A New PIT Nb3Sn Process Toward Improved Cost-Performance for HEP High Field Magnets

Cooperative Research and Development Agreement
Final Report

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Fermilab Technical Contact: Victor Yarba

Summary Report

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In accordance with Requirements set forth in Article XLA(3) 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.

**CRADA number:** FRA-2006-0004

**CRADA Title:** A New PIT Nb3Sn Process Toward Improved Cost-Performance for HEP High Field Magnets

**Parties to the Agreement:** SupraMagnetics, Inc and Fermi Research Alliance, LLC

**Abstract of CRADA work:**

The development of improved, cost-effective Nb3Sn superconductors would have an immediate benefit for high field magnets in High Energy Physics (HEP) applications. This project will develop and demonstrate an economical powder-in-tube (PIT) Nb3Sn process for use in magnets for future HEP accelerator research. In Phase I, a low-cost, intermetallic, phasepure Cu5Sn4 powder was developed, a PIT Nb3Sn process was designed, and prototype Nb3Sn conductors were fabricated. A cost-performance analysis was conducted, which suggested that the approach will meet DOE goals. In Phase II, powder manufacturing will be optimized, and advanced PIT designs will be fabricated on intermediate size billets. The data will be used to assemble and manufacture a scaled-up prototype conductor. Material will be produced and made available for building and testing prototype cables and test magnets at DOE national laboratories.

In addition to HEP applications, an economical Nb3Sn superconductor would have application in high field magnets used in fusion machines and Nuclear Magnetic Resonance (NMR). For fusion machines, a successful demonstration would have enormous economic and social benefits. T

The scope of this CRADA is limited by the term of the Phase II SBIR grant (24 months) to include critical current and magnetization testing of a number of Nb3Sn strand samples, as well as cable fabrication and evaluation to assess and improve strand suitability to plastic deformation.

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**Summary of Research Results:**

We have introduced a new process utilizing Cu5Sn4 powder as a potential low-cost approach for the PIT process. Preliminary PIT wire with Cu5Sn4 cores show good

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processing and drawing characteristics. Filament diameters on the order of 25 micron have been achieved in prototype conductor designs. Heat treatment at 675°C for times up to 60 hours resulted in thick A15 layers of about 10 micron with corresponding grain size of 100 nm to 200 nm.

Short sample critical currents were measured at various applied magnetic fields from 10T to 15T at Fermi National Laboratory. The non-Cu Jc in sample wires presented in this work were 1855 A/mm² to 2037 A/mm² at 12T. The corresponding n-values were on the order of 50. These results are presented in Figure 7. The critical temperature, Tc, was 18K. These measurements were performed at Brookhaven National Laboratory. In comparison to previous work on PIT Nb3Sn conductors with NbSn2 cores,[10] the present performance characteristics as shown in Figure 7 are comparable. Moreover, the new PIT approach with the Cu5Sn4 cores promise lower materials and processing costs.

Related Reports, Publications, and Presentations:


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Subject Inventions listing:

None

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Technical Contact at Fermilab: Victor Yarba

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