§18. Measurement of Properties of High Purity Metals

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Introduction

It is well known that purity is significant factor for electric resistance and thermal conductivity at low temperature. Thermal conductivity of high purity copper can be about 100 times higher than commercially available copper due to less scattering of electron [1), 2), 3)]. And of course annealing of high purity metals is also significant factor. For fusion science, high purity metals can be useful to the design of new superconductor for high field superconducting magnet. Thus, the measurements of properties of high purity metals at cryogenic temperature are important to make databases.

Annealing

In this year, the annealing effect of high purity tungsten wire of 5Nclass had been investigated. Self-annealing by Joule heating cannot control to precise temperature. Thus, the conventional vacuum furnace were used to realize uniform heating which avoid non-uniform crystal growth.

Many annealing temperature condition were tried but the optimal temperature condition couldn't find. Optimal condition mean that the thermal property and brittleness were fine to apply the cryogenic device. Annealing above 1000 degree, thermal conductivity became larger significantly but the brittleness is too small. The tungsten was fragile not enough to cryogenic application.

We had tried to understand the reason why the brittleness got lower by the visualization technique. Figure 1 and Fig. 2 show the typical microscopic pictures of cross section of tungsten with the annealing temperature of 1200 degree by Scanning Electron Microscope (SEM). Figure 1 shows the typical picture before annealing. Figure 2 shows its picture after annealing. After annealing the tungsten, large grain can be observed around the surface of the sample that must be re-crystallization grain. It seems that this rather large grain around surface made the tungsten wire fragile

Development of Cryostat for thermal properties with Pulse tube Cryocooler

To realize the convenient measurement under low temperature condition, we developed the cryostat equipped with pulse tube cryocooler which can cool down to 4 K shown in Fig.3. The cryostat has rather large test space which is about ϕ 200 x 250mm. The rather space can be used to the thermal test for any kinds of material.

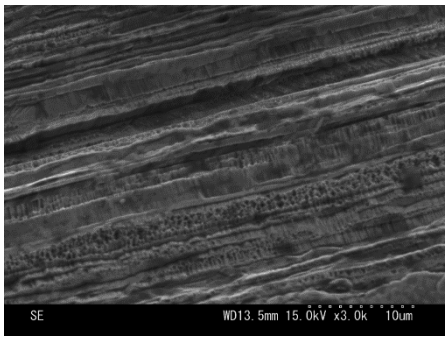

Fig.1 The cross sectional picture of pure tungsten wire of 5N class before annealing

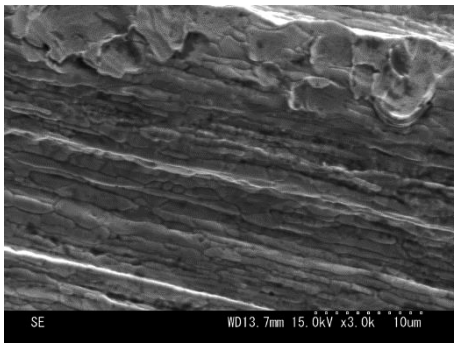

Fig.2 The cross sectional picture of pure tungsten wire of 5N class after annealing around surface

Fig.3 Developed cryostat equipped with the cryocooler

1) T. Tomaru, et al. TEION KOGAKU **46** (2011) 415-420 [in Japanese]

2) K. Kasahara et al. TEION KOGAKU **39** (2004) 25-32 [in Japanese]

3) T. Shintomi et a. TEION KOGAKU **46** (2011) 421-425 [in Japanese]