Nondestructive testing and minimizing defects in high-strength conductors for use in pulsed magnets

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The MagLab's high-field pulsed magnets use wires made of high strength copper alloys and nanocomposites operating near their mechanical breaking points. Since flaws in the conductor can drastically shorten the lifetime of a magnet, it is important to ensure the wires are free of flaws. It is known that internal chevron-shaped cracks can occur in high-strength materials during the drawing process due to a number of causes, among them an unsuitable drawing-die schedule, too-rapid drawing speed, or inadequate lubrication. In addition, very small dents and inclusions of foreign materials on the wire surface also can also compromise the performance of the final wire.

The MagLab developed non-destructive testing (NDT) techniques for inspection of Glidcop AL60 wires (copper wires containing alumina particles) to be applied when the precursor wire arrives from commercial vendors after consolidation and extrusion, but prior to drawing the material to its final dimensions. The techniques include eddy current testing (ECT), x-ray radiography, and ultrasonic testing.

Chevron cracks were found in some AL60 conductors by all three NDT techniques. Surface inclusions were also found by ECT. As such, an ECT wire inspection capability suitable for long wire lengths was developed and implemented, along with a method to repair surface defects and a method to minimize the chance of creating chevron cracks.

Although all pulsed magnets eventually fail due to high mechanical stresses, the MagLab expects the lifetime of future pulsed magnets to increase due to these advances in quality control and improvement.

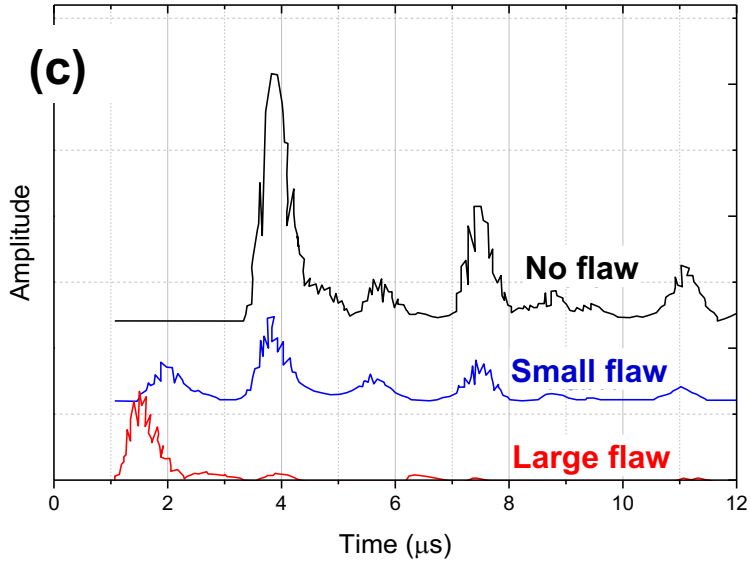

Fig (a) Eddy current inspection of a long length precursor. (b) A chevron crack found by x-ray tomography. (c) Ultrasound echo from flaws of different sizes. The flaw gives rise to the early echo (the peak near 2μs), as well as the diminished amplitudes of all the other echos.

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