【Grant-in-Aid for Scientific Research (S)】
Science and Engineering (Engineering)

Title of Project : Demonstration of a Remountable High-temperature Superconducting Magnet and Construction of Universal Joints toward the Realization of an Innovative Fusion Reactor

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Research Area : Nuclear fusion studies
Keyword : High temperature superconductivity, Electromagnet

【Purpose and Background of the Research】

Research and development (R&D) of the fusion reactor are in steady progress. However, some crucial technical issues for the fusion reactor still remain; reduction of costs and establishment of reasonable maintenance methods. We proposed a remountable high-temperature superconducting (HTS) magnet to reduce cost of superconducting magnet and to make it easy to access inner reactor components. HTS materials are only solution as a superconducting material for the magnet because of its high thermal stability against heat generation due to electrical resistance at the joints.

We have already achieved mechanical (electrical) joint technique of HTS conductor with a current of 100 kA and a resistance of 2 nΩ, which is the best in the world. The purpose of this study is to establish technical breakthrough with an academic viewpoint toward the realization of a fusion reactor. We will perform 1) developing a method of predicting joint extreme performance, 2) designing functionally decomposed conductor based on the theory of superconductor, 3) predicting performance of cooling system with porous media and designing remountable cooling channels and 4) demonstrating and designing the remountable HTS magnet by fabricating 100-kA-class mock-up magnet.

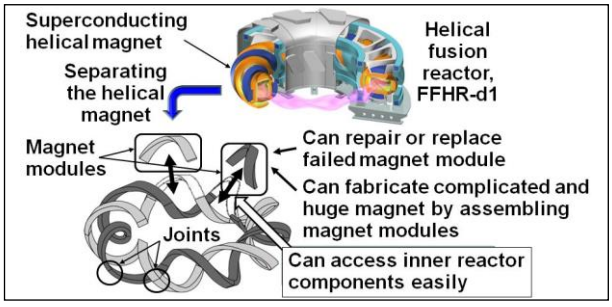

Figure 1 Remountable HTS magnet

【Research Methods】

Superconducting magnets are used under cryogenic and high magnetic field environments. Predicting joint performance at fabrication phase (before cooling the magnet) is quite important. We develop nondestructive testing method to predict the joint performance at first. Then we design functionally decomposed conductor using theory on transport current of type-II superconductor. Furthermore, we optimize cooling system at the joint section of the remountable magnet. Based on the above results we will finally fabricate 100-kA-class mock-up magnet to demonstrate the remountable HTS magnet.

【Expected Research Achievements and Scientific Significance】

Results obtained through this study can become technical breakthrough to realize an attractive fusion reactor with high economic efficiency and reliability. In addition, HTS materials are only solution to achieve this concept. This fact has potential that researches on fusion reactors leads R&D of HTS materials and applications. Furthermore, complex and huge superconducting magnets can be constructed by a quantity of HTS wires with a length of one-pitch of the magnet. That means we don't need quality assurance of HTS wires with several kilo meters long and performance of magnets can increase significantly by using high performance short HTS wires.

【Publications Relevant to the Project】

S. Ito, H. Hashizume, et. al., Bridge-Type Mechanical Lap Joint of a 100 kA-Class HTS Conductor having Stacks of GdBCO Tapes, Plasma and Fusion Research, vol. 9, p. 3405086 (2014).
H. Hashizume, S. Ito, Design prospect of remountable high-temperature superconducting magnet, Fusion Engineering and Design, in press.

【Term of Project】

FY2014-2018

【Budget Allocation】

144,400 Thousand Yen

【Homepage Address and Other Contact Information】

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