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U.S. DEPARTMENT OF ENERGY | SBIR/STTR Programs Office

DOE SBIR/STTR SUCCESS

Tetramer's Frangible Authentication Security Tag (FAST™) technology generates random, unpredictable crack patterns for more efficient security seals.

TETRAMER TECHNOLOGIES

Tamper-indicating security seals are designed to leave non-erasable, unambiguous evidence of unauthorized access or entry. As such, these seals play a critical role in customs, nonproliferation, law enforcement, and counter-terrorism. It has been shown that currently available seals can be quickly and easily spoofed and high-tech electronic seals, although more expensive and labor-intensive, do not necessarily perform better than simple mechanical seals. Currently, the National Nuclear Security Administration (NNSA), the International Atomic Energy Agency (IAEA), and many private companies have expressed a demand for high-performance, lightweight, and inexpensive passive seals.

FACTS

PHASE III SUCCESS
At the end of a DOE SBIR Phase II grant, Tetramer received a $1M Phase III contract from NNSA and is currently working with partners to accelerate technology field deployment.

IMPACT
Tetramer's FAST™ technology delivers a low-cost, passive seal based on a non-reproducible crack pattern, which provides unambiguous tampering evidence by simple camera imaging.

DOE PROGRAM
National Nuclear Security Administration (NNSA)

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Tetramer’s innovation in the field of security seals consists of a low-cost, transparent, and highly strained polymer that can be easily manufactured as a free-standing solid or deposited as a film on conventional seals. Initially, Tetramer focused on the film technology, which could be applied to any existing seal design to improve the performance. Because of the high intrinsic residual strain within the polymer in its solid state, a film of this material cracks and even shatters at the slightest attempt to manipulate the seal for gaining unauthorized access, offering robust tampering evidence. A benefit of this technology, as compared to conventional seals, is that the smaller a pin hole introduced during a tampering attack, the greater the concentrated stress and the probability that the stored energy will be released by the film through cracking. This is a big advantage, particularly for recognizing counterfeiting of products like medicines and wine, for which the polymer film can be applied to the foil that seals a medicine container or on top of the wine cork. The same technology can easily be turned into a real-time tampering detection system by simply shining light through the film and measuring the transmitted intensity, which will instantly decrease once cracking occurs. This type of monitoring can be very effective for internet cameras or other Internet of Things (IOT) devices, to detect a physical attack on cyber systems.

Although Tetramer’s scientists were able to drive down the cost of their technology to meet customers’ expectations, they were confronted with the challenge of making their devices 100% reliable. Tetramer found that even the small chance that their coating would crack following a non-tampering accident would be unacceptable for potential customers. This realization was the driver for modifying Tetramer’s original film technology. Because the originally developed strained films had a non-zero probability to yield a false positive, Tetramer started using the same polymer material to produce not just a coating but the entire seal—a thick, free-standing, lightweight and inexpensive disk that would house wires passing through the hasp of the container to be secured. The disk is obtained by hardening the initially liquid polymer under UV light after the wire loop ends are inserted in the seal, as shown in the figure above. The hardening process locks the wire ends in place, and at the same time produces an initial crack pattern with a unique 3D structure. The initial cracking releases most of the energy stored in the material eliminating the risk of an accidental cracking not associated with tampering. While accidentally hitting the seal may cause only small additional cracking, an attempt to manipulate or pull out the wires produces a much larger response, which can be unequivocally associated with tampering by means of simple imaging techniques to compare before and after images of the seal.

After a Phase II DOE SBIR grant, Tetramer obtained a $1M Phase III from NNSA in 2015 to apply their polymer technology to the detection of tampering in protective enclosures including those used for transporting special nuclear materials from the point of manufacture to a final site. In addition, Tetramer’s technology met the interests of a major Department of Defense (DOD) contractor who worked with Tetramer to develop prototype protected enclosures for a DOD application. Subsequently, Tetramer developed a handheld device that allows for the polymer to be cured and solidified quickly; Tetramer has been in discussions with the IAEA to turn this into a turnkey product. Additionally, Oak Ridge National Laboratory has recently purchased 50 of the FAST™ seals as part of a large nonproliferation seal technology evaluation study.

Tetramer was founded in 2001 with the purpose of commercializing a polymer developed at Clemson University for planar wave guides in optical communications. Following the telecoms crash of the same year, Tetramer soon saw its potential market receding, and left with no customers, looked for alternative applications of its core technology. For the six following years, Tetramer scientists worked on modifying the chemistry of their original polymer material to develop fuel cells with the support of General Motors (GM). After successfully developing its fuel cell membranes, Tetramer adapted its materials technology to develop water transport membranes and electrolyte membranes. Tetramer also assists clients in designing molecular architectures for many other applications, including bio-renewables, fiber optic coatings, and even low-calorie fat replacers for the food industry.

According to Jeffrey DiMaio, CEO of Tetramer, the main value of an SBIR award is to fund R&D on high risk, high value technology, namely a technology that requires new research developments and addresses a non-existing market. "The last thing investors want to fund is a new technology for a new market because of the prospect that the venture might fail on one ground or the other" explains Dr. DiMaio. Tetramer's business strategy consists of leveraging SBIR grants and working with a strategic partner who will ultimately use the technology. This approach is key for reducing both the technical and the commercialization risks. "We never develop a material hoping that someone will use it" says Dr. DiMaio. "We first establish the need for a material, then work with a partner to develop it." Once a new material has been developed, the technical risk has been mitigated and Tetramer can subsequently work on the commercialization front, trying to push the newly developed material into additional applications and markets." A Phase I SBIR is an ideal vehicle to determine proof of concept for a new technology, and at the same time to find a strategic partner who will benefit from the innovation. If the project is well positioned to progress beyond Phase I, Tetramer confirms that a sound value proposition exists before the Phase II project starts by checking whether its partner still has significant interest in the technology and is comfortable with the projected product cost. This approach guarantees that the technology to be developed creates value for a future customer, laying the foundation for a positive commercialization outcome.

Written By Claudia Cantoni, Commercialization Program Manager, DOE SBIR/STTR, April 2019.