Status of 2G HTS Wire Production at SuperOx

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SuperOx, Moscow, Russia
Outline

- About SuperOx
- 2G HTS wire characteristics
- New customization options for 2G HTS wire
- Development for applications at SuperOx
SuperOx

- SuperOx company founded in November 2006 in Moscow
- 2011: SuperOx Japan LLC founded in Tokyo
- 2012: starts production of 2G HTS wire in Russia and Japan
- 2014: delivers 2G HTS to customers in 10 countries worldwide
SuperOx (Moscow)

- production of 2G HTS wire
- development of process equipment
- R&D
- quality control
- development of HTS equipment
- market development

850 m² / staff - 25
SuperOx Japan LLC

- production of 2G HTS wire
- quality control
- R&D
- market development

220 m² / staff - 5
Structure of 2G HTS Wire

Customization
(silver/copper/solder/lamination/isolation)

Substrate
- polishing or planarisation
- buffer layers

HTS layer
# Plans to develop Production in Moscow

<table>
<thead>
<tr>
<th>Stage</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substrate</td>
<td>outsource</td>
<td>outsource</td>
<td>outsource</td>
</tr>
<tr>
<td>Polishing</td>
<td>SuperOx</td>
<td>SuperOx</td>
<td>SuperOx</td>
</tr>
<tr>
<td>Buffer layers</td>
<td>SuperOx Japan</td>
<td>SuperOx</td>
<td>SuperOx</td>
</tr>
<tr>
<td>HTS</td>
<td>SuperOx Japan</td>
<td>SuperOx Japan</td>
<td>SuperOx</td>
</tr>
<tr>
<td>Customization</td>
<td>SuperOx</td>
<td>SuperOx</td>
<td>SuperOx</td>
</tr>
</tbody>
</table>
Production Localization in Russia

SuperOx plans to retain production units both in Japan and Russia

- 2013: 25% + extended customization
- 2014: 40% + buffer layers
- 2015: 70% + HTS layer
- 2016: 95%

Invited Presentation given at CCA 2014, Jeju Island, Korea, Nov. 30 - Dec. 03, 2014.
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### Basic 2G HTS Wire Structure

<table>
<thead>
<tr>
<th>Layer</th>
<th>Thickness/Formation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hastelloy C276</td>
<td>Cold-rolled electropolished (60-100 microns)</td>
</tr>
<tr>
<td>$\text{Al}_2\text{O}_3$</td>
<td>DC sputtering (1-2 microns)</td>
</tr>
<tr>
<td>$\text{LaMnO}_3$</td>
<td>RF sputtering-2 (30-50 nm) at T1</td>
</tr>
<tr>
<td>$\text{IBAD - MgO}$</td>
<td>RF sputtering-2 (30-50 nm) at T1</td>
</tr>
<tr>
<td>$\text{CeO}_2$:RE</td>
<td>RF sputtering-2 (30-50 nm) at T1</td>
</tr>
<tr>
<td>RBCO</td>
<td>PLD-1 (100-200 nm) at T1</td>
</tr>
<tr>
<td>Ag</td>
<td>PLD-2 (1-3 microns) at T2</td>
</tr>
</tbody>
</table>

**Dual-Chamber PLD system**

- **PLD-2 (1-3 microns)**
- **PLD-1 (100-200 nm)**

**Single Chamber**

- Ion beam assisted deposition with RF sputtering (5-7 nm)
2G HTS Wire Properties

Long tapes with critical current of 500 A/12 mm available
Long tapes with critical current of 150 A/12 mm available

2G HTS Wire Properties

Invited Presentation given at CCA 2014, Jeju Island, Korea, Nov. 30 - Dec. 03, 2014.
2G HTS Wire – Our Progress in 2012-2014

March 2014

September 2013

July 2014

<table>
<thead>
<tr>
<th>Year</th>
<th>Ic x Length (A-m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>14</td>
</tr>
<tr>
<td>2013</td>
<td>53</td>
</tr>
<tr>
<td>2014</td>
<td>130</td>
</tr>
<tr>
<td>2015</td>
<td>234</td>
</tr>
</tbody>
</table>
# Short Summary

**Customization:**
- Any silver thickness
- Any copper thickness
- Lamination
- Isolation
- Solder-plating
- Joints
- ... we consider any other options

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single piece length</td>
<td>up to 500 m</td>
</tr>
<tr>
<td>Substrate thickness</td>
<td>60 or 100 microns</td>
</tr>
<tr>
<td>Width</td>
<td>4 mm</td>
</tr>
<tr>
<td>Ic (77K, sf)</td>
<td>100-150 A</td>
</tr>
<tr>
<td>Ic uniformity</td>
<td>±10%</td>
</tr>
</tbody>
</table>
Ic in Magnetic Field

Source:
RRI U Wellington,
HTS-110

4 mm wire

Invited Presentation given at CCA 2014, Jeju Island, Korea, Nov. 30 - Dec. 03, 2014.
Pretty good reproducibility of lift factors at 77K

Source: 4 institutes in Russia + MIT
Lift Factor at 4 to 77K

\[
\frac{I_c(B,T)}{I_c(77K,\text{sf})}
\]

- 5 K ENEA
- 4 K NHMFL
- 4 K CRPP
- 4 K U Geneva
- 20 K ENEA
- 40 K ENEA
- 65 K ENEA
- 77 K ENEA

\[
I_c(20 T, 4.2K) = I_c(77K, \text{sf})
\]
Lift Factor at 4.2 K

Good reproducibility of lift factors at 4K too
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Surround Polyimide Coating

- Alternative to wrapping – more uniform and thinner insulation

Variable thickness PI coating

- bare tape
- new SuperOx process
- standard dip coating
Solder-plated wire

- Useful for making stacks or as alternative stabilization

Variable thickness solder plating

~ 200°C PbSn
~ 120°C SnIn
~ 100°C PbBiSn (Rose’s metal)

etc...
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blocks made from 2G HTS wires provide stable levitation over PM

viable alternative to HTS bulks – any form and size possible

Levitation force is larger than 1 kg per 1 m of 12 mm 2G HTS tape
Thank you for your attention!

www.superox.ru/en