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National Research Initiative (NRI)

Nanotechnology Improves Food Safety by Detecting Prions

by Stacy Kish, CSREES

Mad cow disease is a fatal neurodegenerative condition in cattle that is related to the human form of a disease that has caused the deaths of nearly 200 people worldwide. At the moment, testing for this disease in cattle is a lengthy process that only occasionally results in a correct diagnosis. >>

With funding from USDA's Cooperative State Research, Education, and Extension Service (CSREES) National Research Initiative (NRI), scientists in New York created a new device that may provide a faster, easier, and more reliable way to test for mad cow disease, also known as bovine spongiform encephalopathy (BSE).

This new tool targets prions, which are the cause of BSE. Prions are abnormally structured proteins that convert normal proteins into an abnormal form. Prions are responsible for forms of the neurodegenerative diseases, such as BSE in cattle, scrapie in sheep, and Creutzfeldt-Jakob disease in humans. If often takes years before the symptoms arise and reveal that the disease is present.

There are no rapid tests available to detect for the presence of prions in live cattle.

The only test currently available for BSE involves multiple steps, requires sacrificing an animal host, and takes time. The process requires infecting an animal with a patient's blood.

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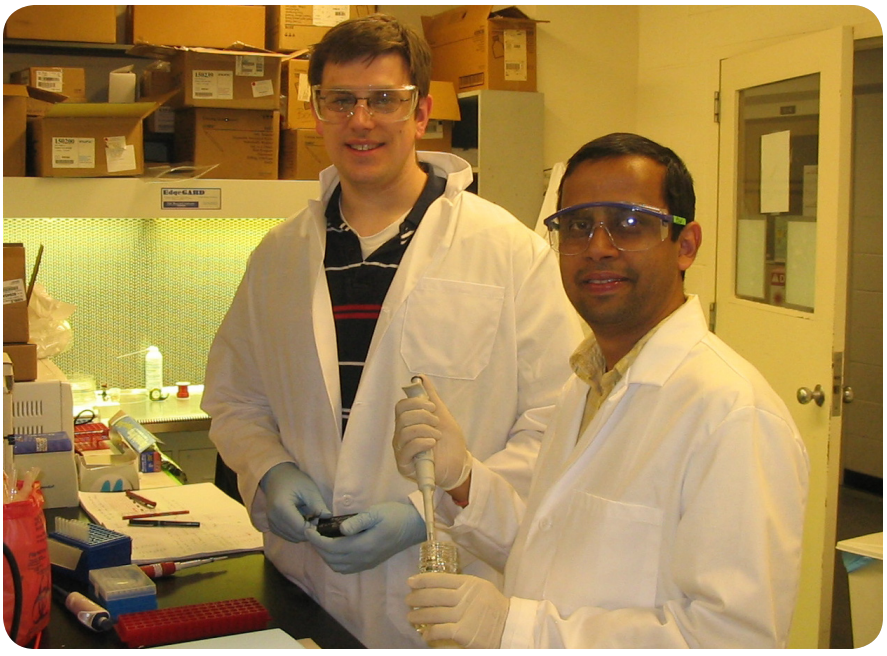

Right: Philip Waggoner (left) and Madhukar Varshney (right) preparing samples for analysis.
Credit: Harold G. Craighead

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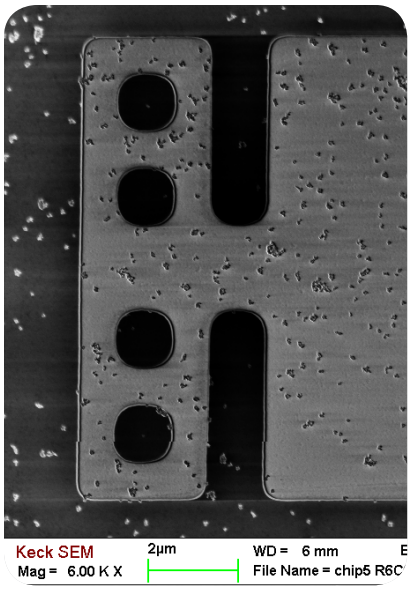

Above: Scanning electron micrograph of the resonating structure (paddlever) showing the detection of prion protein using secondary mass labeling.

Credit: Harold G. Craighead

After several months of incubation, the animal is sacrificed and scientists look for prions during the animal's autopsy. This method produces the correct diagnosis only 31 percent of the time.

A better method of prion detection is necessary to allay public fears, ensure the safety of the nation's food supply, and enhance international trade.

Harold Craighead and colleagues at Cornell University have developed nanoscale resonators, which are tiny devices that function like tuning forks by changing pitch with increased mass.

Craighead's group, in collaboration with Richard Montagna at Innovative Biotechnologies International, Inc., modeled the device after a similar idea used to detect bacterial pathogens. When prions bind to the resonator's silicon sensor, it changes the vibrational resonant frequency of the device. In experimental trials, the sensor detected prions at concentrations as low as two nanograms per milliliter, the smallest levels measured to date.

Currently, the resonator only detects prions in a saline solution. Efforts are now underway to use the resonator to detect prions in more complex solutions, such as blood.

"The real challenge is going to be to build an automated device that can take blood from a cow in the field and give a rapid response as to whether prions are present," Craighead said. "At the moment we only test cows when they fall over, but that is a late stage of the disease. It would be ideal to test cows a lot earlier. Resonators could be one path to doing this."

Scientists hope the new device will soon be used to detect prions in food items to ensure food safety and quality for the national food supply.

CSREES funded this research project through the NRI Nanoscale Science and Engineering for Agriculture and Food Systems program. Through federal funding and leadership for research, education and extension programs, CSREES focuses on investing in science and solving critical issues impacting people's daily lives and the nation's future. For more information, visit www.csrees.usda.gov. ■

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References

Varshney, M., Waggoner, P.S., Tan, C.P., Aubin, K., Montagna, R.A., and Craighead, H.G., Prion protein detection using nanomechanical resonator arrays and secondary mass labeling. *Analytical Chemistry* 80(6): 2141-2148 (2008).