(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-(3) 'LHD Device Engineering Experiments'. The research subjects concerning design studies of advanced superconducting systems for a helical reactor are summarized in Section 2-2-(2) 'Helical Reactor Design'. Also, 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 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) Design and optimization of high Tc superconductors for current lead application. (Yamada, Y., Tokai Univ.)
(2) Basic study on oxide superconductors for nuclear fusion reactor. (Iwakuma, M., Kyushu Univ.)
(3) Thermo-mechanical strength parameters of single crystal rare-earth high Tc bulk superconductors. (Katagiri, K., Iwate Univ.)
(4) Feasibility study on SMES systems using stress-minimized helical coils. (Nomura, S., Tokyo Tech.)
(5) Basic studies of electric properties of polymeric silver(I) complexes at low temperature. (Chikaraishi, N., Kanagawa Univ.)
(6) Reliability of cryogenic composite electrical insulation for LHD. (Nagao, M., Toyohashi Univ. of Tech.)
(7) Development of a new conductor controlled the twist angle to improve the performance of LTS coils. (Sumiyoshi, F., Kagoshima Univ.)
(8) Fundamental study on application of magnetic levitation to laser fusion research using YBCO bulk superconductor. (Tsuda, M., Tohoku Univ.)
(9) Temperature and field dependence of the normal zone propagation velocity of the LHD helical coil. (Shirai, Y., Kyoto Univ.)
(10) Investigation of feasibility of remountable superconducting magnet for helical reactor. (Ito, S., Tohoku Univ.)
(11) Power system for fusion reactor including auxiliary devices with various requirements for supplied power quality. (Ise. T., Osaka Univ.)
(12) Study on improvement of electric power quality by flywheel energy storage system. (Matsukawa, T., Daido Inst. of Tech.)
(13) 3-dimensional measurement of the strand locations in Cable-in-Conduit conductor. (Hamajima, T., Tohoku Univ.)
(14) Influence of the superheating in He II on the heat transfer in narrow channels. (Kobayashi H., Nihon 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.

(15) Thermal runaway characteristics of Bi2212 coil for conduction-cooled SMES. (Hayakawa, N., Nagoya Univ.)
(16) Aluminum-alloy-jacketed Nb3Sn superconductor for the LHD-type fusion reactor FFHR. (Takahata, K., NIFS)
(17) Cryogenic stability of LTS/HTS hybrid conductors. (Yanagi, N., NIFS)
(18) Study of SMES system using dry type superconducting coil designed to protect from momentary voltage drop. (Chikaraishi, H., NIFS)
(19) Two-stage pulse tube refrigerator for the integrated current lead system. (Maekawa, R., NIFS)
(20) Preliminary results of fuel layering on the cryogenic target for the FIREX project. (Iwamoto, A., NIFS)
(21) Numerical analysis on transient heat and mass flow of He II through porous media. (Hamaguchi, S., NIFS)
(22) Development of large current capacity HTS conductors for fusion reactor magnets. (Bansal, G., Sokendai)
(23) Minimum propagation currents of LTS/HTS hybrid conductors. (Bansal, G., Sokendai)

(Imagawa, S., Mito, T.)