IN-FIELD TRANSPORT PROPERTIES OF LTS CONDUCTORS UNDER STRAIN

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Introduction

It is known that the critical current (I_c) of Nb_3Sn conductor strongly depends on the strain [1]. At its operating temperatures, Nb_3Sn in the wire is compressively strained (pre-strained) due to the difference in thermal contraction between Nb_3Sn and Cu. During magnet operation, Lorentz force will exert additional tensile strain on the wires. Therefore, accurate knowledge of I_c strain dependence of Nb_3Sn wires is very important to the design of high field superconducting magnets, e.g. NMR and hybrid magnets. A device has been built to measure the critical current as a function of strain in large-bore high-field magnets [2]. In this work, we present Ic strain dependence results.

Experimental

The Nb_3Sn composite wires were heat treated in vacuum. 5 inches long straight wires were soldered to brass or stainless steel plates and mounted to the Ic-strain device where tensile strain up to 2% can be applied precisely. The experiment was performed at 4.2 K in the 20 T ϕ195 mm bore resistive magnet in cell 4 of the NHMFL.

Results and Discussion

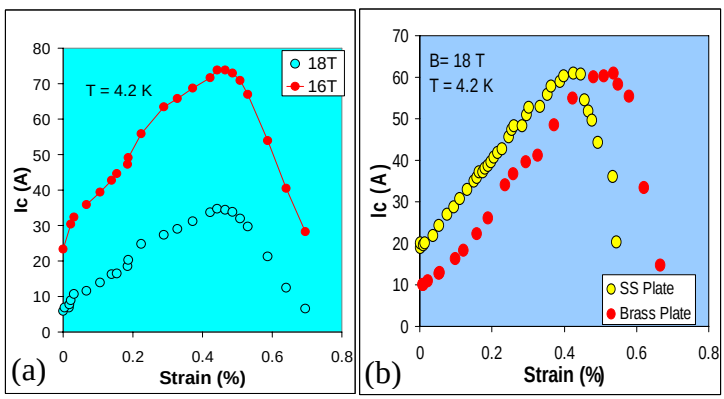

Figure 1. Critical current as function of tensile strain for Nb_3Sn wires soldered to backing plates. For (a) Mitsubish wire on a brass backing plate in different magnetic fields, and (b) Oxford superconducting technology wire in 18 T field with different backing plates.

Figure 1 is the strain dependence of critical current I_c. The n value shows similar strain dependence (not shown). For all the curves, the Ic increases near linearly with tensile strain before reaching a maximum value where the compressive pre-strain is presumably completely compensated by the applied tensile strain. Further straining decreases Ic at a rate faster than it increases. The acceleration of decrease of Ic indicates an occurrence of internal damage under large strain. Therefore, these curves are not symmetrical. Using a scaling law[3], a good agreement was established between our data and the data obtained at 12 T by the conductor manufacturers. The peak shift in figure 1(b) is believed to be from the thermal contraction difference between two backing plates.

Conclusions

Ic and n value is successfully measured as function of tensile strain in field up to 18 T. This work has been presented in Series-connected-hybrid magnet review meeting Keystone CA., Aug 2005, and Low Tc superconductor workshop at Napa CA 2005.

Acknowledgements

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References

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