2-2. Applied Superconductivity Systems

1. Introduction

Advancements of technologies in superconducting systems are needed to go to the next step for realization of fusion reactors 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 MgB_2 wires, A15 phase metallic superconducting wires, V_3Ga superconducting wires, stress/strain effects, ac loss reduction 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, series compensated thyristor converters, low frequency power transmission, partial discharge protection technology, 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, and so on. The titles of the researches are listed in the following.

(1) Increase of MgB_2 phase volume fraction by the reduce particle sized boron powder. (Hishinuma, Y. (NIFS))
(2) Feasibility study on series compensated thyristor converters for superconducting magnets. (Nomura, S. (Meiji Univ.))
(3) Study on analysis of joints between cable-in-conduit conductors. (Miyagi, D. (Tsuda, M.) (Tohoku Univ.))
(4) Electromagnetic and structural investigation of inter-strand resistance in CIC conductor for fusion magnets. (Yagai, T. (Sophia University))
(5) Study on power supply system for superconducting magnets using low frequency power transmission. (Ise. T. (Osaka Univ.))
(6) Stress/strain and their hysteretic effects on the critical current of superconducting wire. (Kasaba, K. (Univ. of Toyama))
(7) Investigation of A15 phase metallic superconducting wires for fusion magnets via react and winding process. (Kikuchi, A. (NIMS))
(8) Study on testing methods for joints of large-scale cable-in-conduit conductors. (Koizumi, N. (JAEA))
(9) Establishment of partial discharge protection technology for improvement on electrical insulation reliability of LHD. (Nagao, M. (Toyohashi University of Technology))
(10) Microstructure of V_3Ga superconducting wires provided Ga from Ti-Ga compound. (Nishimura, K. (Univ. Toyama))
(11) Boiling process in quench of superconducting coil under low-temperature liquid. (Tsuji, Y. (Nagoya Univ.))
(12) Superconducting properties of MgB_2 wires synthesized with external Mg diffusion process. (Yamada, Y. (Tokai Univ.))
(13) HTS current leads prepared by Y-based superconducting tapes. (Yamada, Y. (Tokai Univ.))
(14) Optimum B/Mg ratio of precursor powder for MgB_2 wire fabrication by an *in-situ* powder-in-tube process with Mg_2Cu addition. (Hata, S. (Kyushu Univ.))
(15) Study on mechanical properties of large single-grain superconducting bulks fabricated by RE compositional gradient technique. (Murakami, A. (Ichinoseki National College of Technology))
(16) Basic study on the oxide superconductors with a large current capacity for nuclear fusion reactors. (Iwakuma, M. (Kyushu Univ.))
(17) Improvement of superconducting pulse coils using tapes with high aspect ratio of cross-section. (Kawagoe, A. (Kagosihma Univ.))
(18) Experimental study of a regenerator material economizing method for GM cryocooler. (Masuyama, S. (Oshima National College Maritime Technol.))
(19) Study of heat transfer across the interface of phase transition (He II/He I). (Kimura, N. (KEK))
(20) Structural design of the remountable magnet and development of joint section of a high-temperature superconducting conductor. (Ito, S. (Tohoku Univ.))
(21) Development of dynamic simulator for large superconducting magnet system. (Okamura, T. (KEK))
(22) Estimation of current leads in large superconducting systems. (Kawahara, T. (Chubu 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 100-kA indirectly cooled superconductor, 100 kA-class HTS conductor, butt joint for JT-60SA CS coils, fuel layering experiments, a bobbin-less superconducting magnet, and stress change of wires in a CIC conductor. 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 HTS magnet design and 100 kA-class conductor development for FFHR-d1. (Yanagi, N. (NIFS))
(25) Experiment and analysis of the critical current of a 100-kA class HTS conductor sample. (Terazaki, Y.

(Grad. Univ. Advanced Studies))
(26) Joint resistance measurements of the butt joint for JT-60SA CS coils. (Obana, T. (NIFS))
(27) Development of a small bobbin-less superconducting solenoid magnet of 3T class for adiabatic demagnetization refrigerator. (Takada, S. (NIFS))
(28) Experimental study on stress change of wires in a CIC conductor by being twisted. (Imagawa, S. (NIFS))

(Imagawa, S.)