

Application Note

KEYWORDS

- Optical sensing
- Machine learning
- Industrial processing

TECHNIQUES

- Spectroscopy
- Multispectral sensing

APPLICATIONS

- Color measurement
- QA/QC
- Sorting and grading

Unlocking the Unknowns of Industrial Sensing

How Applied Spectral Knowledge
Delivers Decisive Results



Navigating today's industrial landscape is an ongoing challenge for manufacturers, with dynamic regulatory issues, emerging technologies and global competition placing a premium on innovation and creativity.

As a result, manufacturers seek better ways to manage their supply chains, reduce waste and off-specification product, and increase production yields. For some, even small savings and minor process improvements can be the difference between achieving success and building a strong brand or merely surviving and being an afterthought.

That's where optical sensing solutions like spectrometers, cameras and multispectral sensors come in. Ocean Insight offers robust, scalable sensing tools and deep application knowledge, design and manufacturing expertise to help customers unlock the unknowns of industrial applications. Machine learning and custom algorithm development capabilities add another layer of insight.

Why Choose Optical Sensing for Industrial Processing?

For the uninitiated, spectroscopy is the study of how light interacts with matter. Spectral measurements involve shining light onto or through a sample and capturing a spectrum that shows the wavelengths of light removed by the sample through absorption and scattering. With information on how specific wavelengths of light interact with samples on a process line, manufacturers can identify samples in real time through a spectral fingerprint or determine the chemical composition and concentration of the components.

Inline monitoring of industrial processes enables manufacturers to manage production from raw materials to finished products. Optical sensing measurements can be made at critical stages throughout the process, allowing for quick intervention when parameters go beyond specified ranges. A more tightly controlled process leads to less waste and more consistent product quality.

Spectroscopy is well suited for industrial environments, where a wealth of information can be derived from instrumentation that monitors raw stock, processes and finished goods. Non-contact, non-destructive spectral measurements are easily deployed across a production line for process monitoring and control in real time (**Figure 1**). Custom imaging systems can be integrated into process setups to extract high-contrast spectral information at visible and infrared wavelengths.

Here are some example applications:

- Color measurements to ensure uniform product appearance

- Consistency of glass or other coated products during the coating process
- Detection of defects in finished goods
- Digital display quality and consistency
- Endpoint detection for monitoring and controlling semiconductor processes
- Identification of contaminants and adulterants
- Identification of inbound raw materials and quality assurance of products
- Light intensity, color and quality measurement
- Monitoring of critical process parameters like oxygen, pH and moisture content
- Sorting and grading of products including fruit and vegetables
- Testing and qualification of samples



Figure 1. An advanced spectrophotometer like the FD-D8R is robust yet flexible enough to be mounted onto a robot arm for real-time, non-contact color measurements.

There's more. Flexibility in the selection of detectors, light sources and sampling optics allows for deeper implementation of instrumentation into process flows, and makes it much simpler to optimize setups for multipoint sampling and redundant sensing.

Also, digital tools like artificial intelligence and machine learning can be applied to massive data

sets or used for complex spectral analysis, providing users with real-time insight into sample quality, authenticity and other criteria.

Measurement Challenges in Industrial Environments

In challenging industrial environments, with round-the-clock process lines and often harsh operating conditions, optical sensing adds the capability to monitor and control the process line in real time. Maintaining accurate and repeatable data requires smart, rugged instrumentation that can be seamlessly integrated into the existing process line (**Figure 2**).



Figure 2. Optical sensing solutions are rugged, versatile and fast enough to monitor sample characteristics in high-speed industrial environments.

Circumstances that can affect measurements, such as wide temperature swings and the presence of dust and dirt, are addressed through rugged, industry-specific instrument design. The availability of inline process monitoring spectroscopy solutions empowers manufacturers to perform measurements continuously, eliminating the need to spot-check product offline.

Designing and implementing the optimum sampling interface is also critical to process line monitoring. For example, your choice of a sampling accessory for absorbance depends on various factors. Among the criteria to consider are the sample media (liquid or gas); the optical density of the sample; and whether the measurement will be made inline, at-line or off-line. For measurements in a process stream, you'll need a transmission dip probe or flow cell that can be immersed in the stream.

Other scenarios may suggest different components and methods. For example, with inhomogeneous samples such as grains and feed, "dynamic" sampling is used. Dynamic sampling is a technique where rotational or linear motion is used to measure an average (representative) signal. This removes localized variance from the results, improving measurements.

Another consideration in industrial environments is sample availability – i.e., to create a useful correlation between spectra, one needs three important elements:

- Enough samples from which to make meaningful correlations
- Sufficient variability within those samples
- Ground truth (direct observation) of the sample parameters (which often requires expensive lab tests)

With optical sensing tools and insight from Ocean Insight, customers are able to develop algorithms to derive various quality, grading and other parameters from their data.



Spectral Solutions for Industrial Applications

Ocean Insight offers a range of modular spectroscopy solutions to solve measurement challenges and provide answers, regardless of the environment:

- Compact spectrometers and spectral sensors, multispectral cameras and chemical sensors are ideal for inbound inspection of raw materials, deployment on a production line for process monitoring, or use in quality assurance labs or at-line testing.
- Integration options range from individual spectroscopy components (spectrometers, light sources, sampling accessories) to subsystems and turnkey solutions including custom software or drivers to communicate with production equipment.
- Algorithm development and machine learning provide another level of insight.

Modular spectroscopy components are reliable and robust with excellent performance in even the harshest environments. Typical sampling configurations include non-contact measurements of surfaces, flow cells to measure slip streams and dip probes placed directly into the process stream, enabling real-time data on process conditions and parameters.

Spectrometers designed for process monitoring have industrial connections and a range of communication protocols to interface with industrial equipment. Today's spectral systems perform accurately and reliably, providing data integrity for traceability and quality assurance to meet process analytical technology requirements.



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