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THE DoD SPONSORS A NOVEL, NONDESTRUCTIVE
EVALUATION TECHNOLOGY

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In the continued maintenance of manufactured materials, there is a consistent problem. How do you detect anomalies and defects without disassembling the product? This is particularly an issue in materials such as high-density polyethylene (HDPE), fiberglass, ceramic matrix composites (CMCs), fiber reinforced plastic, and reinforced rubber—used in a wide array of pipes, pumps, cooling towers, military combat vehicles, nuclear power plants, windmill turbines, and advanced aerospace applications. Disassembling these critical components to examine them for defects and anomalies is often not an option.

To address this problem, in the early 1990s, a Louisiana-based company called Evisive arrived at a solution using microwave imaging. Their innovation related to the discovery that electromagnetic radiation, such as microwaves, is reflected at every change in dielectric property, including defects, moisture, foreign matter, and physical geometry. The reflected microwaves can be monitored as an interference pattern, reducing the complexity of microwave imaging systems (which are otherwise very similar to radar), and thus making possible a portable, field-deployable tool.

In short, the part being tested is immersed in microwave energy. These radiated microwaves interact with the detectors as they leave the transducer, where the microwaves are generated, and again as the



Evisive's technology finds material weaknesses through the use of microwaves.

reflected energy is returned. The energy reflected from the specimen, including response from the material and features within the material, is combined with the radiated energy to generate an interference pattern. A response is returned at each interface where the dielectric constant changes; or where there are defects or

material property variations. Depending on the application, the transducer is positioned manually, using a hand-held wireless battery-powered probe, mechanized positioning systems, or using fully automated robotic operation.

Evisive's microwave nondestructive evaluation (NDE) technology is now recognized as the preferred method for inspecting a wide range of dielectric materials. This came as the result of research and development supported by contracts with the Small Business Innovation Research (SBIR) program. Of these, a U.S. Army project, NDE of Ceramic Armor, was critical. The U.S. Air Force project entitled Effective Nondestructive Detection and Quantification of Defects and Damage in Ceramic Matrix Composites (CMCs), dramatically advanced the technology. Additional SBIRs further refined Evisive's groundbreaking work.

The Air Force sought to develop a quality-control technology for manufacturing and condition assessment of advanced CMC materials for a wide range of applications. Unlike typical composites, wherein the matrix

between reinforcing fibers is an organic resin, in CMC materials both the fiber and the matrix are ceramic. The complex reinforcing fiber structure makes these materials extremely challenging to inspect. Conventional testing methods capable of imaging the parts are time consuming and costly, and often not able to test the part in place.

“During the Air Force project under Dr. George Jefferson, we developed and validated a method for efficiently creating a volume image of the material. This involved substantial equipment and methodology development,” said Karl Schmidt, Evisive’s Defense Applications Program Manager. The effort included development of the system to simultaneously image many layers of the material and present a 3D image.

The Air Force SBIR enabled the testing of the technology for in-process measurement of material density, a critical attribute in the manufacturing process. The SBIR advanced the manufacturing process to enable efficient, in-process identification of defects in the material, improving quality in the manufacturing of advanced materials and reducing inspection costs.

Schmidt said, “The objective for the Army was to find a method for condition assessment of ceramic armor for vehicles, which is often made of a monolithic ceramic encased in a complex overwrap panel configuration. These complex structures do not lend themselves well to conventional NDE.” The Army uses the technology daily for armor condition assessment in rebuild programs and related development applications.

William Green, materials engineer at the U.S. Army Research Laboratory, said, “We were looking for an NDE method that wasn’t out there yet, that would make it possible to easily inspect an armored vehicle in the field by just walking up to



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it.” The Army now benefits from reduced costs and improved safety with on-site field inspections.

Lisa Prokurat Franks, U.S. Army, Stryker Fleet System Engineering Branch, said, “I’ve been working with Evisive since 2006 when the senior scientist for nondestructive evaluation at Argonne National Lab identified Evisive to us. They provide the only technology capable of finding damage in the thick non-metals that we need for armor.”

“Equipment delivered in the Army project is being used by the Stryker Exchange Program,” said Jack Little, President of Evisive. “They are reporting substantial cost savings thanks to real-time condition assessment which enables re-use of previously suspect armor panels.”

Evisive’s technological breakthrough has been well-received by standards and certification organizations. The American Society

for Mechanical Engineering (ASME) identified the method for certain critical HDPE inspection applications. The American Society for Nondestructive Testing (ASNT) accepted Microwave Testing as a Method; the first new method recognized in a decade.

The American Society for Testing Methods International (ASTM) is finalizing the HDPE inspection technique as a Standard, and this application is proceeding as an ASTM Method. The Electric Power Research Institute (EPRI) has identified the technology as an inspection requirement for HDPE.

Recognition by standards associations not only validates the technology but also stimulates its commercial potential. Recognizing the impact of the SBIR program on his company’s achievements, Little said, “SBIR is an amazing asset to U.S. small business firms...In addition to providing a path to commercialization, it allows inventors to invent!” 

Evisive, Inc.

Baton Rouge, LA

Modernization Priority: General Warfighting Requirements (GWR)

SBIR contract: W911QX-08-C-0052 • Agency: Army • Topic: A07-186, Non-Destructive Evaluation (NDE) and Testing of Ceramic Armor SBIR contract: W56HZV-11-C-0077 • Agency: Army • Topic: A08-144, Non-Destructive Evaluation (NDE) for Ground Vehicles

SBIR contract: FA8650-12-C-5109 • Agency: Air Force • Topic: AF103-153, Effective Nondestructive Detection and Quantification of Defects and Damage in Ceramic Matrix Composites (CMCs)