SuperPower Inc.
A Furukawa Company

superior performance. powerful technology.

Progress of 2G HTS Wire Development at SuperPower

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ASC 2016 Denver, USA ▪ 05 September 2016

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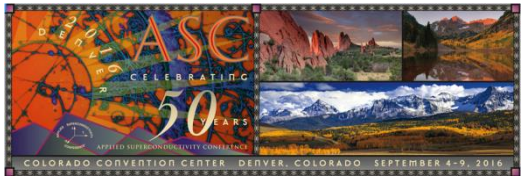
SuperPower Inc. is a subsidiary of Furukawa Electric Co. Ltd.

1MOr2A-03

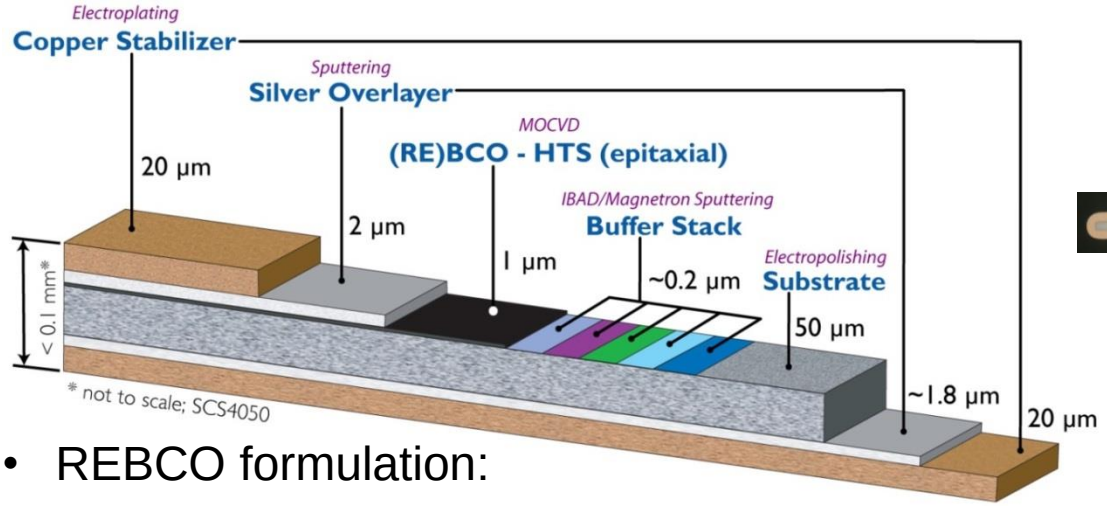


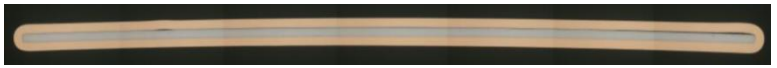
Outline

- Architecture and line-up of 2G HTS wire in SuperPower
- Conductor requirements for various applications
- Latest performance of 2G HTS wire in SuperPower
- New development in SuperPower
- Summary

2G HTS wire production at SuperPower

IBAD-MOCVD based REBCO wire on Hastelloy substrate





Cross-sectional image of a Cu-plated wire

- REBCO formulation:
  - **AP** (Advanced Pinning) – with enhanced in-field performance for B//c, targeting at coil applications such as high-field magnets, SMES, motors/generators
  - **CF** (Cable Formulation) – for cables, transformers
- I_c(77K, s.f.)/12mm = 400-600A, piece length = ~500m.
- Variations in width (2-12mm), substrate thickness (30, 50 or 100µm)
  Ag thickness (1-5µm), Cu thickness (10-115µm), and insulation
- Bonding conductors : 2x2mm, 2x4mm, 2x12mm (face to face / back to back)
- Product lineup is expanding

Demanding applications and conductor requirements

- Our wires are being utilized for device/equipment development for many applications, including high-field magnets, accelerator magnets, fusion magnets, SMES, motors/generators, SFCL, etc.

- Conductor requirements
  - High Ic(B,T,θ) performance
  - Uniformity along length/across width
  - Robustness
  - Long piece length
  - Thinner substrate, Thicker substrate

- Continuous development and improvement driven by customers
  - Innovative conductor design
  - Processing optimization and control
  - In-line inspections
  - Property and quality measurements

- Higher performance + higher yield $\rightarrow$ lower cost/price

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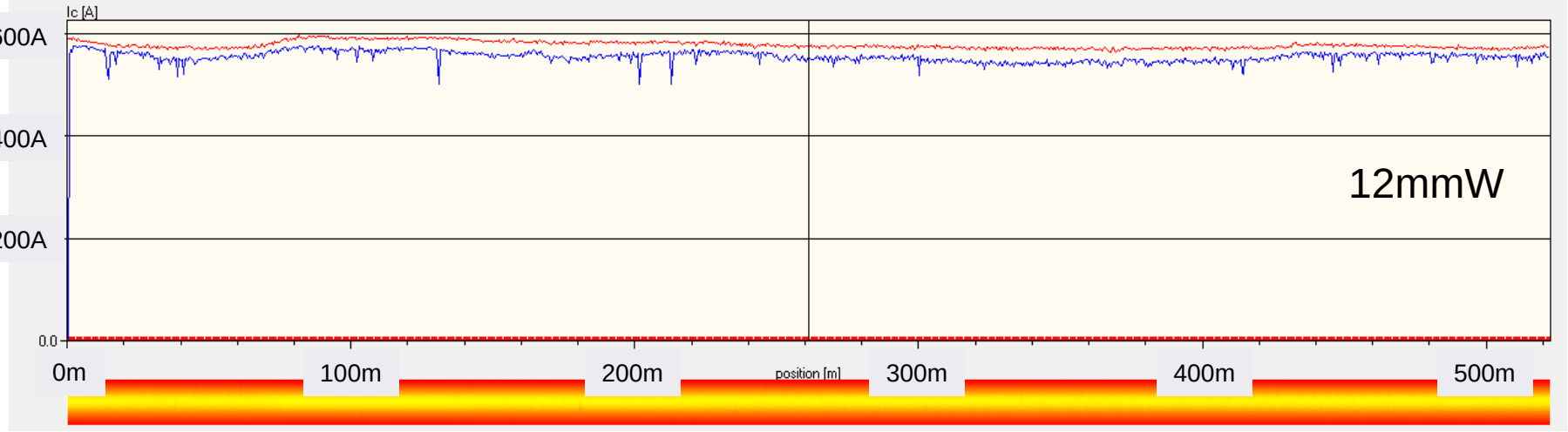
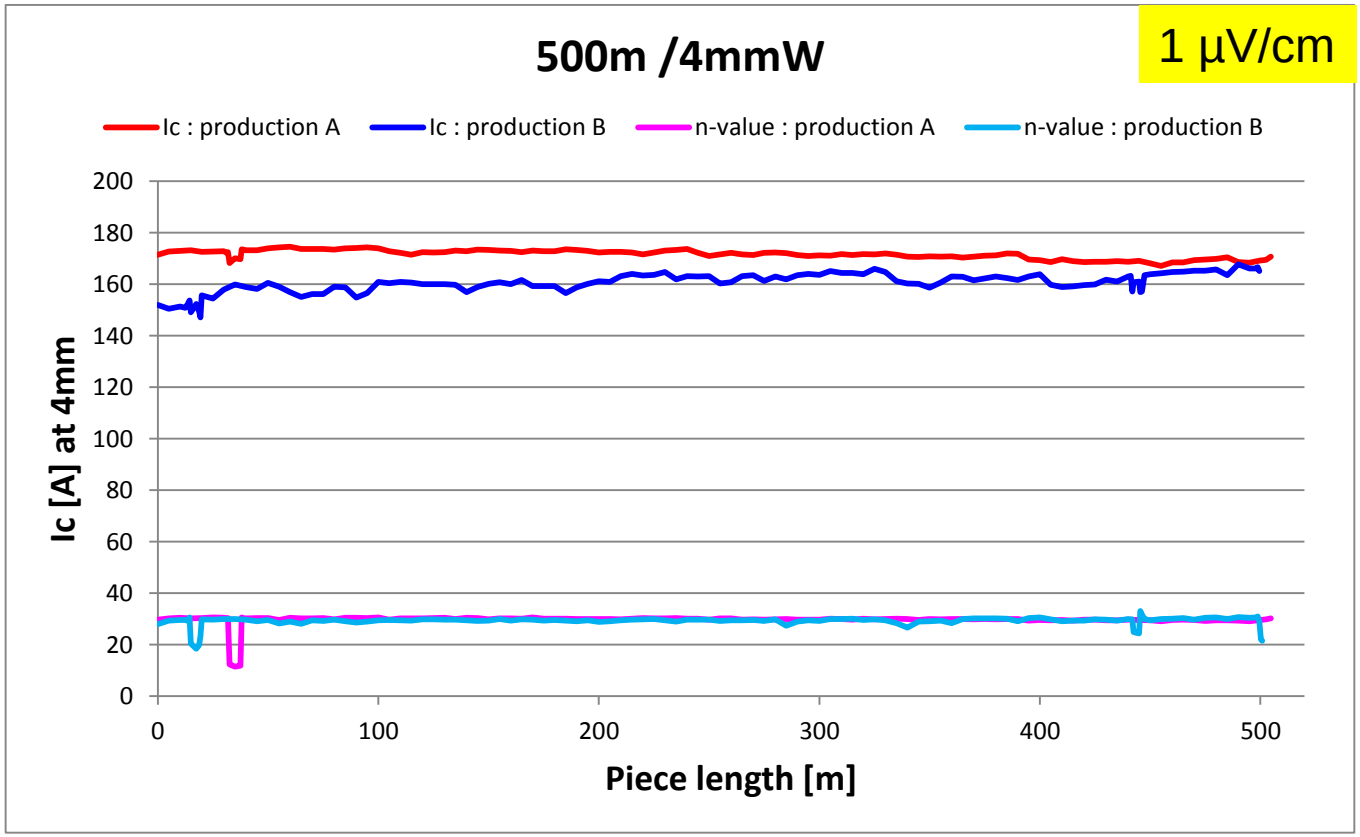
Ic performance of Enhanced A.P wire at 77K/s.f



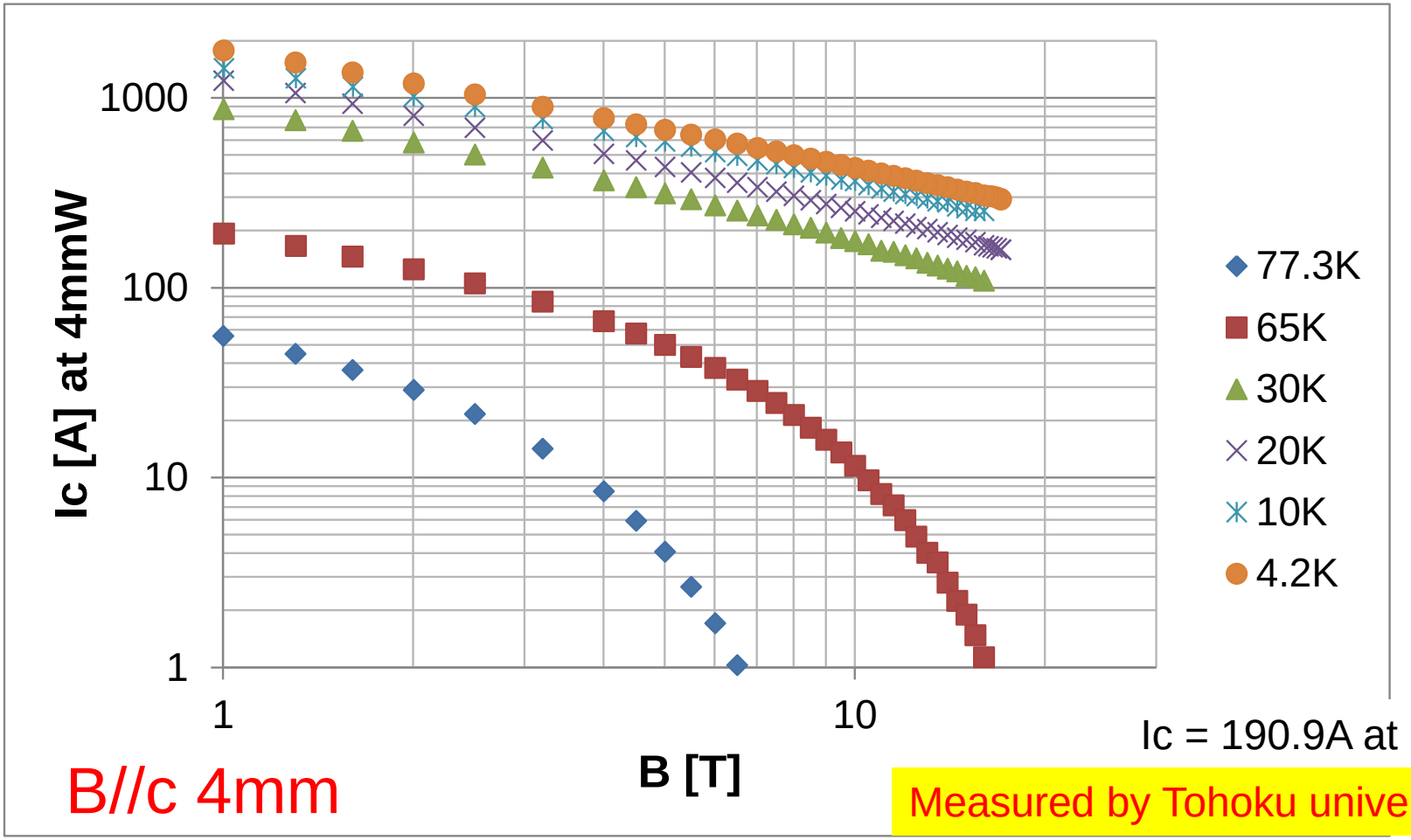
- Magnetic, non-contact measurement
- High special resolution, high speed, reel-to-reel
- Monitoring I_c at multiple production points after MOCVD
- Capable of quantitative 2D uniformity inspection

Ic performance of Enhanced A.P wire at 77K/s.f



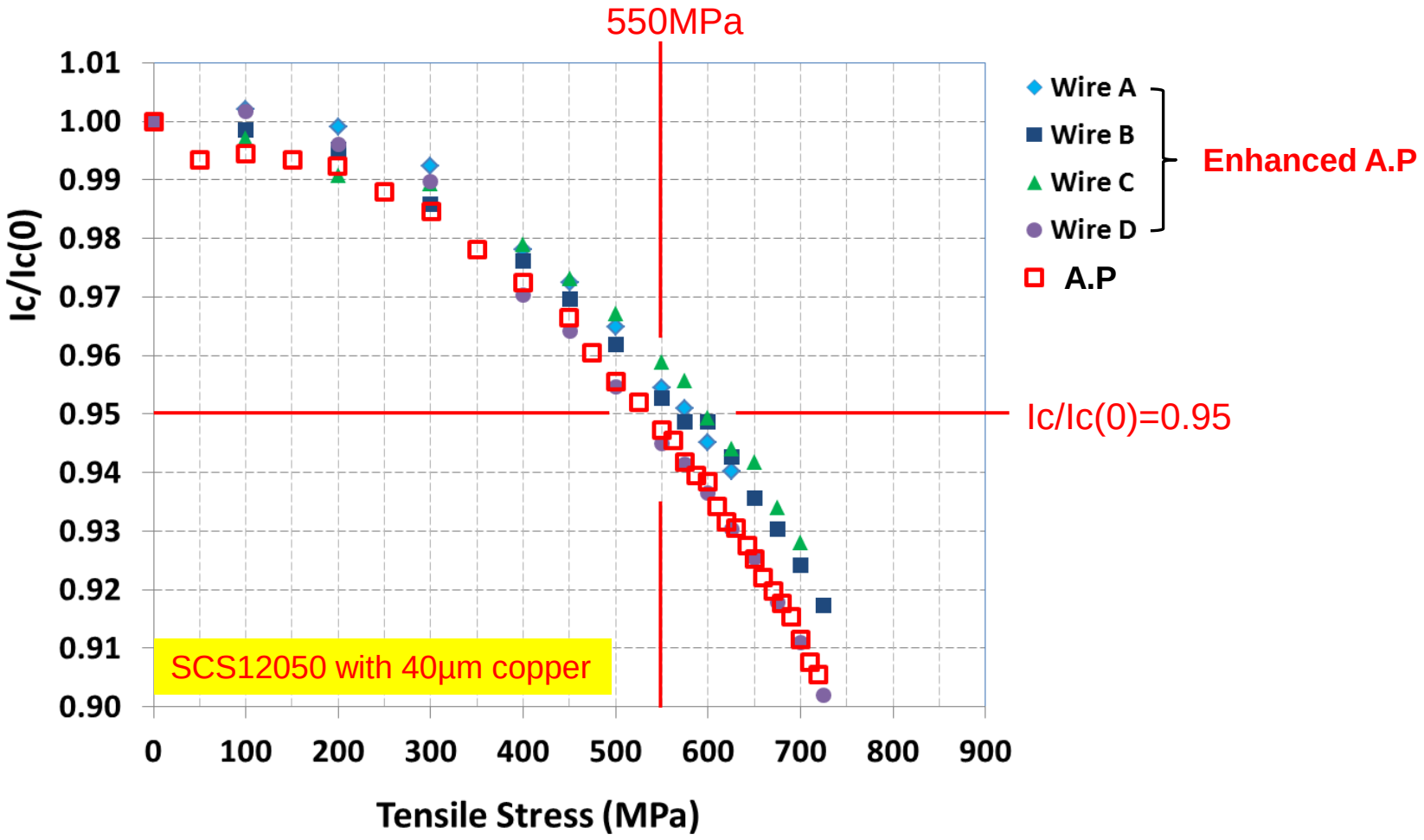
- Transport measurement by every 5m, with 40µm copper.
- Extend the piece length up to 500m

The Performance of Enhanced A.P wire



- Enhanced A.P wire shows high in-field performance

Electromechanical property - Ic under tension at 77K



5MOr1A-05 : Mechanical and electromechanical property study of 2G HTS wires made on 30µm thick Hastelloy substrate

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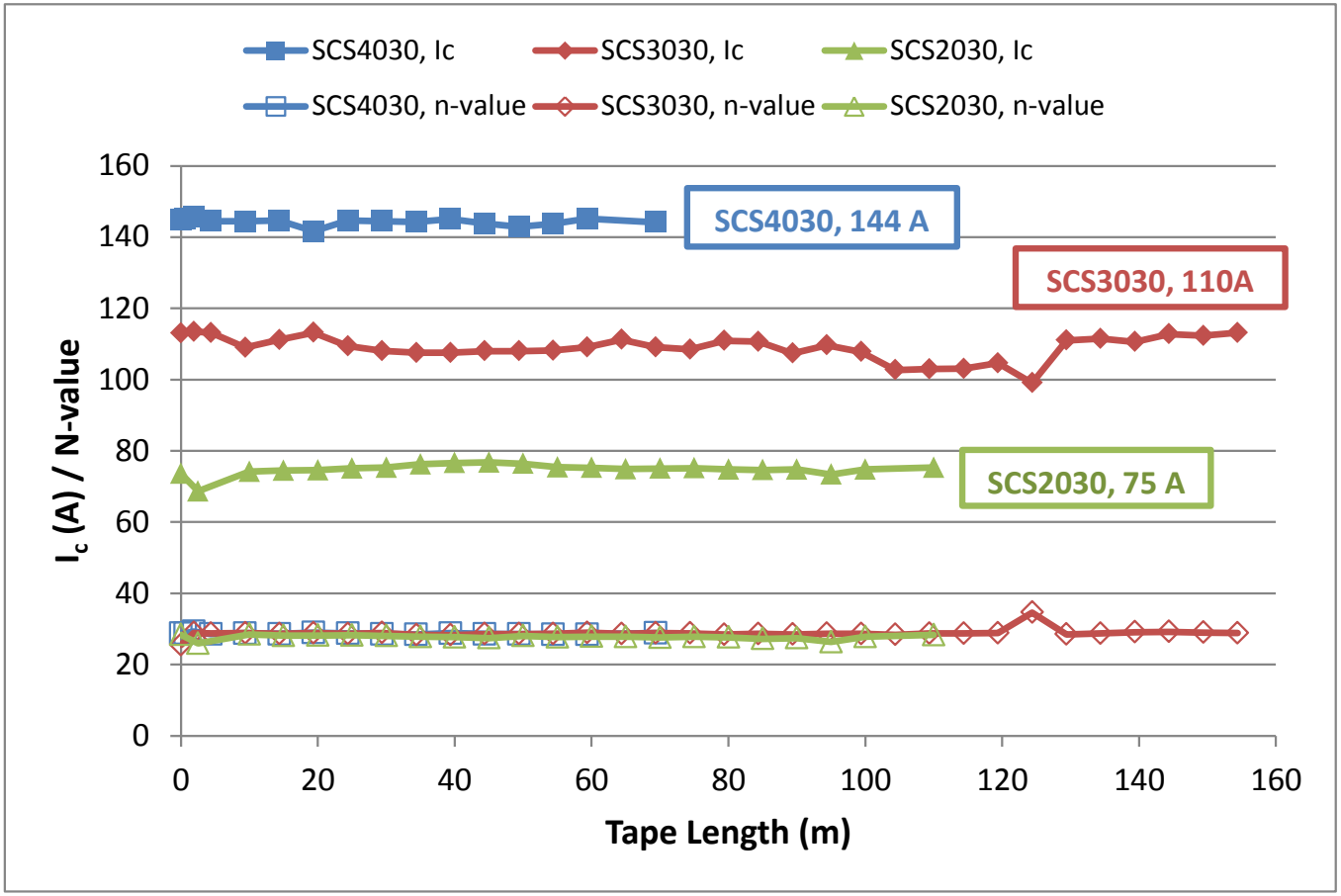
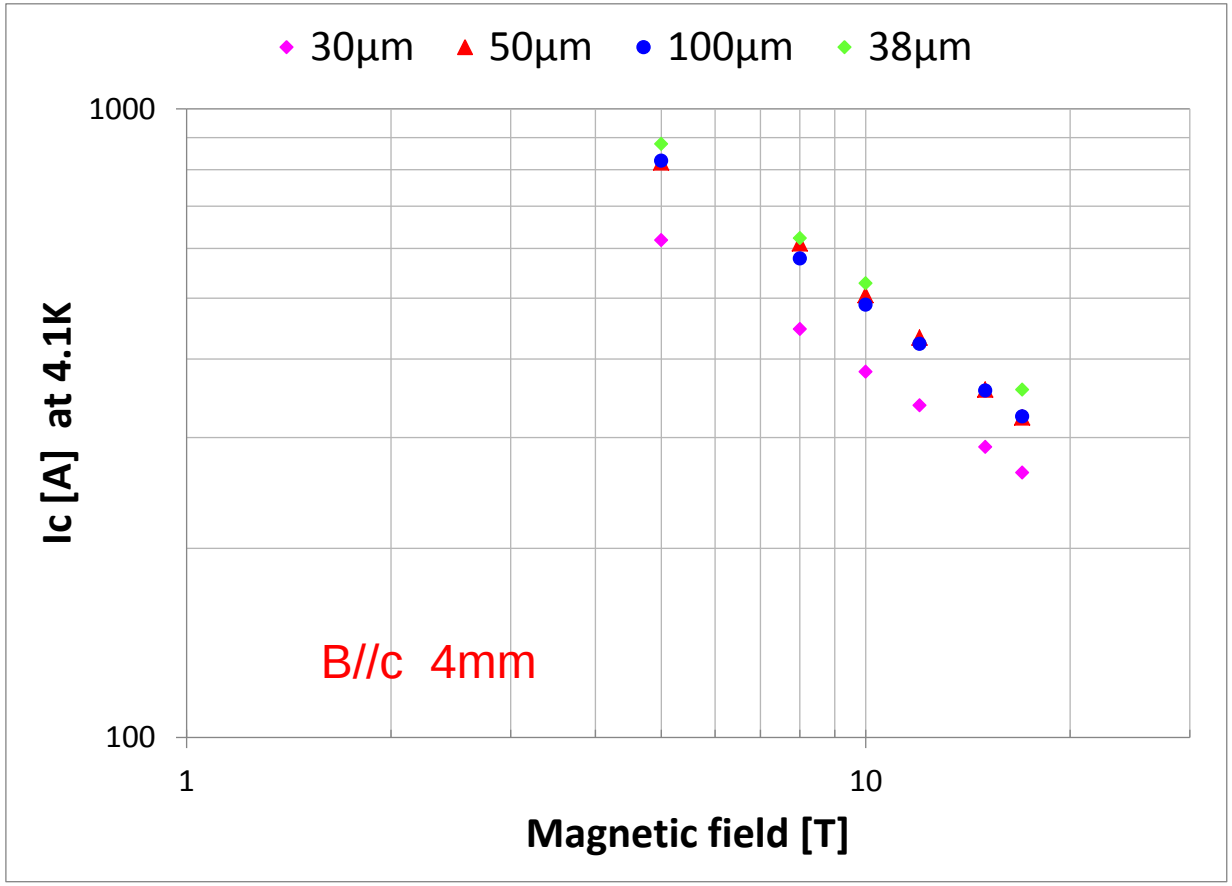
Development progress of 30µm substrate



- Base performance of 30µm substrates are almost same as 50µm.

Ic performance on various substrates

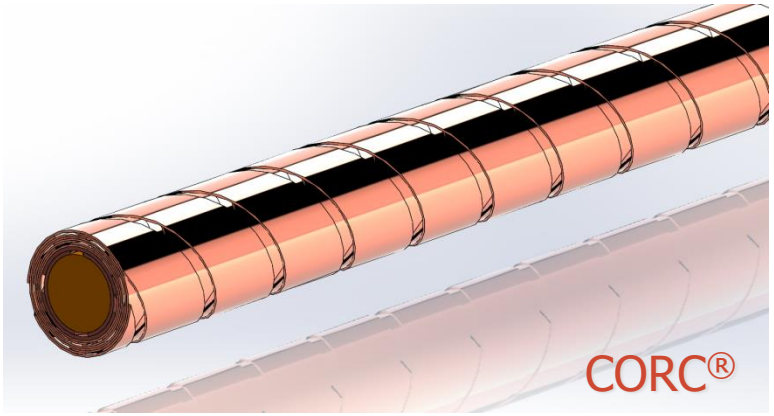


- The Ic performances at 4.1K are comparable on various substrates.
- 30µm substrate is still in developing.

CORC® wires using SuperPower tapes

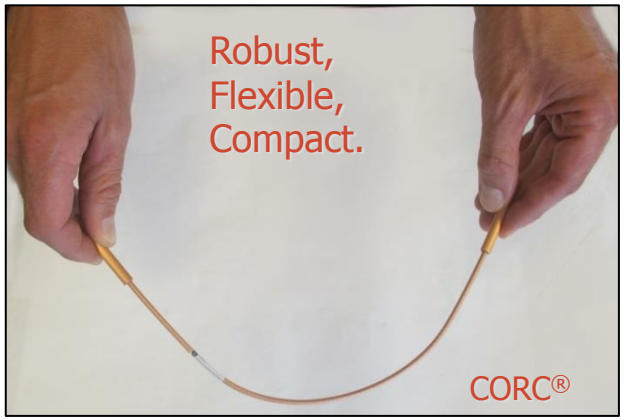
16 superpower tapes wound helically

- Copper core: 2.2 mm diameter
- 2 mm wide tapes with 30 µm substrate
- 6 mm twist pitch with partially transposed tapes for low AC loss
- Wire outer diameter: 3 mm
- Terminal diameter: 6.35 mm
- Nominal wire I_c: > 1,000 A (77 K)

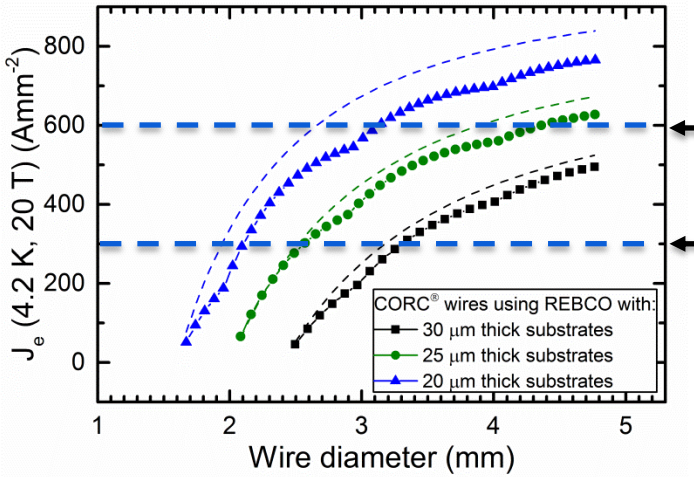


Applications

- High field magnets
- Accelerator magnets
- Fusion magnets
- High power density transmission



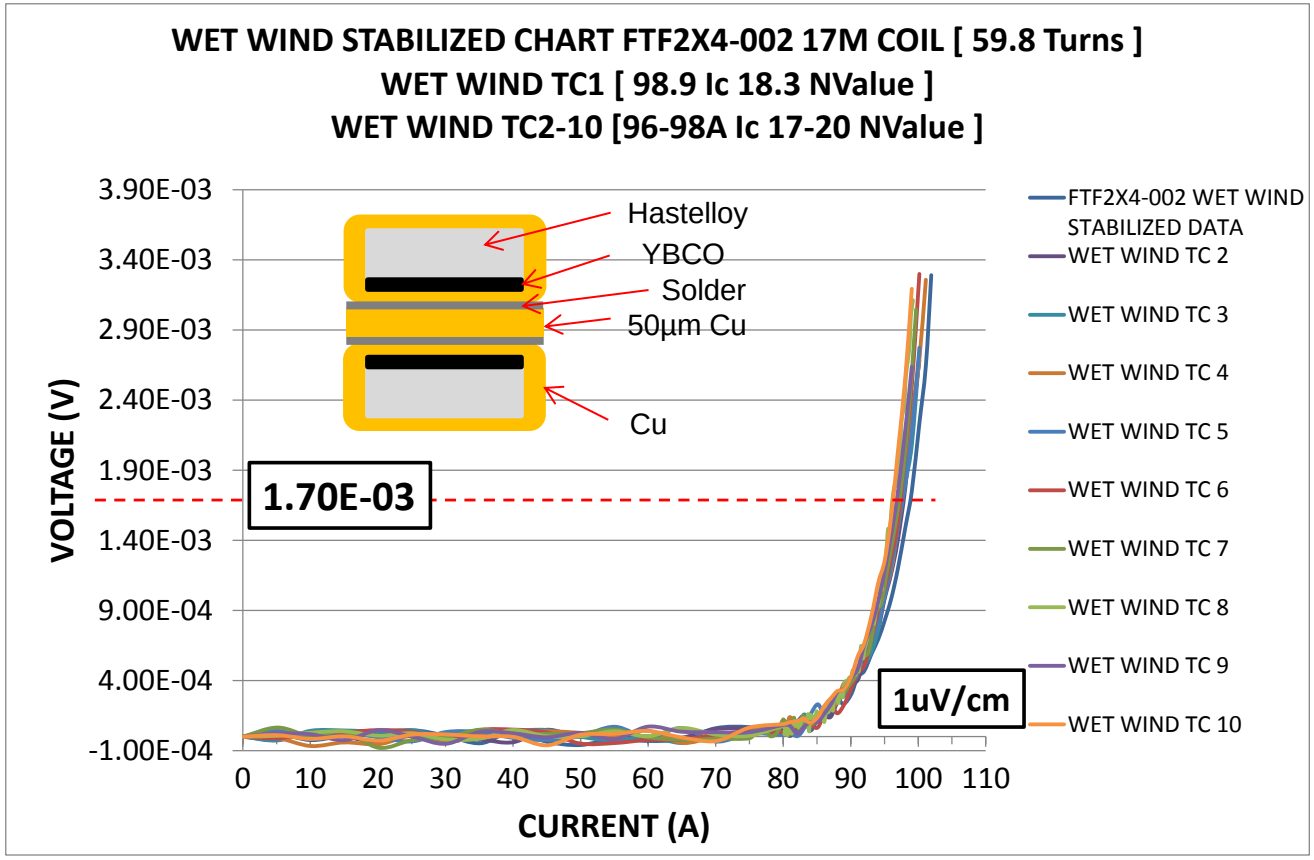
High magnetic field critical current density obtainable by increasing wire diameter and decreasing substrate thickness



2LPo2D-01 : Enhanced flexibility of round HTS CORC® wires for high-field magnet applications

4SPOr3A-04 : Improved current density and flexibility in CORC® magnet cables and wires

Bonding conductors



- Bonding conductor : Face to Face, 2 x 4mm, total thickness ~200µm
- No degradation after 10 times thermal cycles

4LPo2K-06 : Development of 2G HTS conductor for a FCL Transformer

Summary

- Enhanced A.P wire achieved a high performance with ~300A at 4.2K/17T, 4mmW.
- Keep the same mechanical property on enhanced A.P wire.
- The Ic performance at 4.1K are comparable on various substrates. 30 μm substrate is still in developing.
- No degradation on bonding conductor.

Thank you for your attention

SuperPower Inc.
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