Development of Al-stabilized superconductor

Wuxi Toly Electric Works Co., Ltd.
Zhao Yu, Sep. 2022
zhaoyu@toly.com.cn
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5. Summary
Wuxi Toly Electric Works Co., Ltd was established in 1992
Application areas: power equipment, new energy, superconducting magnet
Background

Toly & WST

Toly & Hyper Tech

Toly & IHEP

MT 24, Seoul

CERN

HTS magnet committee
Features
- High filling factor
- High Jc
- High mechanical strength

Parameter design
- Number of strands/wire diameter
- Pitch/twisting angle
- Filling factor
## Rutherford cable

<table>
<thead>
<tr>
<th>Items</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire numbers</td>
<td>$12 \times 4 = 48$</td>
</tr>
<tr>
<td>Diameter</td>
<td>$\phi 0.5 \sim 1.5 \text{mm}$</td>
</tr>
<tr>
<td>Wire tension</td>
<td>$0 \sim 40 \text{N}$</td>
</tr>
<tr>
<td>The speed of rotary movement</td>
<td>$12.5 \text{rpm}$</td>
</tr>
<tr>
<td>The speed of production</td>
<td>$0 \sim 10 \text{m/min}$</td>
</tr>
</tbody>
</table>

![Machine Image](image_url)
Rolling head

The processing technology:
- Twisting
- Shaping

Change in cross section of cable

The main mould:
- Mandrel
- Rolling head

Rutherford cable
Al-stabilized superconductor

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Extrusion wheel diameter/mm</th>
<th>Rod diameter/mm</th>
<th>Cable thickness/mm</th>
<th>Cable width/mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>400</td>
<td>2*9.5~12</td>
<td>3.0~30.0</td>
<td>10.0~70.0</td>
</tr>
</tbody>
</table>
Al-stabilized superconductor

1. Al rods/cable releaser
2. Ultrasonic cleaning
3. Extrusion machine
4. Cooling system
5. Caterpillar tractor
6. Take-up machine
打造全球领先的绕组线企业

Al-stabilized superconductor

NbTi strand → Rutherford cable → Al-stabilized NbTi/Cu superconductor

ReBCO tape → ReBCO Stack Cable → Al-stabilized ReBCO Stacked tape cable

LTS

HTS
The production of dummy cable

- Dimensions
- Surface quality
- Mechanical properties

Key process control: the mechanical strength of the aluminum rod, the rotation speed of the extrusion wheel, the preheating temperature of the cavity mold, the gap between extrusion wheel and mold.
Al-stabilized superconductor for CEPC detector magnet

- **The process of secondary extrusion**
  - The first time with high-purity aluminum: 10*33mm
  - The second time with aluminum alloy: 22*56mm

- **Doped aluminum alloy materials**
  - Goals: high mechanical strength, high RRR value
Al-stabilized superconductor for the Emus project

- Kilometer length al-stabilized superconductor
  - Length: 1490m, 1517m, 1550m
  - Dimension: 4.7*15mm
Al-stabilized superconductor for the Emus project

Test result:
- Yield strength: 159MPa
- Shear strength: 36MPa
Al-stabilized superconductor for CEPC detector magnet (HTS)

The process of ReBCO Stack Cable

The process of Al-stabilized ReBCO Stacked tape cable

building the best enterprise of magnet wires in the world
Al-stabilized superconductor for CEPC detector magnet (HTS)

- Short Al-stabilized ReBCO Stacked tape cable
  - Tensile strength of aluminum rod: 60MPa
  - Temperature of the cavity mold: 500°C

Problems: the core cable is not centered, and the contact time during high temperature procedure is too long
We have carried out the production of short cable for many times……

We will make long cable in the next three months

Short ReBCO Stacked tape cable
Toly Electric is participating in several pre-research projects of CEPC, mainly responsible for the fabrication of superconducting cables.

We have found some difficulties and problems in the R&D. We are working hard to find new solutions.

In the future, the group will increase budget for the R&D of Al-stabilized superconductor.
Thanks for your attention!