2-2. Applied Superconductivity Systems

1. Introduction

Advanced technologies in superconducting systems are essential to construct the next fusion experimental device for the magnetic confinement of plasma. Research activities related to superconductivity and cryogenics are summarized in this section. The research subjects using the superconducting system of LHD are summarized in Section 1-1-(4) 'LHD Device Engineering Experiments'. The research subjects concerning design studies of advanced superconducting systems for a helical reactor are summarized in Section 2-1 'Helical Reactor Design'. In addition, the research subjects of the LHD Project Research Collaboration are summarized in Section 1-4.

2. Research activities of collaboration

We have promoted research collaboration on applied superconducting technology and cryogenic engineering. It includes basic and applied studies. The purpose of these research activities is early realization of a fusion reactor and application of developed technologies to other areas. Various research collaborations have been carried out, such as ac loss reduction of High Temperature Superconductor (HTS), remountable joint of YBCO conductor, HTS low porosity bulks, analysis of joints between CIC (Cable in Conduit) conductors, high efficiency cryocooler, analysis on current leads, analysis of a normal-zone propagation in the LHD helical coil, properties of Cu addition MgB_2 wires, series compensated thyristor converters, inter-strand resistance in CIC conductor, temperature control with high-precision, transposed tape conductors, MgB_2 wires fabricated by low-temperature in-situ processes, boiling process in HeII, partial discharge protection technology, ac loss and stability of CIC conductors, V_3Ga superconducting wires, testing methods for joints, MgB_2 wires synthesized with external Mg diffusion process, Y-based HTS current leads, A15 wires, stress/strain effects on the critical current, power supply system, and so on. The titles of the researches are listed in the following.

(1) Basic study on the ac loss reduction of oxide superconductors for nuclear fusion reactor. (Iwakuma, M. (Kyushu Univ.))
(2) Study on remountable joint of YBCO conductor for remountable high-temperature superconducting magnet. (Ito, S. (Tohoku Univ.))
(5) Fabrication of HTS low porosity bulks in air and evaluations of the fracture strength properties. (Murakami, A. (Ichinoseki National College of Technology))
(6) Analysis of joint-resistance between copper sleeve and strands in cable-in-conduit conductor. (Morimura, T. (Tsuda, T.) (Tohoku Univ.))
(7) Development of a high efficiency cryocooler for cryogen-free cooling system. (Masuyama, S. (Oshima National College Maritime Technol.))
(8) Thermal analysis on current leads for large scale superconducting applications. (Kawahara, T. (Chubu Univ.))
(9) Estimation of heat generation during a normal-zone propagating and recovering in the LHD helical coils. (Shirai, Y. (Kyoto Univ.))
(10) Superconducting properties of Cu addition MgB_2 superconducting wires under liquid hydrogen temperature. (Hishinuma, Y. (NIFS))
(11) Feasibility study on series compensated thyristor converters for superconducting magnets. (Nomura, S. (Meiji Univ.))
(12) Electromagnetic and structural investigation of inter-strand resistance in CIC conductor for fusion magnets. (Yagai, T. (Sophia University))
(13) High-precision temperature control and stabilization using a cryocooler. (Hasegawa, Y. (Saitama Univ.))
(14) Development of a transposed conductor with large capacity using superconducting tapes with high aspect ratio of cross-section. (Kawagoe, A. (Kagosihma Univ.))
(15) Microstructural of MgB_2 wires fabricated by low-temperature in-situ processes with Mg_2Cu addition. (Hata, S. (Kyushu Univ.))
(16) Boiling process in quench of superconducting coil under low-temperature liquid. (Tsuji, Y. (Nagoya Univ.))
(17) Establishment of partial discharge protection technology for reliability improvement on electrical insulation of LHD. (Nagao, M. (Toyohashi University of Technology))
(18) AC loss and stability of large-scale superconducting magnet for fusion. (Nakamura, K. (Sophia University))
(19) Microstructure of V_3Ga superconducting wires provided Ga from Ti-Ga compound. (Kawabata, T. (Nishimura, K.) (Univ. Toyama))
(20) Study on testing methods for joints of large-scale cable-in-conduit conductors. (Koizumi, N. (JAEA))
(21) Superconducting properties of MgB_2 wires synthesized with external Mg diffusion process. (Yamada, Y. (Tokai Univ.))
(22) HTS current leads prepared by Y-based superconducting tapes. (Yamada, Y. (Tokai Univ.))
(23) Investigation of A15 phase metallic superconducting wires for fusion magnets via react and winding process. (Kikuchi, A. (NIMS))
(24) Stress/strain and their hysteretic effects on the critical current of superconducting wire. (Kasaba, K. (Univ. of Toyama))
(25) Study on power supply system for superconducting magnets using low frequency power transmission. (Ise. T. (Osaka Univ.))

3. Research activities in NIFS

Research activities on applied superconductivity systems in NIFS focus on the development of advanced superconducting technology for a helical fusion reactor, such as cryogenic oscillating heat pipes, neutron irradiation effect, aluminum-alloy-jacketed Nb_3Sn conductor, 30 kA-class HTS conductors, V_3Ga wires through the PIT process,

shake-hands lap joints, and design of test facility. The titles of their research activities are listed below.

(26) Enhancement of thermal properties of HTS magnets using built-in cryogenic oscillating heat pipes. (Mito, T. (NIFS))
(27) Neutron irradiation effect on superconducting magnet materials for fusion. (Nishimura, A. (NIFS))
(28) Development of large-current aluminum-alloy-jacketed Nb_3Sn conductor for FFHR. (Takahata, K. (NIFS))
(27) Experiments of 30 kA-class high-temperature superconductor samples. (Yanagi, N. (NIFS))
(28) Critical current measurement of 30 kA class HTS conductor samples. (Terazaki, Y. (Grad. Univ. Advanced Studies))
(29) Effect of Cu addition on superconducting properties of V_3Ga low activation superconducting wires through the PIT process using $TiGa_3$ compound. (Hishinuma, Y. (NIFS))
(30) Joint resistance measurements of the shake-hands lap joints for JT-60SA EF coils. (Obana, T. (NIFS))
(31) Design of 15 T magnets with cold bore of 0.7 m using rectangular conductors. (Imagawa, S. (NIFS))

(Imagawa, S.)