Advanced Plasma Technology Zaps Deadly Microbes

University of Tennessee
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Though we rarely admit it, human beings live in a kind of organic stew, surrounded virtually everywhere by bacteria, viruses, fungi, endospores and volatile organic compounds (VOCs). Most of the time, the presence of our tiny companions is of no particular concern, but there are certain settings — such as in hospitals, hotel rooms and locker rooms — in which a quick and effective means of air purification is not only highly desired but a potential life-saver. Now, thanks to technology that sprang from curiosity about ball lightning at The University of Tennessee (UT), people are able to enjoy healthier, safer, more sanitary environments.

The Genesis of the Idea

In the early 1990s, John Reece Roth and his colleagues Peter Tsai, Chaoya Liu, Mounir Laroussi, Paul Spence and Larry Wadsworth at UT became interested in a natural phenomenon: ball lightning. They wondered: Would it be possible to recreate it in a laboratory?

Ball lightning is atmospheric plasma. Plasma is an energized gas, the fourth state of matter (the first three are solid, liquid and gas) and the most abundant form of matter in the universe. For years researchers had experimented with plasmas in the laboratory, but most of these experiments required the use of vacuum chambers and exotic gases. At the time the UT researchers turned their eyes toward ball lighting, very little was understood about atmospheric plasmas. From their subsequent studies, a whole new field of scientific endeavor would emerge.

During their investigations, they found that atmospheric plasmas — plasmas that occur in ordinary air at standard pressure and ambient temperatures — could indeed be created in the laboratory. After considerable research, they developed a One Atmosphere Uniform Glow Discharge Plasma (OAUGDP) technology that generates atmospheric plasmas comprised of highly reactive chemical species. Funding from several government agencies, including the Department of Defense and NASA, was obtained to demonstrate the technology for several practical applications.

Yes, but What Is it Good For?

> *In 1996, Kim Wintenberg, Ph.D., a microbiologistand now director of new business development for Advanced Plasma Products, was asked to join the UT team to study the ability of the OAUGDP to kill microorganisms.*

As far back as the 1930s, researchers had killed microorganisms with plasma, but all of these techniques involved extreme heat, vacuums or specialty gases. Wintenberg and the team found that the highly oxidative gases in OAUGDP are extremely effective at killing microbes and oxidizing VOCs.

Further, the team discovered that OAUGDP had two key characteristics that might lend themselves to using this technology against microorganisms that are commonly found on surfaces. First the glow discharge is relatively uniform, unlike some other plasma technologies. Second, sensitive materials, such as textiles, can be immersed in the plasma field without pitting or burning. This bodes well for a system that could be used to destroy microbes.

Licensing the Technology

The long road to licensing began in 1993, when the OAUGDP team disclosed several inventions to The University of Tennessee Research Foundation (UTRF). UTRF spent some years looking for potential licensees. In time, Atmospheric Glow Technology licensed the technology but eventually Atmospheric Glow Technology went bankrupt, and the technology reverted to UTRF.

At that time, four entities were interested in the assets of Atmospheric Glow Technology, and one of them was Ken Wood and his business partners. They had joined Applied Science Products, a publicly traded parent company, and saw the opportunity to create a new company. In 2008, he formed Advanced Plasma Products, based in Knoxville, Tenn., bought the physical assets of Atmospheric Glow Technology, brought on some of the key personnel, licensed the technology and began working on a focused commercialization effort.

“They have a robust diligence plan for commercializing product,” says John Hopkins, vice president for UTRF. “The

Advanced Plasma Products team is building good future value for the company, and they have done it in poor economic circumstances and in a short time.”

One reason for the team’s success is simple experience. “I approached the licensing process with some measure of familiarity,” says Wood, now president and chief executive officer of Advanced Plasma Products, “and I was comfortable with assessing the technology and understanding the scope of the underlying intellectual property.

"After that, it was a matter of stepping through the various processes," Wood says. "The UTRF people are pros, so we were able to work through the steps relatively quickly and efficiently. If both sides know what they are doing, it's a bit like getting a mortgage for a house. The UTRF people facilitated the process."

The First OAUGDP Product

Using and building upon the technology developed at UT, Advanced Plasma Products has already brought to market its first offering, the TriClean Pro. The TriClean Pro is a standalone air purification system with capabilities of exchanging and sanitizing the air at least 3.4 times per hour in a 4,000 cubic foot room.

The TriClean Pro operates in two phases. During the capture phase, ambient air that contains microorganisms and VOCs is drawn into the unit. Large particulates are removed by a prefilter, while smaller particles and microbes are removed by a very efficient particulate filter with a low pressure drop. VOCs are trapped by a carbon filter. During the destruction phase, the fan operates at lower speed and the plasma grid is energized. The reactive gases produced by the plasma oxidize VOCs and kill trapped microorganisms. Air is passed over a catalyst to neutralize reactive gases and returns to the air free from odors and harmful contaminants. The TriClean Pro, which requires about 65 watts of power to operate, has met all necessary UL safety tests for ionizing air purifiers, including the tests for ozone.

Applications for the TriClean Pro include health care settings, such as surgical suites, intensive care units where immunocompromised patients are more susceptible to infection, medical waiting rooms, general patient rooms, nursing homes and offsite surgical centers. Additional applications outside of health care include veterinary offices, athletic locker rooms and training facilities, and the hospitality industry, where guests' expectations of clean facilities during their stay are important.

Advanced Plasma Products has invested heavily in developing the technology it licensed from the UT. One of the key developments has been to engineer systems in which the plasma is generated at one site and then the reactive species are delivered to a remote site. Without this capability, plasma systems are limited to treating materials that can fit between the two plasma-generating electrodes, which are typically millimeters apart. By contrast, the new Advanced Plasma Products system can deliver the reactive species onto a wrapped object like a surgical instrument, and those species survive long enough to sterilize it.

In the end, Hopkins has high aspirations for technology transfer through UTRF. "We'd like to grow advanced technology companies in our region that contribute to economic prosperity, hire our graduates and foster entrepreneurialism in the area.

"As a land grant university, we have a responsibility to ordinary people to impact their lives in a positive way," he says. "We want to do that by getting beneficial technologies into society, by providing job opportunities for our students, by supporting the tax base of the state and by the direct return of license revenues to the university."

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