CUSTOMER SUCCESS STORY

Empa (Swiss Federal Laboratories for Materials Science and Technology)

Meeting Food Quality Criteria with Fruit-Sensing Technology Based on the iButton™

Fruit-sensing technology under development by Empa can help produce purveyors better manage quality of their shipments. Photo copyright: Empa

Empa, the Swiss Federal Laboratories for Materials Science and Technology, examines advanced materials and technologies. Headquartered in Switzerland, the research institute strives to bring together its applications-oriented research with the practical implementation of new ideas in areas such as nanostructured, smart materials and surfaces; environmental, energy, and sustainable building technologies; and biotechnology and medical technology.

Challenge

- Accurate temperature sensing in a tiny, durable form factor

Solution

- **DS1922L**

Benefits

- Enabled development of small, accurate, long-lasting temperature measurement technology with potential to enhance shelf life and quality of fresh produce, while reducing food waste and associated revenue losses

Dr. Thijs Defraeye from the institute's Laboratory for Biomimetic Membranes and Textiles works on cold-chain technology for postharvest applications. He and his team are developing a new fruit-sensing device that more accurately measures the pulp temperature of fresh produce in a more reproducible manner. Using this data, produce transporters can better monitor temperatures throughout the postharvest supply chain and identify possible problems. With their innovative technology, the researchers envision enabling produce purveyors to more easily meet food quality and safety guidelines, minimizing food waste and lost revenue.

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"For our purpose, the iButton is the perfect choice because it's so small, robust, and can be reused many times."

- **Dr. Thijs Defraeye**, Laboratory for Biomimetic Membranes and Textiles, Empa (Swiss Federal Laboratories for Materials Science and Technology)

Challenges

Fruits often travel a long way from the time they are picked to the time they are placed on store shelves. A fruit's core temperature is an important indicator of the quality of the fruit as this often is the last location that reaches the cooling air temperature. Attempting to measure fruit core temperature while the produce is shipped overseas at multiple locations in the refrigerated container cargo, the Empa researchers initially tried the approach of inserting temperature sensors inside some of the fruit by making incisions. It was, however, challenging to place sensors exactly in the core of the fruit, due to varying incision depths, and every fruit also had a slightly different size. It was also difficult to insert the instrumented fruit back into a palette, yet the choice of where to insert the sensors affected results. Fruit located closer to the outside of the palette is better refrigerated than fruit on the inside, which remains warmer.

Seeking a more elegant and standardized way to obtain fruit core temperature results throughout the entire cold chain, the researchers conceived of artificial fruits integrated with temperature sensors. The team figured out the average sizes and even shapes based on X-ray tomographies of different types of fruit. They also measured the thermal properties of different types of fruit. With this information, the researchers created plastic shells using a 3D printer and designed thermo-fillings with the same consistency as the pulp of various types of fruit, using a biomimetic approach. "The [artificial] mango even includes the seed," Defraeye noted.

For accurate temperature measurements, the researchers needed a small self-powered sensor that consumes little power, is easy to program, and features data logging.

Solution and Benefits

The Empa researchers found their sensor in the form of Maxim's **DS1922L iButton temperature logger**, highlighting these advantages:

- Wireless, standalone sensor/logger unit
- Small size (17mm diameter, 6mm thickness)
- Autonomy of up to several years, depending on logging intervals
- Available logging intervals that are relevant to cold-chain applications
- Robustness, with its durable stainless-steel casing
- Programming ease

"For our purpose, the iButton is the perfect choice because it's so small, robust, and can be reused many times" Defraeye said.

Evaluating the thermal responses during cooling of an artificial apple versus that of 10 real apples, the researchers found that the cooling time of the artificial fruit was within five percent of that of the real fruits. The artificial fruit can be reused over several years, given the long lifespans of the iButton, and the iButton is easily reprogrammable to provide data logging based on fruit type. "Retailers want to know the history of their fresh produce," said Defraeye, explaining that their fruit-sensing technology can provide these details accurately and cost effectively.

Looking ahead, Defraeye envisions researching how the technology could be applied to other perishable products, such as meat. Meantime, the researchers are seeking a partner to team up with in order to productize their fruit-sensing technology.

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