Introduction

The National High Magnet Field Laboratory works in conjunction with the Los Alamos National Laboratory to construct large electromagnets. Magnets up to 100 tesla (T) (1.5 million to 4 million times the magnetic field of the Earth) have been successfully constructed. To achieve higher fields proposed conductive wires intended to compose the inner-most coil appear to be non-homogeneous toward fracture resistance when bending.

Objective

Microscopically determine the difference between two ends of 200m long Cu-Nb wire. Samples from the interior layer of the spool that was heat treated have fractured when bent to approximately 6mm (¼” inch) diameter mandrill. Samples from the exterior layer of the spool do not fracture when bent to the same diameter mandrill.

Samples were prepared for Scanning Electron Microscope (SEM) examination by the following steps:

1. Cross sections of each sample cut laterally with a high speed saw
2. Making the “puck” to hold the sample in the SEM
3. The “pucks” sanded and polished
4. Using the Scanning Electron Microscope to look at the samples

Procedure

Results

It was observed that after bending the filaments that start out all roughly the sample cross-sectional area changed due to differential stress. SEM images were the analyzed.

The zero strain point on the Exterior has shifted from 60% toward the inside of the bend to 40% for the Interior spool.

After plotting the individual points a contour map was generated. The interior spool had a wider range of strain and a higher maximum strain.

Contour maps were also generated on the unbent heat-treated section to try to determine if the initial strain was different, and whether heat treatment changed the filament arrangement. There is a slight difference, but not significant.

Conclusion

Based on our results, these are the three possibilities: a difference from the manufacturer of the wire; filament arrangement (geometry), and different heat treatment position of the wire.

Miscellaneous Images

The rapid change in strain of the interior spool indicates a greater susceptibility to fracture at a distance of about 750 to 900 micrometers from the outside edge.

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