HIGH PERFORMANCE Nb₃Sn SUPERCONDUCTING WIRE FOR FUSION APPLICATION

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Introduction

Since the highest field performance is a primary goal of the conductor in the next generation of particle accelerators, emphasis has been focused mainly on the increase in current carrying capacity. The conductor needed for fusion application, however, requires much lower magnetization limit along with a critical current as high as possible. Newly revised strand specifications for the International Thermonuclear Experimental Reactor (ITER) and high-energy physics applications require further improvement of current density at little expense of ac loss or effective filament diameter.

A conductor designed to meet such requirements has been fabricated. The effect of heat treatment schedule on its properties was investigated to develop the optimized reaction condition.

Experimental

An attempt was made to explore the effect of restack configuration and reaction heat treatment condition. The target value of non-Cu Jₜ at 12 T and 4.2 K, and non-Cu hysteresis loss for ±3T cycle, were selected as ≥1100 A/mm² and ≤1000 kJ/m³ respectively. Two different heat treatment conditions were given to a set of strand samples. The first heat treatment given was 185°C for 24 hrs, 450°C for 48 hrs, 575°C for 120 hrs followed by 240 hrs at 650°C. The second one was 185°C for 24 hrs, 460°C for 48 hrs, 575°C for 100 and 650°C for 175 hrs. The measured critical current and non-Cu Jₜ as a function of applied field of the sample wire are shown in Figure 1. Also, Kramer behavior at 4.2K Iₜ(B) is illustrated in Figure 2 for the extrapolated values of B_c2.

![Figure 1. I_c and non-Cu J_c as a function of magnetic field.](image1)

![Figure 2. Kramer plot of non-Cu J_c to extrapolate B_c2.](image2)

Results and Discussion

The sample that had undergone the long heat treatment exhibited the non-Cu Jₜ of 1131 A/mm² at 12 T, and had showed slightly higher value of critical current densities over the range of magnetic field up to around 18 T. Also, a small deviation in an extrapolated value of B_c2 (26~27T) was observed between two heat treatment conditions. Average non-Cu Jₜ value of this strand for the long heat treatment has been increased by 20% of the values obtained from the previous material made for such application.

References