

SuperPower® 2G HTS Wire Specifications

Second-Generation High Temperature Superconductor (2G HTS)

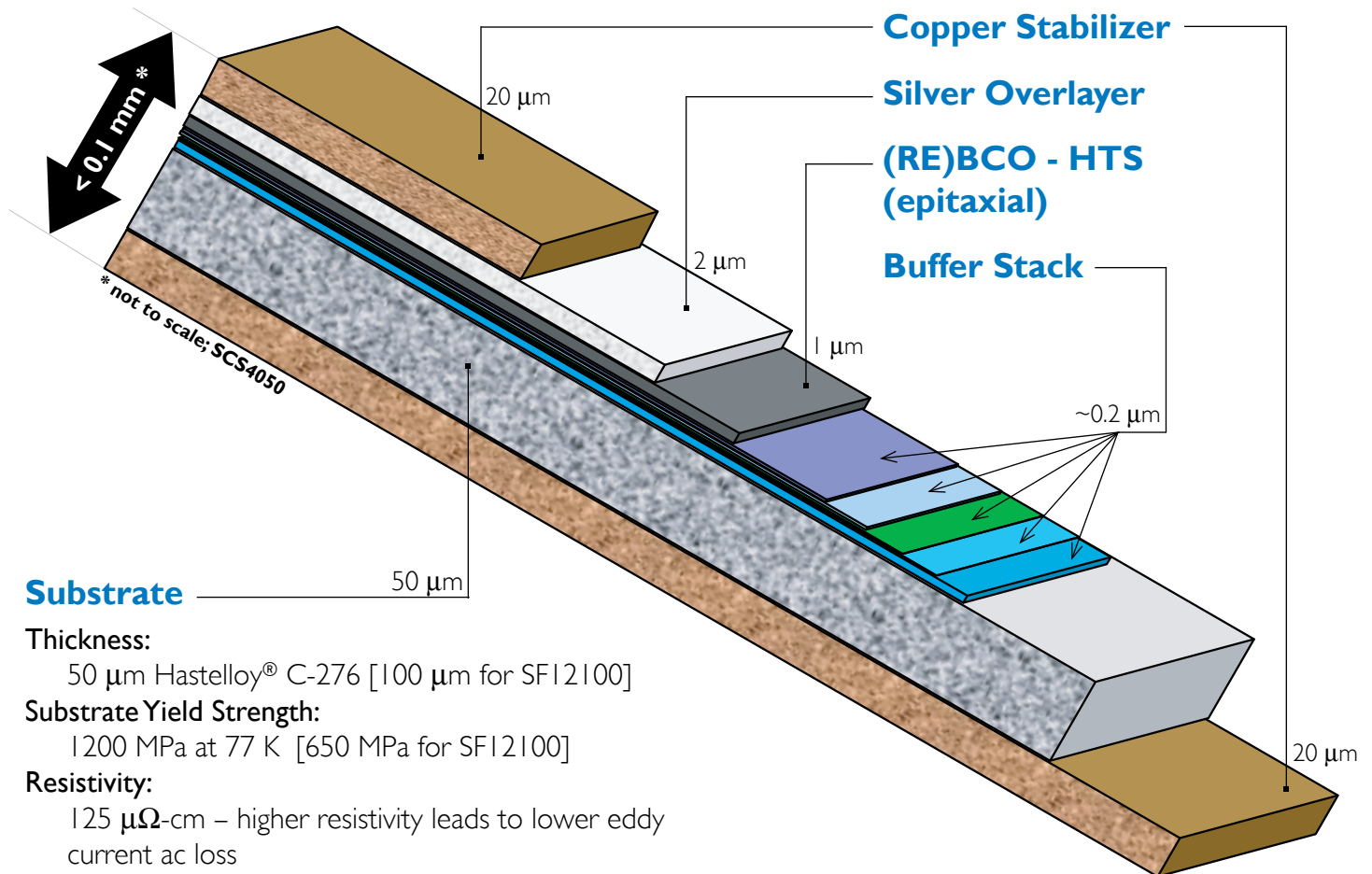
SuperPower has been developing (RE)BCO-based 2G HTS wire at its manufacturing plant in Schenectady, NY since 2000 and is now routinely producing long lengths of high performance wire that is being shipped to customers around the world for a wide range of applications.

SuperPower® 2G HTS Wire is produced in an automated, continuous process beginning with an inexpensive high strength metal alloy “tape” as the base substrate material and adding buffer layers, ceramic-based superconductor material and protective overlayers.

Once the wire has been slit into device-specific widths, Surround Copper Stabilizer (SCS) is applied to completely encase the wire. Overcurrent capability in SCS wire can be tailored to the specific application. The stabilizer protects the conductor and produces rounded edges that are beneficial for high-voltage applications. Further, the probability of failure in the device due to voltage breakdown is reduced in wire with SCS. SuperPower's SCS has been successfully implemented and tested on continuous lengths of hundreds of meters of wire.

SuperPower® 2G HTS Wire Specifications

Spec SF = Stabilizer Free SCS = Surround Copper Stabilizer	SCS3050	SF4050	SCS4050	SF6050	SCS6050	SF12050
Minimum I_c	60	80	80	120	120	240
Widths	3	4	4	6	6	12
Total Wire Thickness	0.1	0.055	0.1	0.055	0.1	0.055
Standard Copper Stabilizer Thickness	0.04	n/a	0.04	n/a	0.04	n/a
Critical Tensile Stress	> 550		> 550		> 550	
Critical Axial Tensile Strain	0.45%	0.45%	0.45%	0.45%	0.45%	0.45%
Critical Bend Diameter in Tension	11	11	11	11	11	11
Critical Bend Diameter in Compression	11	11	11	11	11	11



Thickness:

50 μm Hastelloy® C-276 [100 μm for SF12100]

Substrate Yield Strength:

1200 MPa at 77 K [650 MPa for SF12100]

Resistivity:

125 $\mu\Omega\text{-cm}$ – higher resistivity leads to lower eddy current ac loss

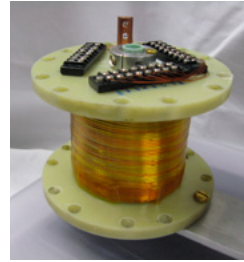
Magnetic Properties:

non-magnetic, leads to lower ferromagnetic ac loss

SuperPower'd™ for superior performance.

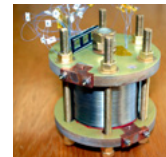
SCS12050	SF12100	Unit	Comment
240	200	amp	measured by continuous direct current
12	12	mm	
0.1	0.105	mm	
0.04	n/a	mm	surround stabilizer with rounded corners
> 550		MPa	at 77K
0.45%	0.4%		at 77K
11	25	mm	at room temperature
11	25	mm	at room temperature

SuperPower® 2G HTS Wire and coil application:



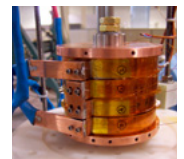
- **2009:** A high field magnet coil fabricated by SuperPower with its 2G HTS wire and tested at NHMFL again breaks world records when achieving a magnetic field of 27.4 Tesla at 4.2K in 19.89 Tesla background field

- **2008:** Coil fabricated by NHMFL with SuperPower® 2G HTS Wire was tested at 4.2K in 31 Tesla background field at NHMFL and achieved a new world record of 33.8 Tesla at an average winding current density of 459 A/mm²



- **2007:** High field magnet coil fabricated with 2G HTS wire and tested at NHMFL achieved a record magnetic field of 26.8 Tesla in 19 Tesla background field at 4.2K

- **2006:** High field coil fabricated with 2G HTS wire achieved a record magnetic field of 2.4 Tesla at 64K



We are ready TODAY to discuss your SuperPower® 2G HTS Wire needs for your specific application.

- Standardized testing provided with all wire deliveries
- Hermeticity - 24 hrs, 10 bar, LN₂, no change in I_c & thickness
- I_c uniformity in long lengths of 2G HTS wire: STDEV less than 10%
- Insulated wire is available (see back page for details)
- I_c values range from 80-110 Amps and higher at 77 K in 4 mm widths
- Engineering Current Density (J_e) = 21 – 29 kA/cm²

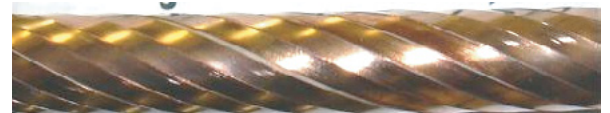
Other custom configurations are available.

Please visit us at <http://www.superpower-inc.com/content/request-quote>, or by email at sales@superpower-inc.com, with your specifications, including:

- Wire length, width and thickness requirements
- Performance characteristics (critical current, stress, etc.)
- Silver overlayer and/or copper stabilizer preference
- Other physical or performance characteristics
- Delivery timeframe
- Application

SuperPower has produced a number of prototype devices utilizing 2G HTS SCS Wire, including:

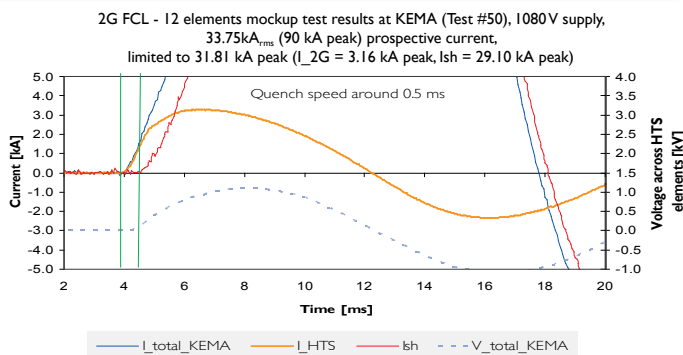
- The world's first in-grid Power Cables utilizing 4 mm wide 2G HTS wire were fabricated by Sumitomo Electric Industries with SuperPower's wire

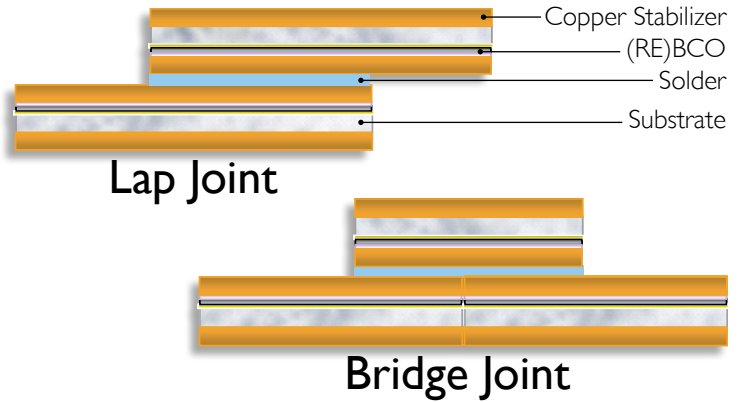
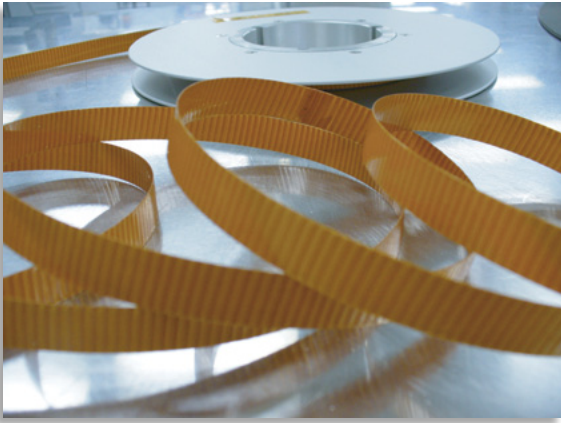


- Measured AC losses in a sample cable were 0.36 W/m at 1000A_{rms} (I_{op/peak}/I_c ~ 65%, 60 Hz) over the entire cable structure

Other applications:

- 2G HTS Wire Type SF12100 with highly resistive substrate is suitable for fault current limiter (FCL) applications. First peak limitation demonstrated with fast response time, low quench current, and rapid recovery.



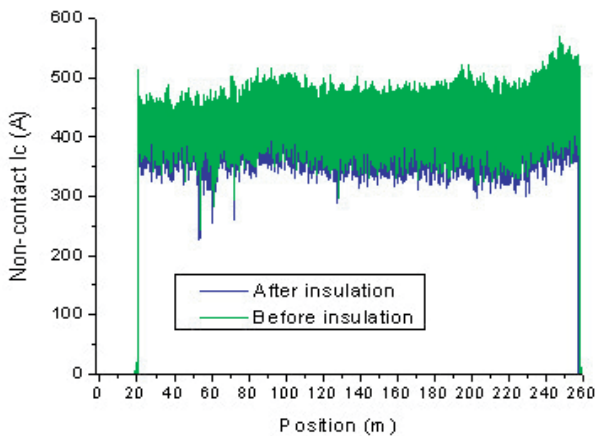


Insulated 2G HTS Wire

SuperPower offers in-house fabrication of insulated wire for a variety of applications. Available configurations include 4 mm and 12 mm wire widths.

Wire is insulated with 0.025 mm or 0.050 mm thick polyimide, both with a ~ 0.050 mm silicone adhesive. Wrapping styles are butt wrapped (no overlap) or an adjustable overlap of 0 to 50%.

After insulation, the wire is not accessible for transport current measurements at every 5 m in the reel-to-reel test system. Therefore, a non-contact I_c technique is used to re-confirm the wire quality after insulation.



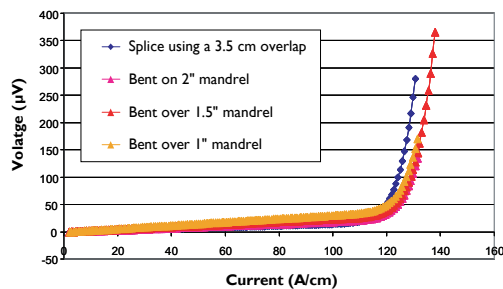
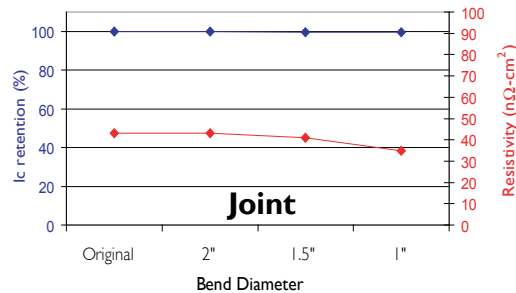
High Quality Joints

SuperPower Inc. routinely holds the world record in long, splice-free lengths of 2G HTS wire. Despite these long lengths, however, it is often necessary to splice wire segments together. Our low resistance, high quality joints and splices have a minimal effect on the superior performance of our wire.

- Base tape thickness = 0.1 mm
- Thickness at joint or splice = 0.22 mm (*about two times thinner than splices with 1G or other 2G wires!*)
- Joint length = 2.5 to 10 cm, or per customer specifications
- Temperature limit on solder up to 250°C (much higher than with other 2G HTS wires)

Joints between 2G HTS wires show excellent electrical and thermo-mechanical properties.

- No degradation in I_c ($1 \mu\text{V}/\text{cm}$) over the joint or splice
- No decrease in I_c and no increase in joint resistivity when bent over a diameter of 1 inch
- Minimum bend diameter at joint = 25 mm
- Joint resistivity = 40-50 $\text{n}\Omega \cdot \text{cm}^2$



FURUKAWA ELECTRIC

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