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 mechanical properties, superconducting properties and nanostructure of MgB_2 wires, evaluation of a GM cryocooler, mechanical properties of Nb_3Sn superconducting wires, Zn substituted high-field Nb_3Sn wires, large current transport tests of Nb_3Al Rutherford cable, High Temperature Superconducting induction/synchronous machine, current distribution of YBCO current leads, joint section of a HTS conductor, modular multilevel converter for large superconducting coil, inter-strand resistance in CIC conductor, evaluation of hall currents on thermal conductivity in a composite conductor, evaluation of effects of hall currents, reliability improvement of cryogenic refrigerant/solid insulator composite electrical insulation system in LHD, visualization of quantum vortex in turbulence in He II, evaluation of AC loss and stability of JT-60SA poloidal field coil, improvement of superconducting pulse coils using tapes with high aspect ratio, properties of high purity metals, boiling heat transfer of liquid nitrogen, dc fault current limiter for practical superconducting system, and so on. The titles of the researches are listed in the following.

(1) Research on mechanical properties of MgB_2. (Murakami, A. (NIT, Ichinoseki College))
(2) Evaluation of a GM cryocooler by equivalent change of regenerator configuration. (Masuyama, S. (NIT, Oshima College))
(3) Superconducting properties and workability of MgB_2 thin wires. (Yamada, Y. (Tokai Univ.))
(4) Current distribution of YBCO tapes applied for HTS current leads. (Yamada, Y. (Tokai Univ.))
(5) Evaluation of mechanical properties of superconducting wires and investigation of their damage. (Kasaba, K. (Univ. of Toyama))
(6) Research and development of high temperature superconducting induction/synchronous machine for liquid cryogen circulation pump. (Nakamura, T. (Kyoto Univ.))
(7) Structural design of the remountable magnet and development of joint section of a high temperature superconducting conductor. (Ito, S. (Tohoku Univ.))
(8) Influence of boron particle size on nanostructure of low activation MgB_2 wire. (Satoshi, H. (Kyushu Univ.))
(9) Effect of Zn substitution into the practical bronze material for high-field Nb_3Sn wires. (Kikuchi, A. (NIMS))
(10) Large current transport test of the RHQT-processed Nb_3Al Rutherford cable. (Tsuchiya, K. (KEK))
(11) Study on current source type modular multilevel converter for large superconducting coil. (Ise, T. (Osaka Univ.))
(12) Electromagnetic and structural investigation of inter-strand resistance in CIC conductor for fusion magnets. (Yagai, T. (Sophia Univ.))
(13) Evaluation of effects of hall currents on the thermal conductivity in a composite conductor of aluminum and copper. (Shirai, Y. (Kyoto Univ.))
(14) Reliability improvement of cryogenic refrigerant/solid insulator composite electrical insulation system in LHD. (Nagao, M. (Toyohashi Univ. of Technology))
(15) Visualization of quantum vortex in turbulence in super fluid He II. (Tsuji, Y. (Nagoya Univ.))
(16) Evaluation of AC loss and stability of JT-60SA poloidal field coil. (Nakamura, K. (Sophia Univ.))
(17) Improvement of superconducting pulse coils using tapes with high aspect ratio of cross-section. (Kawagoe, A. (Kagoshima Univ.))
(18) Measurement of properties of high purity metals. (Tomaru, T. (KEK))
(19) Boiling heat transfer in forced convection flow of liquid nitrogen in narrow channels. (Nozawa, M. (NIT, Akita College))
(20) Development of basic technique of dc fault current limiter for practical superconducting system. (Chikumoto, N. (Chubu Univ.))

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.

(21) Quench analysis of a 13 T superconducting magnets with a 700 mm bore. (Imagawa, S. (NIFS))

(22) Piezo driven contact for low voltage dc power supply to excite superconducting coils of fusion plant. (Chikaraishi, H. (NIFS))
(23) Update of the cooling system for NIFS superconducting magnet test facility. (Hamaguchi, S. (NIFS))
(24) Microstructural observations on butt joint of JT-60SA CS. (Obana, T. (NIFS))
(25) The comparisons of superconductivity between low activation MgB_2 wires using various kinds of the boron-11 isotope powders. (Hishinuma, Y. (NIFS))

(Mito, T.)