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 innovative superconducting current leads, basic study on properties of High Temperature Superconductor (HTS), properties of superfluid HeII, remountable joint of YBCO conductor, HTS low porosity bulks, analysis of joints between CIC (Cable in Conduit) conductors, high efficiency cryocooler, analysis of a normal-zone propagation in the LHD helical coil, next generation power devices, 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, and so on. The titles of the researches are listed in the following.

(1) Superconducting current leads prepared by the YBCO tapes. (Yamada, Y. (Tokai Univ.))
(2) Investigation of the cross-sectional configuration of Ag sheath material for high strength Bi-2212 superconducting wire. (Yamada, Y. (Tokai Univ.))
(3) Basic study on the ac loss reduction of oxide superconductors for nuclear fusion reactor. (Iwakuma, M. (Kyushu Univ.))
(4) Study on dc distribution for the power system of nuclear fusion systems. (Ise. T. (Osaka Univ.))
(5) Study on turbulent control of supercritical helium in cooling channel for superconducting magnet system. (Okamura. T. (KEK))
(6) On the measurement technique of velocity fluctuation in super fluid He II. (Tsuji, Y. (Nagoya Univ.))
(7) Study on remountable joint of YBCO conductor for remountable high-temperature superconducting magnet. (Ito, S. (Tohoku Univ.))
(8) Fabrication of HTS low porosity bulks in air and evaluations of the fracture strength properties. (Murakami, A. (Ichinoseki National College of Technology))
(9) Study on analysis of joints between Cable-in-Conduit conductors. (Hamajima, T. (Tohoku Univ.))
(10) Development of a high efficiency cryocooler for cryogen-free cooling system. (Masuyama, S. (Oshima National College Maritime Technol.))
(11) Thermal Analysis on current leads for large scale superconducting applications. (Kawahara, T. (Chubu Univ.))
(12) Estimation of heat generation during a normal-zone propagating and recovering in the LHD helical coils. (Shirai, Y. (Kyoto Univ.))
(13) Superconducting properties of Cu addition MgB_2 superconducting wires under liquid hydrogen temperature. (Hishinuma, Y. (NIFS))
(14) Feasibility study on series compensated thyristor converters for superconducting magnets. (Nomura, S. (Meiji Univ.))
(15) Electromagnetic and structural investigation of inter-strand resistance in CIC conductor for fusion magnets. (Yagai, T. (Sophia University))
(16) High-precision temperature control and stabilization using a cryocooler. (Hasegawa, Y. (Saitama Univ.))
(17) Development of a transposed conductor with large capacity using superconducting tapes with high aspect ratio of cross-section. (Kawagoe, A. (Kagosihma 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 React-and-Jacket processed Nb_3Sn conductor, irradiation effects, helium heat transfer, MgB_2 multifilamntary wires using ^{11}B, test results of JT-60SA conductors, design of test facility, and study on helical winding. The titles of their research activities are listed below.

(18) Effect of bending on critical current of React-and-Jacket processed Nb_3Sn conductor. (Takahata, K. (NIFS))
(19) Magnetization of neutron irradiated Nb_3Sn strand. (Nishimura, A. (NIFS))
(20) Neutron and gamma ray irradiation effect on interlaminar shear strength of electric insulation composite for fusion device. (Nishimura, A. (NIFS))
(21) Dependence of film boiling heat transfer coefficient on surface orientation. (Iwamoto, A. (NIFS))
(22) Fabrication of MgB_2 multifilamntary wires using ^{11}B isotope powder as the boron source material. (Hishinuma, Y. (NIFS))
(23) Measurements of self magnetic field generated by cable-in-conduit conductors for JT-60SA EF-H and EF-L coils. (Obana, T. (NIFS))
(24) Configuration optimization of 15 T magnets with cold bore of 0.7 m. (Imagawa, S. (NIFS))
(25) Feasibility study of helical winding with CIC conductor for LHD-type reactors. (Imagawa, S. (NIFS))

(Imagawa, S.)