Critical Current Irreversibility Strain of ITER High J_c Nb_3Sn Strands

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Introduction

The international thermonuclear experimental reactor (ITER) will use large quantity of Nb_3Sn wires for its superconducting magnets. The irreversible strain limit of a Nb_3Sn strand, the largest tensile strain under which the Nb_3Sn filaments are not yet cracked, is a crucial parameter for this application. In this work, the critical current (I_C) strain dependence and irreversible strains of four different ITER high J_C Nb_3Sn wires were measured.

Experimental

A home-made apparatus for I_C versus longitudinal strain measurements [1] is used in the 195 mm bore 20 T resistive magnet at the NHMFL.

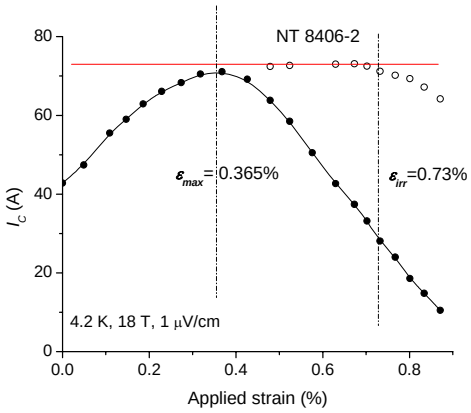

Fig. 1. I_C vs. strain curve of Luvata NT-8406-2 (filled circle). The empty circles are the I_C measured at ε_{max} after applying higher strains.

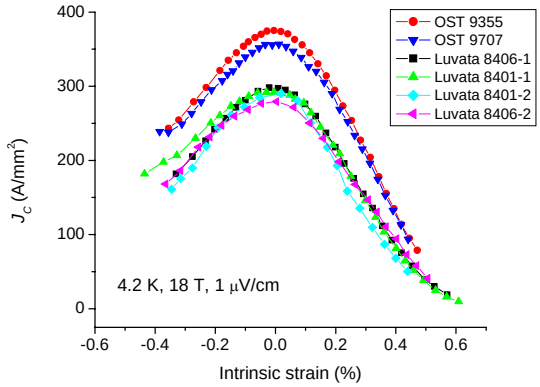

Fig. 2. A comparison of experimental results from all wires.

Results and Discussion

Fig. 1 shows a typical I_C vs. strain curve. The filled circles are the I_C measured at the strain according to the x axis, while the empty circles are the I_C measured at ε_{max} after being strained to the values according to the x axis. The irreversible strain ε_{irr} where the I_C at ε_{max} starts to decrease is indicated in the figure. Some details of this work are given in Ref. 2. Table 1 listed I_{Cmax} and irreversible strains measured by I_C and n values. Fig. 2 plots all the experimental J_C data measured for different wires at 18 T as function of intrinsic strain.

Table 1. The irreversible strains and maximum I_C for all samples

Sample	ε_{irr}- ε_{max} (I_C) %	ε_{irr}- ε_{max} (n) %	I_{Cmax} (A)
Luvata NT8406	0.45	0.42	76.0
Luvata NT8401	0.46	0.40	63.5
OST 9355	0.30	0.31	95.9
OST 9707	0.32	0.34	78.1

Conclusions

The irreversibility strains for four ITER Nb_3Sn wires were measured. The Luvata wires have higher ε_{irr} -ε_{max} than OST wires which however have higher I_{Cmax}.

References

[1] Lu, J., *et al.*, IEEE Trans. Appl. Supercond., **17** (2), 2639 (2007).
[2] Lu, J., *et al.*, MT-20 conference presentation, accepted for publication IEEE Trans. Appl. Supercond., (2008).