§21. Study on the Irradiation Effect of Organic Insulation Materials for the Superconducting Magnet

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1. Introduction

The organic composite material to be used for the insulation system in the fusion magnet is needed to withstand high dose irradiation, cryogenic temperature and high complex combined stresses. It is reported that the radiation resistance can be improved by mixing cyanate ester with epoxy resin which is generally used as an insulation material. In the organic composite materials, it is important to examine the irradiation effect at the interface between different kinds of materials as well as in the resin. The objective of this study is to clarify deterioration mechanism by the radiation exposure on the composite material under the cryogenic temperature, in order to obtain a concrete guideline to improve radiation resistance.

2. Results and discussions

The irradiation effect of insulation material has been evaluated by means of the shear test with S-shape double notch specimen[1)] as shown in Fig. 1. A graph is a result for cyanate ester/epoxy resin (4:6) mixture. A tendency was seen that interlamellar shear examination (ILSS) did not change by gamma irradiation up to 10 MGy. However, it is important to evaluate the fracture behavior under combined stress which must be different from that under pure shear stress. In this study, a new test method is proposed to measure the mechanical strength under combined stress that is compressive and shear at cryogenic condition.

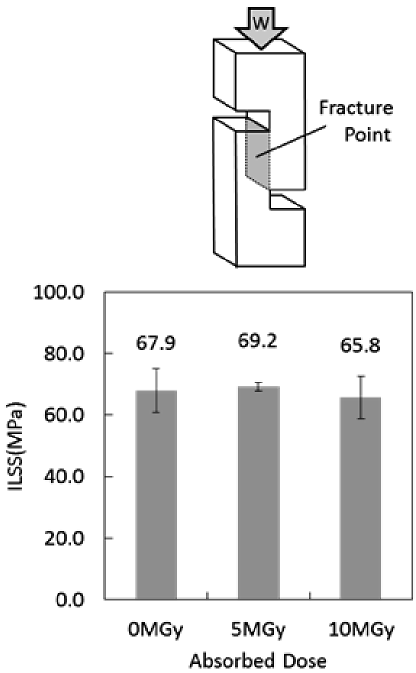

Fig. 1. The evaluation method and result of ILSS.

The newly designed test jigs are shown in Fig. 2. When the load W is applied to the specimen, it results in compressive load $W\sin\theta$ and shear load $W\cos\theta$. Different angle of the jigs enables to evaluate under the different ratio of compressive and shear load. It is possible to perform the mechanical test at cryogenic temperature by immersing the jig in liquid nitrogen. Fig. 3 shows the result of stress analysis in the test jig for the angle of 45°. The analysis shows that the deformation of the test jig is small enough and local stress concentration at the edge enables to specify the fracture point. Therefore, it can be said that it is the appropriate method to measure the mechanical strength of composite materials under combined stress.

In future, we will make the jig based on the results, and perform the tests on the real specimens to examine the irradiation effect on the destruction behavior of the organic composite materials under combined stress.

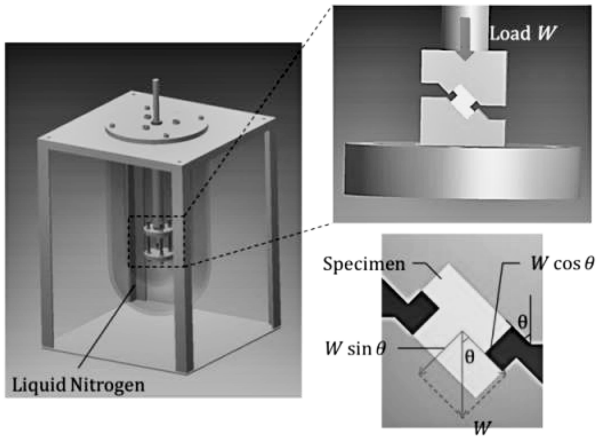

Fig. 2. Schematic designs of the new test jigs.

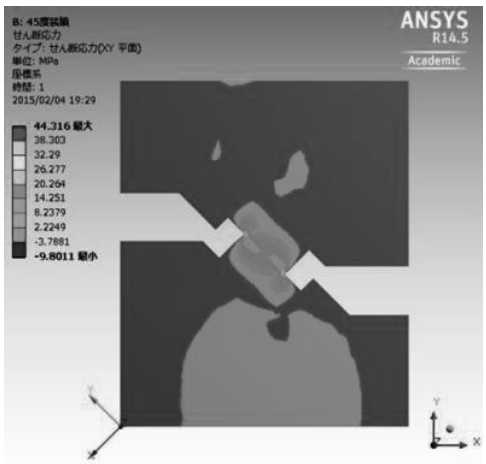

Fig. 3. Stress analysis of the specimen and the jig.

1)T. Takahashi, F. Mishima, Y. Akiyama, S. Nishijima: CSSJ Conference **90** (2014) 206.