superior performance. powerful technology.

HTS Conductor Forum –
Representative Manufacturer’s Point of View
DW Hazelton
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Engineering progress drives 2G HTS adoption

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Wire performance critical to practical applications

- $I_c(B, T, \theta)$
  - Temperature, magnetic field and field orientation dependence of $I_c$
  - Minimum $I_c$ at operating condition
- Mechanical properties (electromechanical performance)
  - Workability for fabrication into various devices
  - Irreversible stress or strain limits under various stress condition, in terms of $I_c$
- Uniformity along length ($I_c$ and other attributes)
- Thermal properties (thermal expansion coefficient and thermal conductivity)
- Quench stability (NZPV and MQE)
- Insulation (material and method)
- Splice
  - Resistance (resistivity)
  - Mechanical strength (tensile and bending)

*Standards for 2G HTS wire property testing are under development*
SuperPower’s ReBCO superconductor with artificial pinning structure provides a solution for demanding applications

- Hastelloy® C276 substrate
  - high strength
  - high resistance
  - non-magnetic
- Buffer layers with IBAD-MgO
  - Diffusion barrier to metal substrate
  - Ideal lattice matching from substrate through ReBCO
- MOCVD grown ReBCO layer with BZO nanorods
  - Flux pinning sites for high in-field \( I_c \)
- Silver and copper stabilization
$I_c(B,T,\Phi)$ characterization is critical to understanding the impacts of processing on operational performance.

Measurements made at the University of Houston

- Lift factor, $I_c(B,T)/I_c(sf, 77K)$, particularly a full matrix of $I_c(B, T, \Phi)$ is in high demand.
- Frequently sought by coil/magnet design engineer, for various applications.
- Used to calculate local $I_{op}/I_c$ ratio inside coil body, and design quench protection.
$I_c$ uniformity along length (TapeStar, transport)

- Magnetic, non-contact measurement
- High spacial resolution, high speed, reel-to-reel
- Monitoring $I_c$ at multiple production points after MOCVD
- Capability of quantitative 2D uniformity inspection
Engineering new wire innovations to address customer requests and meet application requirements

• Additional wire insulation methods
  – Today: Kapton®/Polyimide wrapped
  – Other options under development: thinner profile, better coverage

• Additional wire architectures under development
  – Higher current carrying capability
    • Multi-layer combinations
    • Cable on Round Core (CORC)
    • Roebel cable
  – Custom attributes
    • FCL – normal state resistance feature

ROEBEL cable made by KIT with SuperPower® 2G HTS Wire

Courtesy: Advanced Conductor Technologies
Capability for bonded conductors being developed [higher amperage, specialty applications (FCL)]

- Bonded conductors offer the ability to achieve higher operating currents
  - LV windings of FCL transformer
  - HEP applications
  - High current bus applications
- Bonded conductors offer higher strength
  - FCL transformer fault currents
  - High field HEP applications with high force loadings
- Bonded conductors offer the ability to tailor application specific operating requirements, i.e. normal state resistance for a FCL transformer
Summary

• SuperPower 2G HTS conductor offers a flexible architecture to address the broad range of demanding applications requirements.

• SuperPower is engaging major resources in improving its manufacturing capabilities to deliver a consistent, reliable, high quality 2G HTS product
  – Improved consistency of lift factor
  – Improved piece length
  – Improved current density
  – Improved uniformity

• Alternative conductor configurations are being developed to address customer demand