I_C AXIAL STRAIN DEPENDENCE OF HIGH CURRENT DENSITY Nb_3Sn CONDUCTORS

J. Lu (NHMFL); K. Han (NHMFL); R.P. Walsh (NHMFL); J.R. Miller (NHMFL)

Introduction

Nb_3Sn superconductor technology is essential for the development of high field superconducting magnets. Many major projects at NHMFL involve the design and construction of high field superconducting magnets which requires high performance Nb_3Sn conductors [1]. Among important properties of Nb_3Sn is the critical current (I_c) strain sensitivity in high magnetic fields. In this work we use an I_c-strain measurement apparatus developed at NHMFL to characterize high performance Nb_3Sn wires that are candidate conductors for future large high field magnets development at NHMFL.

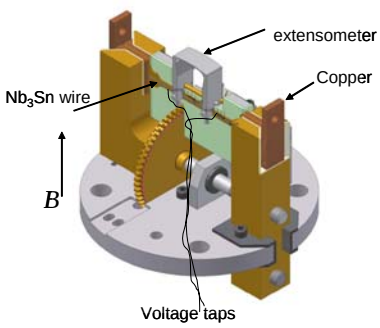

Fig. 1. A schematic of the I_c-strain apparatus at NHMFL.

Experimental

The I_c-strain measurement apparatus are depicted in Fig. 1. A ~150 mm long conductor is soldered to a dog-bone shaped backing plate that can be made of different materials. Two copper blocks act as both pull grips and current leads were soldered to the backing plate leaving ~100 mm conductor available for I_c strain measurement. An extensometer with a span of ~25 mm was mechanically clipped on the backing plate. Voltage taps of ~ 40 mm apart were soldered to the sample. A worm gear pulling mechanism was used to apply axial tensile strain. The apparatus was immersed in liquid He within a liquid helium dewar. A 20 T 195 mm bore resistive magnet at NHMFL is used for the measurements.

Results and Discussion

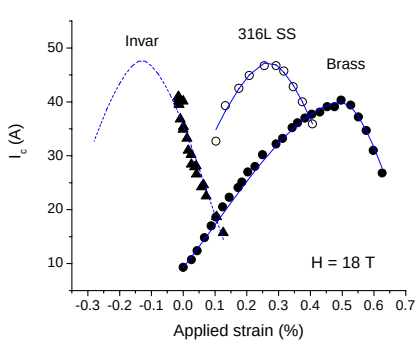

Fig. 2. I_c $-\varepsilon$ curves of Mitsubishi-1400 on difference backing plates in 18T field.

We measured the I_c strain curves of number of high performance Nb_3Sn wires. In addition, T_c strain characteristic was measured on one wire in a separate experiment to compare with the I_c-strain of the same wire. Fig. 2 shows an example of three identical Mitsubishi-1400 wires soldered to different backing plates including brass, stainless steel and Invar. The data were fitted using an established scaling law. [2] The fitted strain values corresponds to the maximum I_c are 0.50%, 0.27% and -0.13% for brass, stainless steel, and Invar respectively. This is consistent with our prediction assuming that the backing plate is dominant in the process of thermal contraction.

Conclusions

We have developed a unique apparatus for Nb_3Sn I_c strain dependence measurement taking advantage of the 195 mm bore 20 T resistive magnet at NHMFL. A number of conductors were characterized using this apparatus. The effect of the backing plate thermal contraction on the I_c strain behavior was studied. Our I_c-strain results from samples soldered on different backing plates show that the thermal strain of Nb_3Sn is approximately the thermal contraction difference between the backing plate material and Nb_3Sn.

Acknowledgements

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References

[1] Lu, J., *et al.*, The NHFML 2005 annual reports.
[2] Summers, L.T. *et al.*, IEEE Trans. Mag. Vol. 27, no. 2, pp. 2041-2044, 1991.