Info for DOE osti.gov/elink online submission from CRADA, 2011S003, Faraday Technologies

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DESCRIPTION/ABSTRACT - Provide a clear, concise, and publicly releasable English language summary of the information content of the STI product. The abstract length should be no more than 5,000 characters.

This Phase I SBIR program addressed the need for an improved manufacturing process for electropolishing niobium RF superconducting cavities for the International Linear Collider (ILC). The ILC is a proposed particle accelerator that will be used to gain a deeper understanding of the forces of energy and matter by colliding beams of electrons and positrons at nearly the speed of light. The energy required for this to happen will be achieved through the use of advanced superconducting technology, specifically ~16,000 RF superconducting cavities operating at near absolute zero. The RF superconductor cavities will be fabricated from highly pure Nb, which has an extremely low surface resistance at 2 Kelvin when compared to other materials. To take full advantage of the superconducting properties of the Nb cavities, the inner surface must be a) polished to a microscale roughness < 0.1 µm with removal of at least 100 µm of material, and b) cleaned to be free of impurities that would degrade performance of the ILC. State-of-the-art polishing uses either chemical polishing or electropolishing, both of which require hydrofluoric acid to achieve breakdown of the strong passive film on the surface. In this Phase I program, Faraday worked with its collaborators at the Thomas Jefferson National Accelerator Facility (JLab) to demonstrate the feasibility of an electropolishing process for pure niobium, utilizing an environmentally benign alternative to chemical or electrochemical polishing electrolytes containing hydrofluoric acid. Faraday utilized a 31 wt% aqueous sulfuric acid solution (devoid of hydrofluoric acid) in conjunction with the FARADAYIC^{SM} Process, which uses pulse/pulse reverse fields for electropolishing, to demonstrate the ability to electropolish niobium to the desired surface finish. The anticipated benefits of the FARADAYIC^{SM} Electropolishing process will be a simpler, safer, and less expensive method capable of surface finishing high purity niobium cavities. Another potential benefit would be for the medical industry that uses hydrofluoric acid to electropolish niobium-alloy materials. The FARADAYIC^{SM} Electropolishing process will eliminate the environmental hazards posed by the use of hydrofluoric acid employed by chemical polishing and conventional electropolishing. Further, improved performance benefits may be possible. The overall objective of the Phase I program was to demonstrate that FARADAYIC Electropolishing of niobium cavities in electrolytes free of hydrofluoric acid can meet the RF superconducting performance criteria of those cavities. The FARADAYIC Electropolishing Process developed in the Phase I program was used to polish 50 mm Nb disks to a surface roughness (R_A) of < 1 nm over a small area through process and post-processing optimization. An excellent level of surface cleanliness was achieved. While the desired 2K RF performance has not yet been achieved, Faraday believes that surface oxide state can be controlled through manipulation of the process parameters, to meet the 2K RF standard. Faraday is establishing apparatus and facilities infrastructure for single-cell SRF cavity electropolishing, through a synergistic effort with the Fermi National Accelerator Facility (Fermilab) to scale-up electropolishing of superconducting RF cavities. Faraday proposes to commercialize the subject technology via an IP based strategic relationship with a partner with established market channels within two primary commercialization avenues: 1) the superconducting particle accelerator community, 2) the medical device and implant market. Faraday will initially maintain Low Rate Initial Production capabilities for an application, but latterly seek a strategic partner who is solely dedicated to high rate production.

KEYWORDS - These are phrases identifying major concepts in the STI product. More than one keyword may be entered.
Niobium, electropolishing, superconducting radio frequency cavities, International Linear Collider, hydrofluoric acid, manufacturing