

Understanding Our Needs

SC Power Systems, Inc.

Woody Gibson, Managing Director

Presented to:

US DOE

**Superconductivity Program for Electric Systems
'2006 Wire Development Workshop'**

**Observations and decisions about where we go as a
commercial enterprise in the HTS enabled world**

About SC Power Systems

1986
HTS Discovered

1987
First Patent

1997
FCC Mk1

1999
FCC Mk2

2003
FCC Mk3

1999

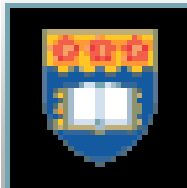
2004



1988



1994



2004



2005



2005



Why superconductors and the need for 2nd Generation Wire?

Superconductors reduce energy losses in: Transport of electricity from one point to another and creates useful magnetic fields

- Transformers
- Cable wires
- Coils
- Fault Current Limiters
- UPS Backups (SMES)
- Active Power Filters
- Motors/Generators
- The production of strong magnetic fields
- Medical (MRI)

Parameter	Pulsed Laser Deposition (PLD)	E-Beam	MOC VD	Sol gel	CVD	Aerosols/spray pyrolysis	MOD	Electrodeposition	Electrophoresis
<h1>Subjective Evaluation</h1>									
<i>Chemical and material related</i>									
Raw material availability/cost	2	2	4	4	2	2	1.5	2	2.5
Chemical stability	2.5	3	3.5	4	2	2.5	3	2.5	2.5
Continuous/semi-continuous system	3	2.5	3	3	3	3.5	3.5	3	2.5
Film stoichiometry	2	2.5	3.5	2.5	4	3	2.5	4	4
Large area coverage	4	2.5	3.5	2	4	3	2	2.5	3.5
Film surface quality	2	2	2.5	2.5	4	4	3	4	3
Material utilisation efficiency	3.5	3	4	3	4	3	2.5	3	
<i>Engineering and environment related</i>									
Process complexity	3.5	2	3.5	3.5	4	4	3.5	3	3
Energy needs	4	3.5	3.5	3.5	4	3.5	3	4	3.5
Controllability	3	3	3.5	3.5	4	4	3	3.5	3.5
Automation	4	3	3.5	3.5	4	3.5	3	2.5	2.5
Reproducibility	2.5	3	3.5	3.5	4	4	3.5	3.5	3.5
Current status/development needed	3.5	3	3.5	3.5	4	4	3.5	4	3.5
Scale up potential	3.5	2.5	3.5	4	4	3.5	3.5	4	3.5
Environmental acceptability	2.5	3.5	4	4	3	3.5	4	3	3
Safety	3	3.5	3.5	3.5	4	2.5	3.5	2.5	2.5
Waste management	2.5	3.5	4	4	4	3	4	3	3
Corrosion	2	3	3.5	3.5	4	2.5	4	3	2.5
Toxicity and health hazards	3	3	3.5	3.5	4	3	3.5	3	3
Total Score	56	54.	67	64	70	62	60	60	59

Need for more Intelligent Controls for 1000X Variables in HTS wire Manufacturing

Introduction to Run-to-Run Control

- Manufacturing: multiple copies of same product
- Product quality determined *after* manufacturing (run)
- Product quality is influenced by *recipe variables*
- Recipe variables are *pre-set* and *fixed* during the run
- Run-to-Run control problem:

Adjust recipe for next run based on results of previous runs such that product quality improves

Our Next Generation 3-D HTS Wire Under Development

3-D Superconducting wire - Process materials and Process steps.

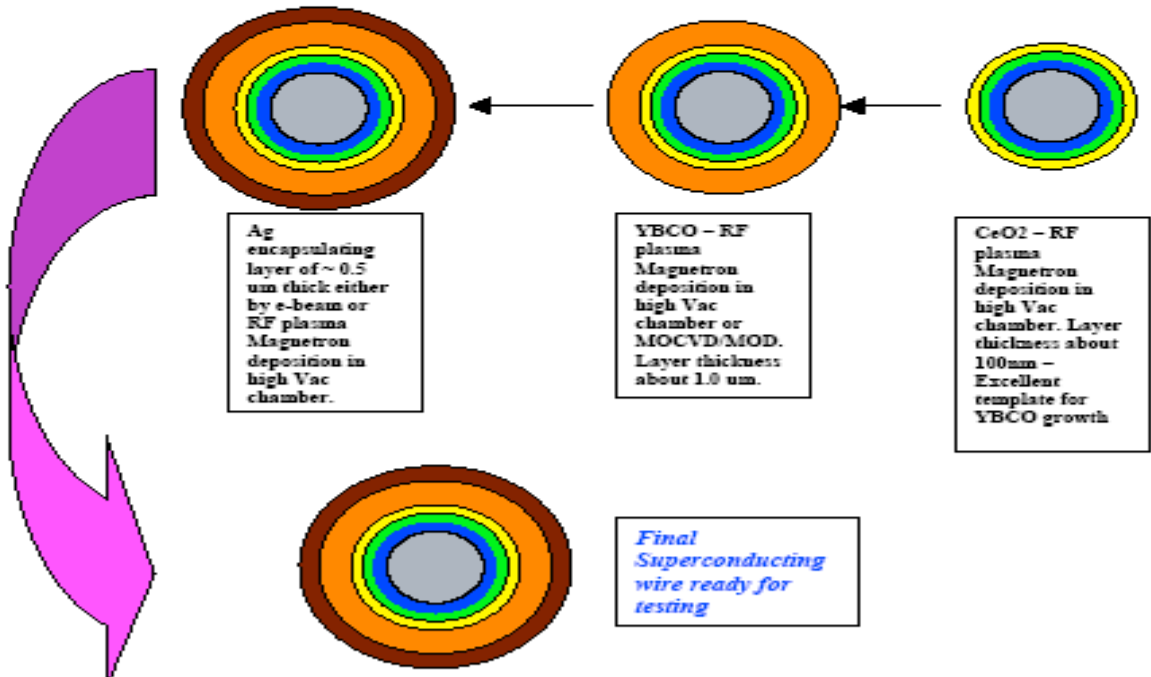
Ni Alloy Round Wire

Thorough cleaning of wire with Alcohol

Thermo-mechanical Texturing of Wire - to be done at Colorado School of mines

Y2O3 - RF magnetron plasma deposition in high Vac chamber. Layer thickness about 100nm - provides good adhesion to metal oxide and epitaxial across the interface

YSZ - RF plasma Magnetron deposition in high Vac chamber. Layer thickness about 100nm - Blocks metal atom diffusion



Ag encapsulating layer of ~ 0.5 um thick either by e-beam or RF plasma Magnetron deposition in high Vac chamber.

YBCO - RF plasma Magnetron deposition in high Vac chamber or MOCVD/MOD. Layer thickness about 1.0 um.

CeO2 - RF plasma Magnetron deposition in high Vac chamber. Layer thickness about 100nm - Excellent template for YBCO growth

Final Superconducting wire ready for testing

Note: If we compare the Critical current capacity (Ic) between 4mm width flat conductor and 4mm dia. round conductor—Round conductor gives 314% higher capacity when compared to 4mm flat conductor coated on one side- 157% higher when compared to double sided coated flat conductors. Because of buffer layers, the alignment of YBCO grains will not be disturbed even under short radius bends of wire.

What are our needs?

- Low cost high performance HTS wire
 - To enable our HTS enabled (FCL/FCC, Transformers, SMES and Active Power Filters devices for power quality improvement.
 - For power quality magnetic field performance to enhance our manufacturing clients' requirements who have motors and generators under development for Hydro and Wind power generation equipment.
- BSCCO-2223 is proving successful presently, but won't meet all our requirements in two years time.
- 100s of kilometers of low-cost next generation HTS wire in two years time.
- If someone else can't supply it we will manufacture it.

We will sign CRADAS with DOE Labs &

Universities to assist us in the below activities

- We have on-going **Development** in several Universities worldwide and our own development facility.
- We have joint manufacturing agreements in place.
- We are developing 'Intelligent Control Systems'.
- We have targeted three coated conductor HTS processes. May the best one win.
- We do not fund material science (MS) research. We fund MS for development to make a product as fast as possible for profit for our investors and support of our customers' needs.
- We have looked at almost all the on-going HTS R&D and have an open mind to explore any application that has a chance.

How can DOE Labs Help Us

- Joint directed development and testing of HTS coated conductors.
- Intelligent control systems (software) and conversion of defense monitoring and testing equipment.
- High power testing of HTS enabled prototype devices. Monitoring and observing how HTS coils react in-field to different high power loads.
- Joint study on how HTS enabled power devices can help the Homeland respond to power losses due to natural disasters and man-made power losses.