2-2. Applied Superconductivity Systems

1. Introduction

Advancements of technologies in applied superconductivity are indispensable to go to the next step for realization of fusion reactors for the magnetic confinement of plasma. Research activities related to applied superconductivity and cryogenics are summarized in this section.

2. Research activities of collaboration

We have promoted research collaboration on applied superconductivity technology and cryogenic engineering. The purpose of these research activities is early realization of a fusion reactor and spread of fusion-developed technologies to various fields by pervasive effect. Various research collaborations have been carried out, such as MgB_2 wires, A15 phase metallic superconducting wires, stress/strain effects, making high performance of High Temperature Superconductor (HTS), HTS current leads, joint section of a HTS conductor, analysis of joints between CIC (Cable in Conduit) conductors, inter-strand resistance in CIC conductor, testing methods for joints of large-scale CIC conductors, low frequency power transmission, partial discharge protection technology, evaluation of effects of hall currents, boiling process in quench of superconducting coil, a regenerator material for GM cryocooler, heat transfer across the interface of phase transition (He II/He I), dynamic simulator, HTS induction/synchronous machine, mechanical properties of HTS bulks, and so on. The titles of the researches are listed in the following.

(1) Superconducting properties and workability of MgB_2 thin wires. (Yamada, Y. (Tokai Univ.))
(2) Effect of grain refinement of ^{11}B powders in an in-situ fabrication process of MgB_2 superconducting wires. (Shimada, Y. (Kyushu Univ.))
(3) Effect of Zn substitution into the practical bronze material for high-field Nb_3Sn wires. (Kikuchi, A. (NIMS))
(4) Stress/strain and their hysteretic effects on the critical current of superconducting wire. (Kasaba, K. (Univ. of Toyama))
(5) Fabrication of REBCO coil and application for fusion plasma experimental device Mini-RT - Electron Bernstein wave experiments -. (Ogawa, Y. (Univ. of Tokyo))
(6) Experimental study on high temperature superconducting coils using external jacket configurations. (Nomura, S. (Meiji Univ.))
(7) Improvement of superconducting pulse coils using tapes with high aspect ratio of cross-section. (Kawagoe, A. (Kagoshima Univ.))
(8) Current distribution of YBCO tapes applied for HTS current leads. (Yamada, Y. (Tokai Univ.))
(9) Estimation of current leads in large superconducting systems. (Kawahara, T. (Chubu Univ.))
(10) Structural design of the re-mountable magnet and development of joint section of a high temperature superconducting conductor. (Ito, S. (Tohoku Univ.))
(11) Thermal stability of joint between conductors for large-scale superconducting magnet. (Nakamura, K. (Sophia Univ.))
(12) Electromagnetic and structural investigation of inter-strand resistance in CIC conductor for fusion magnets. (Yagai, T. (Sophia Univ.))
(13) Study on power supply system for superconducting magnets using low frequency power transmission. (Ise, T. (Osaka Univ.))
(14) Establishment of partial discharge protection technology for reliability improvement of electrical insulation of LHD. (Nagao, M. (Toyohashi Univ. of Technology))
(15) Evaluation of effects of hall currents on the thermal conductivity in a composite conductor of aluminum and copper. (Shirai, Y. (Kyoto Univ.))
(16) Visualization study of behavior of nucleation bubble in cooling channel. (Nozawa, M. (NIT, Akita College))
(17) Experimental study of a regenerator material economizing method for GM cryocooler. (Masuyama, S. (NIT, Oshima College))
(18) Study of heat transfer across the interface of phase transition (He II/He I). (Kimura, N. (KEK))
(19) Development of dynamic simulator for large superconducting magnet system. (Okamura, T. (KEK))
(20) Measurement of properties of high purity metals. (Tomaru, T. (KEK))
(21) Research and development of high temperature superconducting induction/synchronous machine for liquid cryogen circulation pump. (Nakamura, T. (Kyoto Univ.))
(22) Study on mechanical properties of large single-grain superconducting bulks fabricated by RE compositional gradient technique. (Murakami, A. (Ichinoseki College))

3. Research activities in NIFS

Research activities on applied superconductivity technology and cryogenic engineering in NIFS focus on the large-scale superconducting magnet system, the high-performance superconductors of 100 kA-class current capacities at the high magnetic fields over 13 T. Research is being conducted for developing advanced conductors of indirectly cooled low-temperature superconductor and high-temperature superconductor. In order to examine superconducting properties of such large conductors in real conditions, a new superconducting test facility of 13 T magnetic field with a variable-temperature bore of 0.7 m has been installed. Actual environment testing can be carried out to estimate the characteristics of superconducting materials under conditions with cryogenic temperatures, intense

magnetic field and neutron irradiation. The titles of their research activities are listed below.

(23) Development of 100-kA indirectly cooled superconductor for FFHR. (Takahata, K. (NIFS))
(24) Progress of magnet design for the helical fusion reactor with 100-kA HTS STARS conductor. (Yanagi, N. (NIFS))
(25) Design of testing sample of high-current superconductors for a 15 T test facility. (Imagawa, S. (NIFS))
(26) Joint resistance measurements of the feeder joint for JT-60SA EF coils. (Obana, T. (NIFS))
(27) Visualization study of stephan problem in superfluid helium under microgravity condition. (Takada, S. (NIFS))
(28) Fabrication and superconductivity of low activation MgB_2 wire using small particle sized boron-11 isotope powder. (Hishinuma, Y. (NIFS))

(Mito, T.)