How Fiber Optics Can Ensure Grain Quality, Keep Milk Safe, and Make Pretzels Crispy

Fiber optics offer a food-safe way to perform continuous spectroscopic analysis during every step of food production

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With a growing world population, more people depend on foods that have been cooked, frozen, mixed, dried, or preserved in some way. Urbanization and modernization in Latin America, increased consumer buying power in Asia, and limited agricultural production in the Middle East are all forecasted to increase demand for processed foods. Meanwhile, in Europe and the U.S., consumers are seeking out convenient ready-made meals and snacks that fit their busy lifestyles.[1]

When we purchase food at a grocery store, the steps it took to make a high-quality product are not obvious. Analytical techniques such as spectroscopy play a critical role in ensuring quality and safety for almost every stage of making a processed food. Spectroscopy is used to determine the chemical makeup of a food based on light transmitted through or reflected from a sample. The technique is based upon the fact that water, fat, proteins, and other components of food all have certain fingerprints in the visible and near-infrared portions of the wavelength spectrum that can be used to determine quality and check for contaminants.

Spectroscopic analysis can be used to measure the quality of ingredients arriving at a production facility and ensure milk remains safe throughout production. When a final baked good such as a pretzel is made, spectroscopy even ensures it is baked to the perfect color and crispiness and can also confirm that nutrition labels are correct.

Fiber optics made of lead-free glass offer a powerful, food-safe way to perform spectroscopy in the challenging environments involved in food production. By bringing light from a source to the sample and then focusing the light from the sample back to the spectrometer, fiber optics allow spectroscopic detection to be performed away from the food, keeping the spectrometer away from extreme temperatures and wet environments. Because fiber optics can withstand wet environments as well as hot and cold temperatures, they can be used for continuous measurements without requiring an operator to remove samples for analysis.

A CRISPY PRETZEL STARTS WITH QUALITY INGREDIENTS

Making a pretzel that not only tastes good but also cooks to a crispy texture and maintains a perfect shape starts with quality ingredients. Today, many grains and beans are purchased according to their protein content instead of weight or volume, with high protein indicating high quality. Spectroscopy performed at visible wavelengths can be used to determine the protein content of wheat or beans upon delivery. Fiber optics provide an easy way to incorporate spectroscopy into a pipe feeding wheat, for example, providing more flexibility in the design of a production line than if spectrometers were used for direct measurements. In addition, spectroscopy can measure color, which is useful for detecting and discarding bad nuts, for example.

Milk is another key ingredient in many baked goods. Throughout production, milk is monitored for its fat, protein, and lactose content and for any unwanted contaminants. Combining a spectrometer with fiber optics enables continuous measurements throughout the entire milk production process. This not only eliminates taking samples to the lab every so often for testing but also provides earlier detection of problems that could potentially spoil the milk.

Using fiber optics to separate the spectrometer unit from the milk also eliminates vibrations and temperature variations that would affect spectrometer readings. If a spectrometer was used directly in a milk line, the high pasteurization temperatures used to kill pathogens would not only affect readings but could also damage the instrument. However, a fiber probe can be placed directly into the milk stream for continuous monitoring even during pasteurization. This type of setup also eliminates weight or constructional limitations that would come with placing a spectrometer into the production setup because only a small fiber probe is used.

Spectroscopy can also detect inferior or harmful chemical substances in food, which is especially important in places where food adulteration is a problem. In India, detergent, caustic soda, urea, and paint are often added to milk to cut production costs to increase profit.[2] In 2008, there was a large food safety incident in China in which melamine was added to milk and infant formula to make it appear to have more protein. This led to a harmful protein deficiency in the formula and milk.[3]

When it comes to the final product, food manufacturers want to make sure every single pretzel is a golden brown and crispy. This can be challenging because spectrometers can’t withstand the high heat of an oven, and it would be time-consuming to take every pretzel or even a sample from each batch to a lab for analysis. A fiber probe can be used to take constant measurements right in the oven to check when the pretzel is the right shade of brown. This ensures the pretzels are cooked properly, which prevents food waste and lowers the cost of manufacturing.

CONSIDERATIONS WHEN INCORPORATING FIBER

A fiber-based system for spectroscopy can offer a great deal of design flexibility. Fibers fit through extremely tight spaces with very tight mechanical tolerances, allowing them to be easily incorporated into almost any food production setup as well as the spectrometer itself. Customized components and fiber optic assemblies are also available to add even more capabilities to a fiber spectroscopy design. For example, a cross-section converter can be used to transform a fiber bundle that is round at the sample end into a line that matches the geometry of the spectrometer’s detector.

In addition, multiple fibers can be used to direct one illumination source into multiple areas and to feed multiple light measurements into a single spectrometer. These types of setups enable measurements from different points in a food

production process and detection of multiple food components through different wavelength ranges. Using one spectrometer and one light source for multiple measurements saves money because there's no need to purchase multiple spectrometers and light sources.

Working with a glass and fiber expert with years of experience in numerous industries can ensure the system design meets your specific needs in a reproducible manner while also providing the highest-quality fibers. High-quality glass as well as glass expertise are necessary to create fibers that maintain a high transmission over the entire length of the fiber with very low color shift to ensure the accuracy of spectroscopic measurements.

Various materials such as plastic and metal can be used to cover fibers or fiber bundles to offer protection in a production environment. For example, certain sleeves can protect from high temperatures or sprayed liquids, while other sleeves are designed more for ruggedness. Different types of sleeves offer different degrees of flexibility, so it's important to work with an expert to determine the right balance between flexibility and protection.

With expertise in glass that transmits from the visible to near infrared, SCHOTT experts will listen to your needs and help you understand how fiber optics might benefit your food production process and setup. SCHOTT can collaborate on a design and then provide high-quality fiber and components in large quantities while also responding to very specialized needs.

In summary, fiber optics are streamlining food production from the arrival of ingredients to the final product, helping food makers save money and time while producing high-quality, safe products. Using fiber optics to keep a spectrometer away from the sample allows continuous analysis during food production even in challenging environments such as liquids or hot ovens. In addition, fiber can be easily incorporated into tight spaces and complicated food production setups to allow spectroscopic analysis without the need to take samples to a laboratory.

REFERENCES

1. *Global Processed Food Market Industry Analysis, Growth and Forecast 2018 – 2026, Coherent Market Insights*
2. *Indian milk widely "contaminated" with added substances, BBC News*
3. *International experts limit melamine levels in food (WHO)*

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