(2) Applied Superconductivity and Cryogenics

1. Introduction

The superconducting technology is indispensable to construct a large-scale fusion experimental device for the magnetic confinement of plasma, because steady-state plasma experiments are required for the next step. From the view point of the efficiency of an energy source, adoption of superconducting systems is essential for fusion power plants. Research activities related to applied 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-(2) 'Helical Reactor Design'. Also, the research subjects of the LHD Project Research Collaboration are summarized in Section 1-5.

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 applications of High Temperature Superconductor (HTS) for a current lead and magnetic levitation, HTS magnets for a fusion reactor, thermo-mechanical properties of HTS bulk superconductor, reliability of cryogenic electrical insulation, an advanced twisted conductor, characteristics of super-fluid helium, advanced power systems, etc. The titles of the researches are listed in the following.

(1) Basic study on the electromagnetic properties of oxide superconductors for nuclear fusion reactor. (Iwakuma, M. (Kyushu Univ.))
(2) MgB2 superconducting wires for current lead application. (Yamada, Y. (Tokai Univ.))
(3) Development of the design code for a curved dipole superconducting coil. (Obana, T. (NIFS), Yamamoto, A. (KEK))
(4) Behaviors of He II in two-dimensional channels filled with He II. (Kobayashi, H. (Nihon Univ.))
(5) Reliability of cryogenic composite electrical insulation for LHD. (Nagao, M. (Toyohashi Univ. of Tech.))
(6) Magnetic levitation of miniature-sized spherical-shaped RE123 bulk superconductors. (Tsuda, M. (Tohoku Univ.))
(7) Evaluation of the mechanical properties of HTS single-grain bulks by indentation. (Murakami, A. (Hirosaki Univ.))
(8) Temperature and field dependence of the normal zone propagation velocity of the LHD helical coil. (Shirai, Y. (Kyoto Univ.))
(9) Feasibility study on SMES systems using stress-minimized helical coils. (Nomura, S. (Tokyo Tech.))
(10) 3-dimensional measurement of the strand trajectories in a large CIC conductor. (Hamajima, T. (Tohoku Univ.))
(11) Power system for fusion reactor including auxiliary devices with various requirements for supplied power quality. (Ise. T. (Osaka Univ.))

3. Research activities of the applied superconductivity group of NIFS

The applied superconductivity group is belonging to the Fusion & Advanced Technology Systems Division of the Department of Large Helical Device Project. The group is pursuing not only the establishment of operation of LHD superconducting system but also rigorous researches to improve its performance. Furthermore, we focus on the design study of a helical fusion reactor and on the development of its superconducting technology. Our research activities are listed below.

(12) Development of fast ignition target. (Norimatsu, T. (ILE, Osaka Univ.))
(13) Development of 1 MJ Conduction-Cooled LTS Pulse Coil for UPS-SMES. (Mito, T. (NIFS))
(14) Conceptual study on internal dump methods for superconducting magnets with conductive sheets between turns. (Imagawa, S. (NIFS))
(15) Aluminum-alloy-jacketed Nb_3Sn Superconductor for the LHD-type fusion reactor FFHR. (Takahata, K. (NIFS))
(16) Study on 1 GW class hybrid energy transfer line of hydrogen and electricity. (Yamada, S. (NIFS))
(17) Dynamic behaviors of a large scale cryogenic plant. (Maekawa, R. (NIFS))
(18) Study of solid H2 redistribution in the cryogenic target for the FIREX project. (Iwamoto, A. (NIFS))
(19) Design study of an enhancement superconducting coil for the NIFS superconductor test facility. (Obana, T. (NIFS))
(20) Upgrading the NIFS superconductor test facility for JT-60SA conductors. (Obana, T. (NIFS))
(21) Experimental investigation of large-current capacity HTS conductors for fusion magnets. (Bansal, G., Sokendai))
(22) First test results of large-current capacity YBCO HTS conductors for fusion magnets. (Bansal, G., Sokendai))

(Imagawa, S.)