Fine-Filament MgB$_2$ Superconductor Wire

For turboelectric aircraft propulsion systems and numerous commercial uses

Hyper Tech Research, Inc., has developed fine-filament magnesium diboride (MgB$_2$) superconductor wire for motors and generators used in turboelectric aircraft propulsion systems. In Phase I of the project, Hyper Tech demonstrated that MgB$_2$ multifilament wires (<10 micrometers) could reduce alternating current (AC) losses that occur due to hysteresis, eddy currents, and coupling losses. The company refined a manufacturing method that incorporates a magnesium-infiltration process and provides a tenfold enhancement in critical current density over wire made by a conventional method involving magnesium-boron powder mixtures. Hyper Tech also improved its wire-drawing capability to fabricate fine multifilament strands.

In Phase II, the company developed, manufactured, and tested the wire for superconductor and engineering current density and AC losses. Hyper Tech also fabricated MgB$_2$ rotor coil packs for a superconducting generator. The ultimate goal is to enable low-cost, round, lightweight, low-AC-loss superconductors for motor and generator stator coils operating at 25 K in next-generation turboelectric aircraft propulsion systems.

**Applications**

**NASA**
- Stator coils for all-electric aircraft
- Generators
- Motors
- Transformers
- Inductors
- Power conditioning equipment
- Magnetic bearings
- Actuators
- Magnetohydrodynamic magnets
- Propulsion engines
- Magnetic shielding in space
- Magnetic launch devices

**Commercial**
- Rotor coils for motors and generators
- Background magnets for magnetic resonance imaging (MRI) devices
- Inductive-type superconducting fault current limiters
- Resistive fault current limiters
- Low-speed direct-drive wind turbine generators
- Stators for generators and motors (50–400 Hz)
- Transformers
- Reactors
- Inductors

**Phase II Objectives**

- Develop high-filament-count, single-restack MgB$_2$ superconductors
- Optimize the double-restack conductor
- Reduce the twist pitch and develop MgB$_2$ conductors with a reduced number of magnetic components
- Develop MgB$_2$ superconductors with reduced transport current losses and different versions of MgB$_2$ cables
- Develop low-AC-loss second-generation MgB$_2$ superconductor wire
- Characterize the superconductivity and AC losses of MgB$_2$ wire, cables, and racetrack coils
- Deliver low-AC-loss MgB$_2$ wire to NASA and other collaborators
- Outline a follow-on Phase III program

**Benefits**

- Low cost
- Lightweight
- Low density
- Configurable in any critical current as a round wire
- Low AC loss

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