SBIR·STTR America's Seed Fund

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

RADIATION MONITORING DEVICES INC.

Based in Watertown MA, Radiation Monitoring Devices, Inc. (RMD) was founded in 1974 and, since 2008, has operated as a subsidiary of Dynasil Corporation of America, serving as the incubator for new product innovations. From its early days, RMD's mission has been twofold: 1) perform world-class research and, 2) transition technologies from research to commercial products. To meet these objectives, RMD adopts a variety of commercialization strategies, depending on the particular technology and the most appropriate business model. RMD performs R&D in an impressive range of scientific fields, from space science to particle physics, and from nuclear security and safeguard to clinical diagnoses and environmental research. Within these areas, RMD develops advanced functional materials, instrumentation, electronics, and software for imaging and augmented reality.

FACTS

PHASE III SUCCESS
RMD launched a novel scintillation material, CLYC, in October 2014. CLYC is used in a variety of radiation detection instruments including Spectroscopic Personal Radiation Detection instruments (SPRDs). CLYC crystal/detector sales are currently at more than $ 1M/year and are expected to increase considerably in the coming years.

IMPACT
With dual neutron and gamma ray detection, CLYC provides a uniquely flexible tool for nuclear-event-site first responders and for monitoring unauthorized nuclear materials.

DOE OFFICES
Defense Nuclear Nonproliferation (DNN), Nuclear Physics (NP), Nuclear Energy (NE).

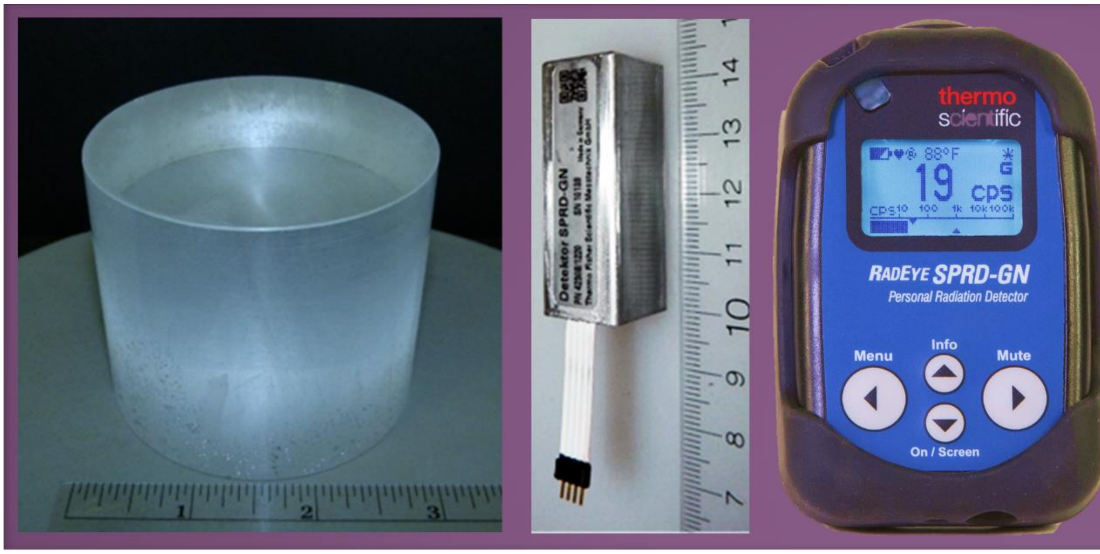
RMD is extremely committed to protecting its intellectual property, with 64 awarded patents since 2004 and 55 applications currently under review. RMD defines itself as a truly innovative small business, exploring the potential of many new technologies at the earliest Phase 0 stage. While not all of this research leads to commercial products, the most promising are identified, and R&D and business plans are implemented to bring these technologies to market. Although some of the technologies explored by RMD do not pass the proof-of-concept stage, RMD has commercialized six technologies in the last five years. These products are either manufactured and sold directly by RMD, or licensed to other companies for commercialization.

One of the most recent among RMD's successes is a portable solid state radiation detector based on CLYC (Cs_2LiYCl_6). CLYC is a crystalline scintillation material that emits photons when struck by ionizing radiation. CLYC has the ability to detect and discriminate both gamma rays and neutrons. Additionally, it is capable of high resolution gamma ray spectroscopy, which provides very accurate identification of the radiation source.

CLYC is coupled to a photomultiplier tube or a solid state photodetector to make up a complete detector. The packaged detector is complemented by electronics to analyze the emitted signal and assembled into a finished instrument. Aimed at first responders, the device is a very sensitive, portable instrument that detects both neutrons and gamma rays. This enables first responders at the site of a radiation incident to quickly locate and identify a wide range of radioactive materials utilizing a single device.

The work necessary to assess the feasibility of a CLYC-based detector and to demonstrate the technological and commercial potential of the scintillator was performed by RMD with the support of SBIR programs from the Department of Energy (DOE), as well as funding from the Domestic Nuclear Detection Office (DNDO) and the Defense Threat Reduction Agency (DTRA). This co-funding is in fact a perfect example of how collaboration between multiple government agencies can expedite the development of breakthrough technologies.

The research on CLYC at RMD began through DOE SBIR program, funded by the office of Nuclear Physics (NP) followed by funding from DTRA. This early research showed that in addition to neutron detection and gamma-neutron discrimination, CLYC can also provide high energy resolution gamma-ray spectroscopy. With the onset of the Helium-3 crisis in late 2008, DNDO in early 2009 accelerated development of the most promising Helium-3 replacement technologies based on prior work funded by DOE, DTRA, and DNDO, and this included the CLYC technology. DNDO supported low rate production (LRP) of CLYC scintillator crystals including sampling of these crystals to selected users and integration into prototype performance test units through DNDO-funded programs. An SBIR Phase II project from DOE supporting CLYC began in 2013 and was funded by the Office of Nuclear Energy (NE). This DOE SBIR effort focused on developing and optimizing algorithms for CLYC crystals for discriminating between gamma rays and neutrons at high event rates based on pulse height discrimination (PHD), as well as more powerful pulse shape discrimination (PSD). Thereafter, DTRA funded work to scale-up crystal sizes (up to 3" diameter) in a cost-effective manner in order to provide higher efficiency detectors and to make production more cost-effective. Finally, the detector crystals produced by RMD were supplied to Thermo Fisher Scientific, which developed the complete final detector product and marketed it as the RadEye SPRD-GN (spectroscopic personal radiation detector – gamma neutron).



From left to right: RMD's 3-inch-diameter CLYC scintillator crystal; packaged detector from RMD; and the RadEye SPRD-GN instrument from Thermo Fisher Scientific.

What makes the RadEye SPRD-GN stand out against competing devices is its portability, sensitivity, and ability to identify different sources of nuclear activity. While harmful ionizing radiation can vary, including for example alpha particles, beta particles, and gamma rays, most radiation detectors are calibrated to respond to a single type of radiation. The RadEye SPRD-GN, however, is calibrated across multiple isotopes in the energy range from 60 keV to 3 MeV. This allows the operator to accurately identify which material, among multiple potential radiation sources, needs to be secured, and how long it is safe to work in its vicinity. Moreover, the RadEye SPRD-GN is able to distinguish real threats from false alarms triggered by medical materials, as well as materials that are natural emitters of radiation, such as marble and granite, often found in concrete.

This is where the concurrent detection of neutrons becomes very important. While gamma rays can come from many sources, the naturally occurring neutron background is very low, and detection of neutrons above a certain threshold is almost always associated with special nuclear materials or a nuclear event. The CLYC technology is presently in high demand by government agencies and defense contractors, and additional future customers will likely include hospitals and the recycling industry.

Among other industry sectors, identifying nuclear radiation signatures is particularly needed on container ships. While on land many larger detectors are in place to screen for neutrons, on the ocean it is essential to rely on a portable, but sensitive technology, especially when the technology can reliably distinguish among artificial and natural sources of radiation stored together in a single container.

Over 100,000 of the many RadEye variants have been sold worldwide. Customers include the Washington DC Metro, the New York Fire Department, the Houston Bomb Squad, and Jacksonville, FL Fire and Rescue. The new CLYC-based version, the RadEye SPRD-GN, is a strong addition to the RadEye line.

Development is currently underway on a new scintillation material for the next generation of dual-mode gamma ray and neutron detectors. Through a different DOE Phase II grant awarded by the Office of Defense Nuclear Nonproliferation, as well as DNDO and DTRA funding, RMD discovered that by replacing the Y in CLYC with La, and by adding some Br to the Cl site, a new crystal is created, CLLBC that emits more than two times the light of CLYC. This significantly improves the energy resolution, which is a critical parameter for the fast, accurate identification of radioactive isotopes. The discovery was patented by RMD, and subsequently funded by DTRA to scale-up the crystal growth to larger sizes. Prototype detectors are currently available using 1” and 1.5” diameter crystals, and larger versions based on 2” and 3” diameter crystals will be launched this year.

RMD’s President, Dr. Kanai Shah, stated that, “CLYC and other RMD successes are based on the implementation of a commercialization model in which multi-agency support is leveraged to bring a technology through the research phase and launch it into the marketplace”. RMD’s Vice President of Commercial Development, Martin Waters, describes the SBIR program as an invaluable and irreplaceable means to explore technological innovation and select those technologies that have the greatest potential for commercial success. “Without SBIR,” Mr. Waters explains, “a small business would not have the capability to make this determination, which is the first step in securing the necessary subsequent funds for scale-up and product launch.”

Written By Claudia Cantoni, Commercialization Program Manager, DOE SBIR/STTR, November 2017.