

Killing Anthrax Spores with Improved Phosphors

By Abby Vogel

Photo: Gary Meek

In October 2001, letters containing anthrax spores were mailed to several news media offices and two U.S. senators, killing five people and infecting 17 others. Clearing the Senate Office Building of the spores with chlorine dioxide gas cost \$27 million, while cleaning the Brentwood postal facility outside Washington, D.C. cost \$130 million and took 26 months.

Researchers at the Georgia Tech Research Institute (GTRI), in collaboration with Austin-based Stellar Micro Devices, Inc. (SMD), have developed prototypes of a rapid, non-disruptive and less expensive method that could be used to decontaminate future bioterrorism hazards.

Using flat panel modules that produce X-rays and ultraviolet-C (UV-C) light simultaneously, the researchers can kill anthrax spores in two to three hours without any lingering effects. The system also has the ability to kill anthrax spores hidden in places like computer keyboards without causing damage.

"This is certainly an improvement over previous techniques," says Brent Wagner, GTRI principal research scientist and director of its Phosphor Technology Center of Excellence (PTCOE). "The UV-C attacks spores on surfaces and the X-rays penetrate through materials and kill spores in cracks and crevices."

The current decontamination standard – chlorine dioxide gas – cannot reach hidden spores. Hard surfaces must be cleaned independently with harsh liquid chlorine dioxide. In addition, people cannot re-enter a room fumigated with chlorine dioxide until the gas is neutralized with sodium bisulfite vapor and vented from the building.

The new decontamination system resembles a coat rack with radiation modules arranged on rings at various heights that face outward to broadcast radiation throughout a room.

UV-C light in the modules is produced using the optical and electrical phenomenon of cathodoluminescence. Numerous electron beams are generated by arrays of cold cathodes, each acting like the electron gun in a cathode ray tube.

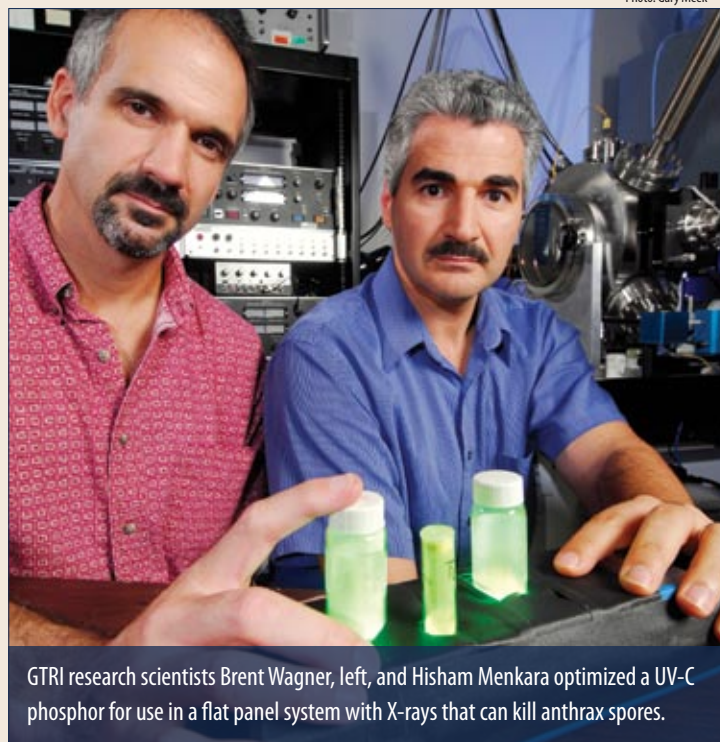
"When an electron beam hits a powder phosphor, it luminesces and emits visible and/or non-visible light," explains Hisham Menkara, a GTRI senior research scientist.

GTRI became involved in SMD's project, which was funded by the Air Force Research Laboratory's Small Business Innovation Research program, because the PTCOE housed UV-C phosphors created and patented by Sarnoff Corporation in the mid-1970s.

"We knew that Georgia Tech had experts in powder phosphors with regard to flat panel displays and we approached them to develop new phosphors for our decontamination purpose," says Mark Eaton, president and CEO of SMD. "We were fortunate that they had UV-C phosphors available from decades earlier."

With the Sarnoff phosphors, Wagner and Menkara set off to determine the best UV-C emitting phosphor and optimize its properties for use with X-rays in SMD's small flat panel display.

To find the best phosphor that emitted light in the UV-C region of the spectrum – wavelengths below 280 nanometers – the emission spectrum of each phosphor was



GTRI research scientists Brent Wagner, left, and Hisham Menkara optimized a UV-C phosphor for use in a flat panel system with X-rays that can kill anthrax spores.

measured against the DNA absorption curve. This curve shows the optimal wavelengths to destroy an organism's DNA.

After investigating many different phosphors, the researchers chose lanthanum phosphate:praseodymium (LaPO₄:Pr or LAP:Pr) as the most efficient phosphor. In the laboratory, Menkara created the phosphor by mixing precursors lanthanum oxide, hydrogen phosphate and praseodymium fluoride (La₂O₃, H₃PO₄ and PrF₃, respectively) in a glass beaker with methanol (CH₃OH) and ammonium chloride (NH₄Cl).

After evaporating the methanol, the resultant cake was crushed into a fine powder, heated in a furnace to a temperature as high as 1,250 degrees Celsius. Wagner and Menkara also found that adding lithium fluoride (LiF) and reducing the praseodymium concentration increased the cathodoluminescent properties of the LAP:Pr phosphor.

With the improved phosphor, laboratory tests conducted by SMD showed that the combined X-ray and UV-C decontamination system could kill anthrax spores. Beyond biocontamination, UV-C panels could be used for sterilizing medical equipment or purification applications.

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