APP5-1

A Study on Active Protection for Prototype 1.0-T MgB_2 Magnet

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Magnesium diboride (MgB_2) has been actively studied for MRI magnets owing to its critical temperature of 39 K in zero field, which can be operated in liquid helium (LHe) free cooling system. However, when quenching occurs in MgB_2 magnets, the heat generated by the quench is scarcely dissipated because of slow normal zone propagation velocity of MgB_2 wires compared to the low temperature superconductors. Hence, the heat would be chiefly accumulated within the MgB_2 magnet, which consequently leads to the permanent damage of the magnet. Therefore, a proper protection scheme for the MgB_2 magnet should be investigated to practically utilize the magnet in real-scale superconducting applications. In this study, we investigated the detect-and-activate-heater technique for the protection of a prototype 1.0-T MgB_2 magnet. The detailed parameters for the detect-and-activate-heater protection, such as power requirement, minimum detection time required, and minimum normal zone area for the protection, will be discussed thoroughly.

Keywords: MgB2 magnet, Active Protection, Detect-and-activate-heater protection, Quench

APP5-2

Protection System for Normal Transitions in a Single-phase Bi2223 Full Superconducting Transformer by the Active Power Method under Flowing Various Frequency Current

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The authors have developed a large AC current supply [1][2] with a single-phase Bi2223 full superconducting transformer [3]. The supply is very small and light and can output current of various value and frequency. In order to operate the supply safely, a protection system for normal transitions in the transformer is essential. The authors have proposed the system based on the active power method [3], which detects the normal transitions as dissipated active power in the normal area. Previous studies have shown that the protection system can work well for the transformer in transporting constant current of 60 Hz [3]. The supply is used under transporting current of various value and frequency. AC loss and iron loss in the transformer are increased by increasing the value and frequency and then they are detected as active power in a superconducting state. Therefore these losses cause incorrect recognition of the normal transitions. In this presentation, the authors propose the system which can detect correctly the normal transitions regardless of the losses. The experimental results show its usefulness for the transformer.

[1] N Nanato, S Nakamura and S Tanaka: Detection of normal transitions in a hybrid single-phase Bi2223 high temperature superconducting transformer by using the active power method and a magnetic flux detection coil, Journal of Physics: Conference Series, Vol. 871, 012085 (2017)
[2] N Nanato, N Kishi, Y Tanaka and M Kondo: Basic study for a large AC current supply with a single phase air-core Bi2223 high temperature superconducting transformer, Journal of Physics: Conference Series, Vol. 871, 012101 (2017)
[3] N. Nanato, Y. Kobayashi, Quench Detection and Protection for High Temperature Superconducting Transformers by Using the Active Power Method, Physics Procedia, Vol. 58, pp. 264-267 (2014)

Keywords: Normal transition, Protection, Active power method, HTS Transformer

APP5-3

High Resolution Location of Normal Transitions in A High Temperature Superconducting Coil by Capacitor Type Voltage Terminals

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It is important to locate positions of normal transitions in a high temperature superconducting (HTS) coil for identifying its design and fabrication weakness. The authors have presented capacitor type voltage terminals as a contactless method to measure voltages of the coil windings through insulation of the windings [1]. It was shown that this method was useful for locating the positions of the normal transitions [2][3]. High resolution of the location is achieved by attaching many terminals to the coil. Then shorter electro-conductive sheets of capacitor type voltage terminals are needed. However, the shorter sheets make the measured voltage signals small and the signals are supposed to be incorrectly measured. In this presentation, the authors propose a method to achieve high resolution location by long electro-conductive sheets of capacitor type voltage terminals. Numerical values of the measured voltage by the terminals depend on the positions of the normal transitions and therefore analysis of the value can achieve high resolution location without increasing the number of the terminals. Through experimental results for a Bi2223 HTS coil, it was confirmed that the proposed method achieved high resolution location.

[1] Type references here if any. N. Nanato, K. Nishiyama: Non-destructive Detection of Normal Transitions in High Temperature Superconducting Coil, Physics Procedia, Vol. 58, pp. 260-263 (2014)
[2] N. Nanato, K. Nishiyama: Locating of normal transitions in a Bi2223 high temperature superconducting coil by non-contact voltage measurement method, Cryogenics, Vol. 72, pp. 53-56 (2015)
[3] N Nanato, K Okura, H Kumagai and H Aoyama: Locating of normal transitions in a Bi2223 high temperature superconducting coil by using capacitor type voltage terminals and the active power method, Journal of Physics: Conference Series, Vol. 871, 012084 (2017)

Keywords: Normal transition, Location, Capacitor type voltage terminals, High resolution

APP5-4

Study on a Magnetic Flux Detection Coil for Detection of Normal Transitions in a Hybrid Single-phase Bi2223 Superconducting Transformer by the Active Power Method

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The authors have been developing a small and light AC power source [1][2] with a hybrid single-phase Bi2223 superconducting transformer [3]. The transformer consists of a primary copper coil and a secondary Bi2223 superconducting coil and can output current of 500 A. For safety operation of the transformer, it is important to detect normal transitions in the transformer and to protect it from excessive heating in the normal area. The authors have presented a protection system based on the active power method and a magnetic flux detection coil attached on the inside of the secondary coil [3]. The normal transitions are detected by measuring active power dissipated in the only secondary coil by the method. However, in the conventional method, the active power does not become zero in a superconducting state due to iron loss and AC loss and therefore incorrect recognition of the normal transitions may be caused. In this presentation, the authors propose a method to reduce the loss signals by configuration and mounting position of the magnetic flux detection coil. Through experimental results for a hybrid single-phase Bi2223 superconducting transformer, the authors show that the proposed method can detect the normal transitions more accurately than the conventional one.

[1] N. Nanato, Y. Kobayashi, Quench Detection and Protection for High Temperature Superconducting Transformers by Using the Active Power Method, Physics Procedia, Vol. 58, pp. 264-267 (2014)
[2] N Nanato, N Kishi, Y Tanaka and M Kondo: Basic study for a large AC current supply with a single-phase air-core Bi2223 high temperature superconducting transformer, Journal of Physics: Conference Series, Vol. 871, 012101 (2017)HTS
[3] N Nanato, S Nakamura and S Tanaka: Detection of normal transitions in a hybrid single-phase Bi2223 high temperature superconducting transformer by using the active power method and a magnetic flux detection coil, Journal of Physics: Conference Series, Vol. 871, 012085 (2017)

Keywords: Normal transition, Bi2223 superconducting transformer, Active power method, Magnetic flux detection coil

APP5-6

Investigation on Thermal and Electrical Characteristics of Metal-clad GdBCO Coil

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This study reports the effectiveness of the metal-cladding (MC) winding technique that employs a GdBCO tape with a micrometre-thick SUS-cladding layer in comparison with that of the partial insulation (PI) winding technique, using the results of charge-discharge, sudden discharge, and overcurrent tests. The charge-discharge and the sudden discharge tests showed that the charge-discharge delay of the coil using the metal-clad GdBCO tape was considerably lower compared to that of the PI coils, because the characteristic resistance of the MC coil was higher than that of the PI coil. Although the MC coil exhibited lower thermal/electrical stabilities compared to the PI coils at conditions of excessive current flow, the MC coil was more stable than the fully insulated coil. This study demonstrates that the MC winding technique is promising for the development of electrically stable high-temperature superconducting magnets with fast charge-discharge rates.

Keywords: Metal-cladding, Partial insulation, Thermal/electrical stabilities, HTS magnet