

Ensuring Food Safety Using SERS

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SERS Quantifies Toxic Melamine in Infant Formula

Application Note

Keywords

- Food contamination
- Melamine
- Infant formula

Techniques

- SERS
- Modular Raman spectroscopy

Applications

- Food safety testing
- Contaminant screening
- Trace level detection

In 2008, an estimated 300,000 babies became ill in China after being fed milk powder adulterated with melamine. Melamine is a flame-retardant plastic most often used in industrial products like plastics, adhesives, countertops, dishware and whiteboards. Though the addition of melamine to food is not approved by the World Health Organization's food commission, it was nevertheless added to watered-down milk to boost the nitrogen content. In doing so, manufacturers were able to fool tests designed to detect natural amino acids – tests to ensure that the protein content of milk products meets minimum acceptable levels for human consumption.

More than 20 companies were found to be adding melamine to their powdered infant formulas during the scandal, demonstrating how prevalent food fraud can become in an industry when it is economically motivated. Six infants died during the crisis, and more than 50,000 were hospitalized with symptoms of kidney stones, kidney damage and malnutrition. The crisis of confidence has resulted in a significant long-term decline in milk sales from the region, with severe economic impact to areas supported by the industry.



A modular SERS system like this can be configured for rapid, portable analysis of contaminants and is a convenient alternative to other screening techniques.

The scandal came on the heels of several incidents in 2007 in which melamine-contaminated wheat gluten and rice protein concentrate exported from China was used in the manufacture of pet food in the United States. A large number of dogs and cats died due to kidney failure as a result. Also, melamine has been discovered in eggs, possibly as a result of use in animal feed, spurring industry to investigate methods for its detection.

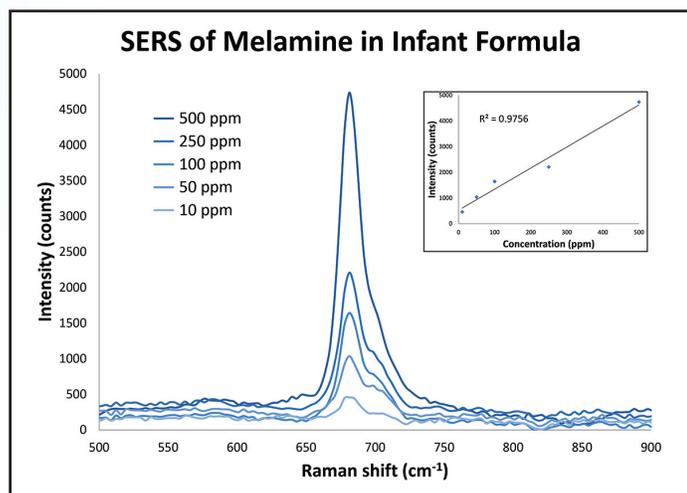
SERS Enables Sensitive, Direct Detection of Melamine in Infant Formula

Surface-Enhanced Raman Spectroscopy (SERS) offers a rapid, field-portable alternative to chromatographic and other screening techniques for

melamine and other contaminants. In SERS, analytes are adsorbed onto a silver or gold surface prior to analysis, boosting the Raman signal intensity by up to 100 trillion times. The use of solid-state substrates for SERS allows ppb-level detection of chemical and biological materials in the field, and is well suited to the detection of food contaminants at trace levels, including fungicides, pesticides and mycotoxins.

Highly sensitive and molecule-specific, SERS is capable of detecting the low ppb to ppm (trace) levels seen in contaminated milk products, with minimal sample preparation. We tested infant formula doped with melamine at several concentrations using our inkjet-printed SERS substrates. These substrates offer better performance than conventional substrates fabricated using lithography, at a fraction of the price. Both sensitive and specific, they are a cost-effective solution for testing food products throughout the supply chain.

Samples of infant formula spiked with known amounts of melamine were applied directly to our SERS substrates with no sample preparation. Each slide was measured using a 785 nm QE *Pro* modular Raman system, displaying a strong peak at ~680 nm attributable to melamine. Formula alone exhibits a variety of Raman peaks, and so measurements of unadulterated formula were stored as a "dark" or baseline reference and subtracted from each sample measurement.



Melamine spectra on inkjet-printed SERS substrates as a function of concentration in infant formula

The SERS peak at ~680 nm was seen clearly at levels ranging from 500 ppm down to 10 ppm. By plotting the peak height versus concentration, a calibration curve could be obtained with a good fit ($R^2=0.9756$), demon-

strating the suitability of SERS for quantitative measurements of melamine in infant formula. With additional testing and optimization of the measurement method, Ocean Optics SERS substrates offer an attractive alternative to expensive and time-consuming laboratory techniques for measurement of the 250 ppb limit of melamine allowed according to FDA regulations.

This is good news for consumers. Rapid, field-portable systems like SERS are part of the new wave of spectroscopy-based options for testing of food safety and quality throughout the supply chain, and represent our best line of defense against economically motivated food fraud. 🍌

References

1. "2008 Chinese Milk Scandal." Wikipedia. Wikimedia Foundation, n.d. Web. 24 Sept. 2015. <https://en.wikipedia.org/wiki/2008_Chinese_milk_scandal>.
2. "Questions and Answers on Melamine." WHO. N.p., n.d. Web. <<http://www.who.int/csr/media/faq/QAmelamine/en/>>.
3. "The New York Times." Melamine Traces Found in U.S. Infant Formula. The New York Times, 25 Nov. 2008. Web. <<http://mobile.nytimes.com/2008/11/26/us/26formula.html?referrer=&r=0>>.

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