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Ultrasound potentially safe, effective way to kill bacteria

December 11, 2002

University Park, Pa. - High-power ultrasound, currently used for cell disruption, particle size reduction, welding and vaporization, has been shown to be 99.99 percent effective in killing bacterial spores after only 30 seconds of non-contact exposure in experiments conducted by researchers at Penn State and Ultran Labs, Boalsburg, Pa.

In the experiments, bacterial spores contained in a paper envelope, were placed slightly (3mm) above the active area of a specially equipped source of inaudible, high frequency (70 to 200 kHz) sound waves and hit for 30 seconds. There was no contact medium, such as water or gel, between the ultrasound source and the spores as is typically used in low-power, medical diagnostic ultrasound. The experiments mark the first time that Non-Contact Ultrasound (NCU) has been shown to inactivate bacterial spores.

The researchers say the experiments demonstrate that NCU is a potentially safe, effective, non-radioactive way to decontaminate mail, including packages, since ultrasound waves potentially can penetrate cardboard and other wrappings just as they do layers of skin and tissue when used to image internal organs in the human body. They add that the technology could potentially sterilize medical and surgical equipment, food materials, the air duct systems of buildings, airplanes - even the space station.

The research team includes Dr. Kelli Hoover, assistant professor of entomology; Mahesh Bhardwaj, director of research and development, Ultran Labs; and Dr. Nancy Ostiguy, senior research associate in entomology. A patent, "Gas Contact Ultrasound Germicide and Therapeutic Treatment," is pending on the technique.

Hoover explains that the team used Bt spores in their experiments rather than the deadly anthrax spores found to contaminate mail last year. Bt, bacillus thuringiensis, is a common commercial insecticide and is also a close cousin of the anthrax bacillus. "Bacillus anthracis and bacillus thuringiensis are very close relatives," she adds. "They differ by only a few genes on their plasmids that encode different toxins. If you remove those plasmids, Bt cannot be distinguished from B. anthracis and therefore can serve as a safe model for testing."

In the experiments, samples of Bt spores were each subjected to different amounts of NCU exposure for different lengths of time. The spores were then supplied with nutrients so that they could grow. The number of bacterial spores that survived was determined by counting

the number of colonies that grew.

The NCU devices used in the experiments were invented by Bhardwaj who also develops and markets speciality transducers for industrial and biomedical applications. Bhardwaj holds U.S and international patents for very high transduction NCU transducers that can generate high power ultrasound in air in the frequency range of 50 kHz to 10 MHz, comparable to conventional ultrasound frequencies.

"I thought these NCU transducers should be investigated to destroy germs and spores since conventional high power ultrasound was already being used for invasive and non-invasive tissue destruction," adds Bhardwaj, who is director of R&D at Ultran.

He says, "The efficiency of an NCU device is dependent on the properties of the transition layers on the piezoelectric material which create the high acoustic pressure ultrasound waves in air. This principal, in conjunction with new materials, is applied in the new patented NCU device developed for decontamination."

Bhardwaj, who a Penn State alumnus, recruited Hoover and Ostiguy for the decontamination studies, which were supported, in part, by Hoover's Hatch grants.

The researchers described their findings in a paper, Destruction of Bacterial Spores by Phenomenally High Efficiency Non-Contact Ultrasonic Transducers," which is posted at http://link.springer.de/link/service/journals/10019/tocs.htm by the publication Materials Research Innovations and will be brought out in hard copy. To access the paper online, click on "OnLine First - Immediate Online Publications."

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Last Updated March 19, 2009