation, which can be used to measure a body's temperature. This radiation penetrates the atmosphere. With the help of a lens (input optics) the beams are focused on a detector element, which penetrates an electrical signal proportional to the radiation. The signal is amplified and, using successive digital signal processing, is transformed into an output signal proportional to the object temperature.

The measuring value may be shown in a display or released as analogue output signal, which supports an easy connection to control systems of the process management.

Advantages of non-contact temperature measurement

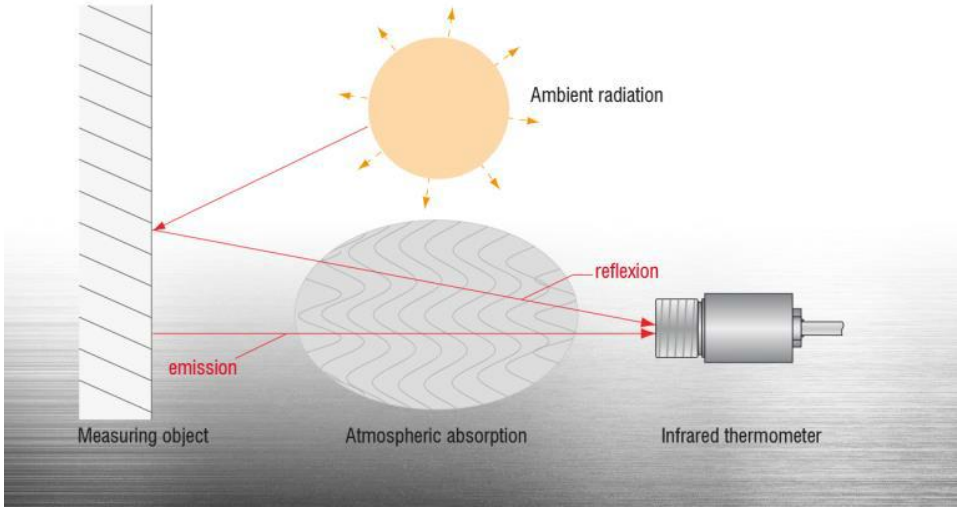
- Temperature measurements of moving or overheated objects and of objects in hazardous surroundings
- Very fast response and exposure times
- Measurement without inter-reaction, no influence on the measuring object
- Non-destructive measurement
- Long lasting measurement, no mechanical wear

Key parameters emissivity and wavelength

For accurate temperature measurement, users must carefully consider two key parameters: emissivity and wavelength.

Emissivity

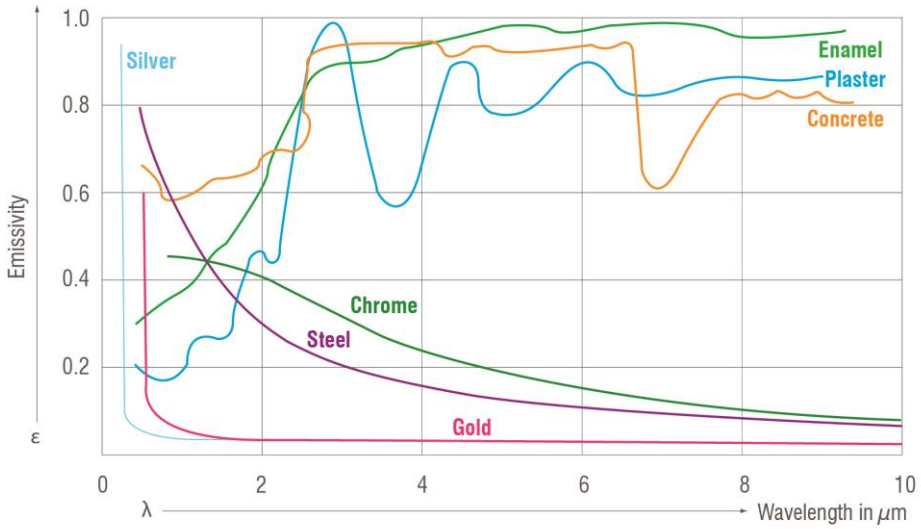
All bodies above absolute Kelvin (-273°C) emit infrared radiation in three ways, via a combination of emitted radiation, radiation reflected from the surroundings, and by transmitting the radiation through itself. How these factors interact depends on the material of the object to be measured. However, for non-contact infrared temperature measurements, only the emitted radiation element is important.



Three ways of emissivity

The relationship of the emission types to each other is best described in the following way. If at any given temperature, the sum of the radiation of the three emission types is equal to one, and it is assumed that solid bodies transmit negligible radiation, the transmitted element can be treated as zero. Therefore, the heat energy coming from an object only comprises emitted and reflected radiation.

This is why objects such as polished and shiny metals can only have a low emission, or emissivity, as radiation from the surrounding environment is strongly reflected (and so proportionally high) from these surfaces.

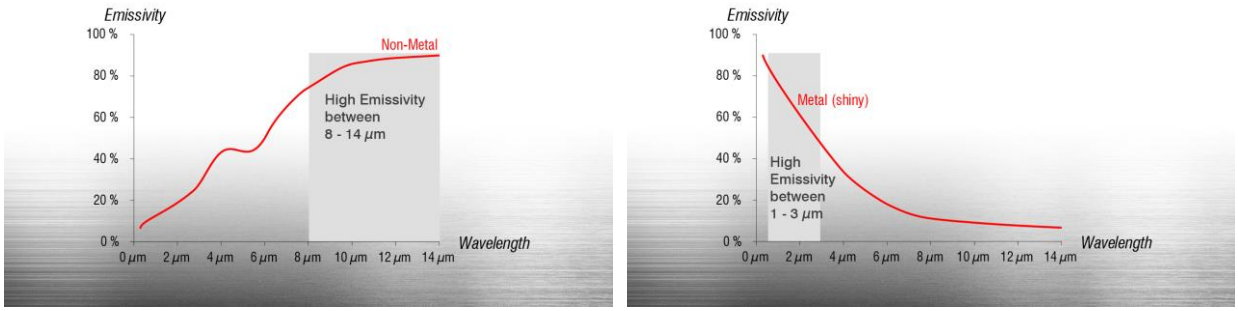


Emissivity for non-metals and metals

Wavelength

The emissivity of an object, however, will be greater or lower when monitoring the radiated heat energy at different wavelengths. Therefore, using IR cameras and pyrometers that measure temperature at specific wavelengths that match the high emissivity of specific materials can significantly increase measurement accuracy and stability.

Today, around 80% of IR pyrometers and cameras on the market operate over the wavelength band of 8-14µm, which means these devices are only giving accurate and stable measurement on objects with high emissivity in this wavelength band. These are generally objects with matt surfaces. Metal or shiny surfaces cannot be measured accurately using devices that operate at the 8-14µm wavelength band.



Wavelengths of non-metals and metals

When selecting a suitable device, it is therefore vital that the wavelength band over which it measures is known and is best suited to the object to be measured. The object emissivity values over this wavelength and the temperature range to be measured must also be known or calculated. If the supplier doesn't have a specific wavelength camera or IR sensor for the material you need to measure, find one that does.

IR cameras and sensors for manifold applications

Micro-Epsilon has developed a complete range of IR cameras and temperature sensors for almost every conceivable target material. Specific wavelength sensors and cameras for measuring the temperature of hot metal surfaces or glass products (including very thin solar panel glass) and plastics, as well as devices for low temperature matt surfaces, are now available.

Thermal imagers and IR temperature sensors from Micro-Epsilon are fixed into position in a production process or R&D laboratory to monitor the temperature profile of target materials or objects. The cameras are designed for high speed, high accuracy measurements in process control, quality and R&D applications. In addition, a license-free, fully featured software is supplied as standard.

Micro-Epsilon's thermal imagers and IR sensors are suitable for manifold applications

The following criteria will help to find the optimal measuring device for your application:

1. Temperature Range

Choose the temperature range of the sensor as optimal as possible in order to reach a high resolution of the object temperature. The measuring ranges can be adjusted to the measuring task manually or via digital interface.

2. Environmental Conditions

The maximum acceptable ambient temperature of the sensors is very important. The CT pyrometer series from Micro-Epsilon operates in up to 250°C without any cooling. By using water and air cooling the measuring devices work in even higher ambient temperatures. Air purge systems help to keep the optics clean from additional dust in the atmosphere.

3. Spot Size

The size of the measuring object has to be equal to or bigger than the viewing field of the measurement device in order to reach accurate results. The spot diameter changes accordingly to the distance of the sensor. Compared to temperature sensors thermal imagers have a so called field of view (FOV), not just a point. Different exchangeable lenses are available for various measuring distances between camera and object. Thus, you can choose the optimal adjustment for your application.

4. Response Time of Infrared Thermometers

The response time of infrared sensors is very small compared to contact thermometers. They range between 1 ms to 250 ms, strongly depending on the detector of the device. Because of the detector the response time is limited in the lower range. The electronics help to correct and adjust the response time according to the application (e.g. averaging or maximum hold). Thermal imagers offer real-time thermography with a frame rate of up to 128Hz frame rate.

5. Interfaces for the Signal Output

The interface supports the analysis of the measuring results. The following interfaces are available:
Analog outputs 0/4 - 20 mA and 0 - 1/10 V
Bus, CAN and DP interfaces
RS232, RS485, USB

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