Nondestructive testing of high strength conductors for high field pulsed magnets

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ABSTRACT

High field pulsed magnets at the NHMFL use high strength conductors near their ultimate tensile strength. So stringent quality assurance of these conductors is critically important.

Here we present results of our nondestructive testing (NDT) of Glidcop AL-60 wires using Eddy current testing, ultrasonic testing and x-ray tomography (2D and 3D) methods. The advantages and disadvantages of each method are compared. We have successfully developed the capability for a long length eddy current wire inspection.

EXPERIMENTAL

1. X-ray at Delphi Precision Imaging Inc.

North Star X-5000 system
• 225 kV microfocus tube.
• 16’x16’, 200 µm pixel detector.
• Resolution 13 – 28 µm.
• Both 2D and 3D (CT) scans.

Sample stage

2. Eddy current at NHMFL

Olympus N600 eddy current flaw detector
Olympus EPOCH 650 ultrasonic flaw detector

A. Internal chevron cracks

Central bursts or 'chevron' cracks occur in cold drawn wire when lubrication is inadequate, or the drawing die geometry is not optimized. They cannot be seen by visual inspection. We found chevron cracks in Glidcop AL60 wires.

B. Surface cracks and inclusions

Ferromagnetic surface inclusions
Eddy current signal from surface inclusions

C. Long length inspections

Long length eddy current testing capability for AL60 wires and precursors is developed. This picture shows surface inspection of 0.54” diameter long-length AL60 precursor wire has been developed.

SUMMARY

We have been developing NDT methods for quality assurance of high strength conductors for pulsed magnets. Eddy current, ultrasonic and x-ray (2D and 3D) inspection were used on Glidcop AL-60 wires. Chevron cracks were found in Glidcop AL60 wires by all three NDT methods. In addition, surface inclusions were found on finished wires as well as on an AL60 precursor. We have developed a long length eddy current wire inspection capability.

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