Critical Current Longitudinal and Transverse Strain Sensitivities of High J_c Nb_3Sn Wires

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Introduction

The series-connected hybrid magnet (SCH) under construction at the NHMFL uses high critical current density (J_C) Nb_3Sn strands. It is well known that J_C of Nb_3Sn decreases under strains. Unfortunately the high J_C Nb_3Sn wire is very sensitive to strains and the correlation between the J_C strain sensitivity and the strand design is not clear. Therefore experimental measurement is the only way to provide reliable J_C vs. strain characteristics which is crucial for a reliable SCH magnet design.

Experimental

An apparatus for I_C versus longitudinal strain measurements is designed and built [1] taking advantage of the 195 mm bore 20 T resistive magnet at the NHMFL. An I_C vs. transverse stress device (Fig. 1) is also designed for use in the same magnet.

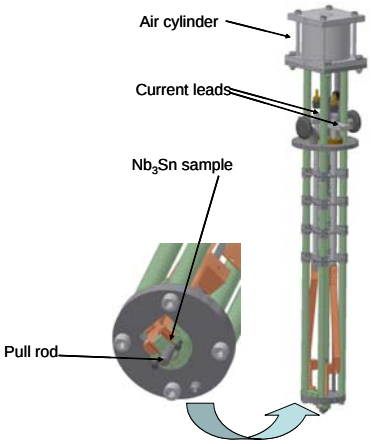

Fig. 1. Schematic of the device to measure *Ic* vs. transverse stress.

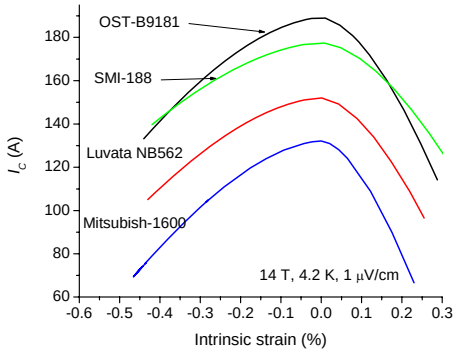

Fig. 2. I_C vs. intrinsic strain for SCH candidate wires at 14 T.

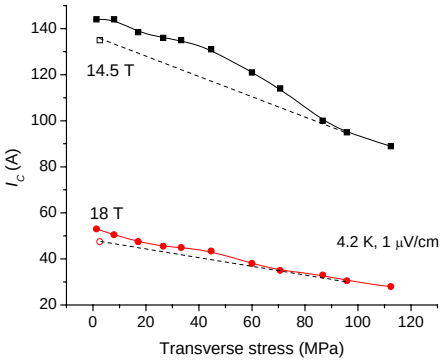

Fig. 3. I_C vs. applied transverse stress for the SMI-188 wire measured at 14.5 and 18 T.

Results and Discussion

Fig. 2 shows the I_C vs. intrinsic longitudinal strain for a few SCH candidate wires. The curves are calculated from experimental data using the Summers scaling law.[2] Among the candidate wires, OST B9181 and SMI-188 have higher I_C within the measured strain range. Fig. 3 is the I_C vs. transverse stress for the SMI-188 wire. The monotonic decrease of I_C with transverse stress is consistent with the behavior of low J_C wires reported in the literature.[3]

Summary

I_C of high J_C Nb_3Sn wires, candidates for SCH, is measured as function of longitudinal and transverse strains. I_C longitudinal strain sensitivities of these wires are compared. An apparatus has been developed to measure the I_C transverse stress dependence. Our results on the SMI-188 wire show that the transverse stress results in monotonic decrease of I_C. This behavior is consistent with results from the literature.

References

[1] Lu, J., *et al*., IEEE Trans. Appl. Supercond., **17** (2), 2639 (2007).
[2] Summers, L.T., *et al*., IEEE Trans. Mag., **27** (2), 2041-2044 (1991).
[3] Nishijima, G., *et al*., Cryogenics, **45**, 653–658 (2005).