**Development of round flexible HTS CORC® wires for fault current limiting applications**

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**CORC® topology**

Conductor on Round Core (CORC®) conductors consist of High Temperature Superconducting (HTS) tapes wound helically around a small former:

- CORC® power transmission and Fault Current Limiting (FCL) cables and wires were developed with support of the U.S. Navy and in collaboration with the Center for Advanced Power Systems at Florida State University.
- CORC® conductors form a unique solution for power transmission needs in liquid nitrogen or pressurized helium gas.

HTS tapes are layered and transversed:

- Can incorporate any number of normal and superconducting tapes to tailor operating current, normal state resistivity, and thermal management.
- Direct contact between each tape and up to 8 other tapes.
- Several paths for current sharing adds electrical stability.
- Several thermal contacts allows proficient cooling.
- Such high level of current sharing is not available in conventional HTS FCL cables that typically require laminates.

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**Conductor response to pulsed overcurrents**

Overcurrent testing of CORC® FCL wires in nitrogen:

- Electric field as a function of various applied overcurrents for both wires:
  - Optimized wire 2 develops orders of magnitude more voltage than wire 1 at same applied overcurrent.

Optimized wire 2 develops sufficient voltage to divert overcurrent to parallel resistive path:

- Peak current in FCL wire 2,700 A after 3 ms.
- FCL voltage 10 V/m after 5 ms.
- Current in FCL wire back below Ic after 10 ms, while maintaining ~10 V/m over hybrid cable system.
- Constant voltage suggests CORC® wire remains at constant temperature, although dissipation at ~10 kW/m.
- Rapid cool down requires switch to isolate the CORC® wire.

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**Recent test of CORC® power transmission cable in He gas**

- 2-Pole CORC® power transmission cable.
- 10 meter long twisted pair cable layout.
- Results suggest that Ic (peak), at 50 K, would be > 10,000 A.

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**Conclusions**

CORC® cables and wires can be operated as Fault Current Limiters:

- Current sharing between tapes in CORC® cables/wires allows us to produce FCL conductors without the need for laminates.
- Low thermal capacity and high normal resistance allow for very fast response to fault currents.
- Response time is nearly instantaneous, with voltage rise following the current ramp which takes 3-4 ms rise-time to reach Ic := 2.5.
- Fast acting CORC® FCL wire demonstrated with 50 V/m after 5 ms of overcurrent in LN2.

A hybrid CORC® FCL system was successfully demonstrated:

- 10 V/m after current pulse rise-time of 4 ms.

Extensive cycling did not degrade the CORC® FCL conductors.

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**Design of wires for overcurrent testing**

<table>
<thead>
<tr>
<th>Sample name</th>
<th>Ic at 76 K (A)</th>
<th>Ic at 76 K (A/mm²)</th>
<th>Total wire diameter (mm)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CORC FCL wire 1</td>
<td>646</td>
<td>80</td>
<td>3.2</td>
<td>Typical CORC® power transmission wire</td>
</tr>
<tr>
<td>CORC FCL wire 2</td>
<td>1124</td>
<td>99</td>
<td>3.8</td>
<td>CORC® wire optimized for FCL application</td>
</tr>
</tbody>
</table>

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