§22. Stress/strain and their Hysteretic Effects on the Critical Current of Superconducting Wire

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1. Introduction

Due to its high B_{c2}, Nb_3Sn superconducting wires are widely used for high field superconducting magnets. However the critical current I_c of them is known to be very sensitive to the applied stress/strain. Therefore the effect of stress/strain on I_c has to be evaluated. In this research, internal Sn diffusion process and bronze process Nb_3Sn wires for ITER TF coils (heat treated with 873K, 600h) with diameter 0.8mm were evaluated. The progress of the improvement of the stress/strain effect test apparatus is also reported.

2. Experiment.

An experiment for an evaluation of stress/strain effect is conducted by the test apparatus that can be inserted into a bore of high field solenoid magnet shown in Fig.1. A specimen and its loading JIG sizes are limited in small bore area, and therefore a length of a specimen is short (40mm). A stepping motor for a loading and the new self-produced clip gage were applied to the test apparatus for the improvement of the measurement system. This test apparatus was inserted into the superconducting magnet in Tohoku University. The effect of stress/strain on I_c was evaluated under 14.5T and 4.2K. The electrical force during a measurement of I_c tends to bring about a movement of a specimen and a clip gage. A nominal strain by an abrupt slip of gage edge clipping was generated during a measurement of I_c also in this research, and it had to be removed by the post processing. The electrical force also causes a noise more than the I_c definition voltage, 1μV/cm, on a *V-I* curve as shown in Fig.3. Therefore the I_c of this research was estimated by the intersection point between the experimental *V-I* and the offset line of 1μV from the least square line of experimental *V-I* under 100A. Fig.2 is obtained results by those post processing. Compressive thermal pre-strain by the heat treat and a cooling to 4.2K is around 0.5%, a little larger than the other Nb_3Sn wires evaluated in our laboratory before. Therefore higher allowable tensile strain is expected of these wires of TF coils. Between the two kinds of Nb_3Sn wires in this research, the internal Sn diffusion process wire is more sensitive to a strain than bronze process wire to a certain degree. A slow increase of a voltage in the range of after quench 133-138A like shown in Fig.3 was observed in all the internal Sn diffusion process wires. A current bypass mechanism from a quenched local area to a super area was temporary activated in the range.

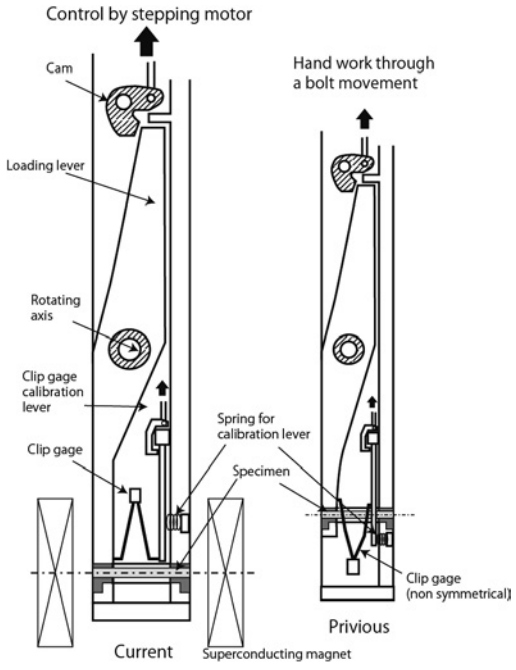

Fig.1 Rod for the experiment

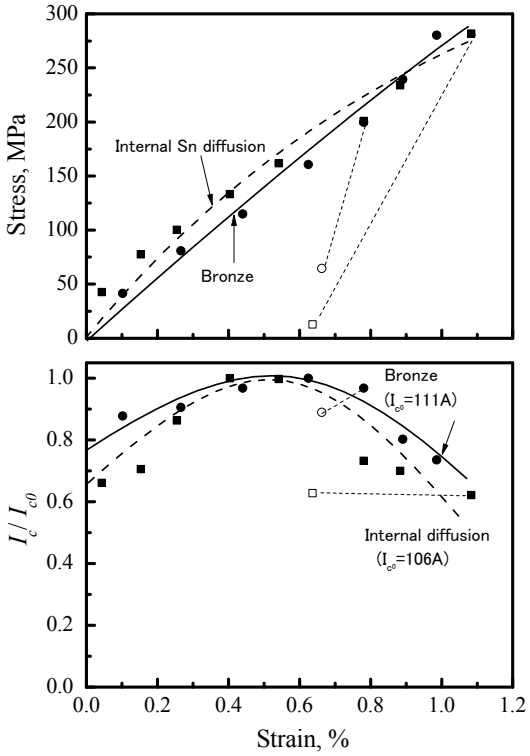

Fig.2 Experimental results of stress/strain effect

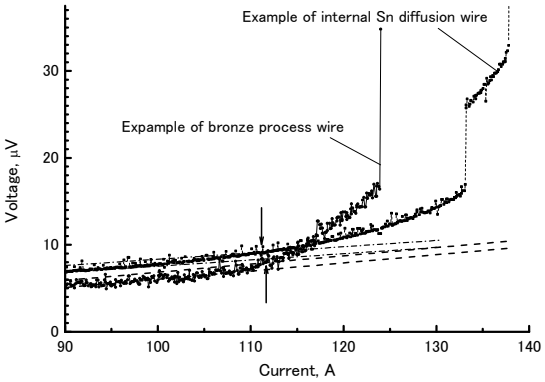

Fig.3 Example of *V-I* curve