DEPARTMENT OF THE NAVY
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TRANSITIONS

ENGI-MAT SPOTLIGHT

Composite Powders Enhance Cathode Performance for Essential Devices

Source: Brian Mackey, Chief Executive Officer, Engi-Mat

For many decades, conventional thermionic cathodes have been used in diverse applications across the U.S. Navy. The growing demand for enhanced cathode performance by the vacuum electron devices (VEDs) which incorporate these standard cathodes requires a novel solution. Now, a Navy STTR project is funding a successful development effort to translate capabilities previously seen only at laboratory scale to manufacturing in the large volumes required to fulfill the needs of the U.S. Navy.

"The core concept of the program is based on the academic findings that indicate improved cathode performance for VEDs can be attained using scandia/tungsten powders. The anticipated performance improvement had not been consistently observed and demonstrated in volume quantities sufficient for the Navy and others," said Brian Mackey, Chief Executive Officer at Engi-Mat.

Engi-Mat, which has focused on nanotechnology for over 25 years, has developed a scandia-doped tungsten powder to extend the life and increase the power of cathodes in VEDs, and, along with its partners, cathode manufacturer 3M/Ceradyne and the University of Kentucky, has demonstrated the ability to provide volume quantities of the high-performance product necessary to translate small-scale results into commercial production.

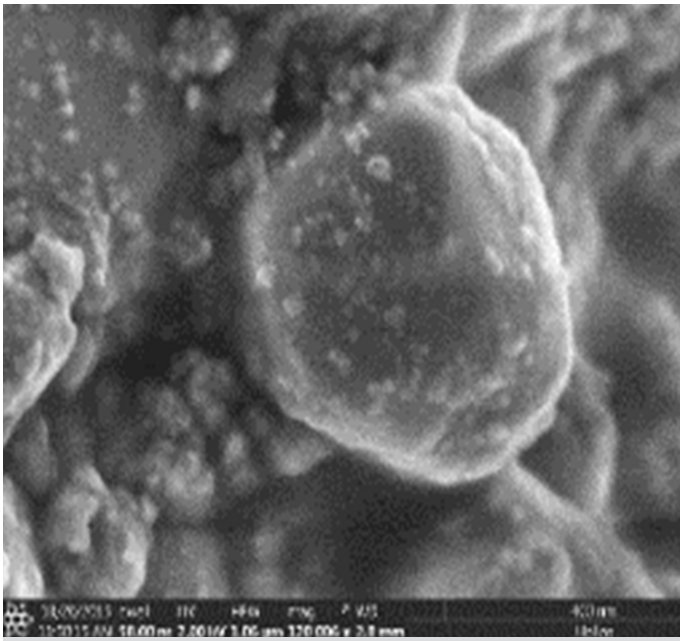

Image provided by Engi-Mat

Engi-Mat, which is ISO9001:2015 certified for the design and production of nanopowders, will provide high-quality scandia/tungsten composite powder to cathode manufacturers. The scandate cathodes will function as replacements for the current M-type cathodes. Radio frequency (RF) systems that incorporate these cathodes, such as satellites and communications systems, will be able to operate at higher power, expanding the boundaries of their operational performance. Scandate cathodes will also enable smaller cathode designs at the same cathode loading. Additionally, the extended life span of the cathode will reduce downtime and costly repairs of critical systems.

"Many existing naval weapon systems, including radar and electronic warfare (EW) systems, rely on microwave vacuum electronics (microwave tubes) as the primary source of RF power. Future RF sensors will require unprecedented performance in output power and bandwidth," explained Mackey. Microwave tubes will exist in naval systems for many decades to come due to the sustainment of legacy systems, and in the deployment of future systems for which size, weight, and power make vacuum electronics the only viable option. Mackey added, "Engi-Mat's production of scandia-doped tungsten powder for use in advanced high current density thermionic cathodes supports these requirements."

Compared to conventional M-type cathodes, the scandia/tungsten composite materials developed in this program are expected to enable 10 times longer cathode operational life cycles by lowering the required operating temperature, or enable higher cathode loadings (five times the power) for applications such as THz generation and millimeter wave. Despite the significant improvement in performance, the cost increase of the fully configured device is expected to be small.

Through the Navy STP program, Engi-Mat was able to better understand the applications within the U.S. Navy where the improved cathode performance is critical. These applications vary widely across diverse Navy systems, so the increased exposure afforded by the Navy STP was very valuable, Mackey said.

In August, Engi-Mat fulfilled its first commercial purchase order for this high-performance powder. Transition opportunities include any users of systems incorporating cathode devices and VEDs, including communications, radar, and other systems. The U.S. domestic vacuum electron device industry also supplies products for a variety of commercial applications, including fusion research, microwave heating, and satellite uplink stations. Mackey concluded, "We're very excited about the technical success we've achieved during this STTR project. As a small company, it's very rewarding to provide a solution that supports the long-term objectives of the U.S. Navy."