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Deposit high purity Alumnium on Nb in support of conduction cooled SRF cavities

Cooperative Research and Development Agreement Final Report

CRADA Number: FRA-2015-0079

Fermilab Technical Contact: Lance Cooley

Summary Report
1 July 2019

NOTICE

In accordance with Requirements set forth in Article X.A(2) of the CRADA document, this document is the final CRADA report, including a list of Subject Inventions, to be forwarded to the Office of Science and Technical Information as part of the commitment to the public to demonstrate results of federally funded research.

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CRADA Title: Deposit high purity Alumnium on Nb in support of conduction cooled SRF cavities

Parties to the Agreement: PAVAC Industries, Inc. and Fermi Research Alliance, LLC

Abstract of CRADA work:

The project will demonstrate a potential manufacturing method that could result in a means to operate superconducting radio frequency (SRF) cavities without liquid cryogens. The technical approach sought to apply high-purity (99.999%) aluminum to cavity-grade niobium components via a new and proprietary electron-beam additive manufacturing technique contributed by PAVAC. High thermal conductivity of the aluminum could enable a cryocooler, which is a compact electrically powered refrigeration device, to extract sufficient heat for operating the cavity for a variety of applications. Trial coatings of niobium components were to be evaluated for metallurgy, mechanical bonding, and thermal and electrical conductivity using superconducting materials characterization facilities at Fermilab. The results of the characterization were intended to provide process feedback and optimization to PAVAC. During the project, PAVAC completed one set of samples. However, due to a business reorganization, PAVAC choose not to proceed toward a second set of samples using their proprietary approach. The PAVAC technical goal was replaced by a Fermilab goal to determine whether high-purity aluminum could be attached to niobium by a system of welded stud anchors and fasteners. The project pivoted to evaluations of trial stud welded anchors using infrastructure and expertise similar to that applied to the PAVAC applied coatings.

Summary of Research Results:

Using surface heat dissipation in cavities and cooling power of a commercial cryocooler, Fermilab and PAVAC analyzed the thermal behavior of a cryogen-free conduction-cooled SRF system. The thermal conductance requirement of the link connecting the cavity to the cryocooler was identified for qualitative cases with static heat load and imperfect Nb3Sn coating. A simple-to-construct conduction link design is described, which can support the cavity operation in all of the cases considered.

Related Reports, Publications, and Presentations:

http://lss.fnal.gov/archive/2018/pub/fermilab-pub-18-491-di-td.pdf

Subject Inventions listing:

None

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