Low Temperature Physical Properties of a High Mn Austenitic Steel JK2LB

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Introduction
High manganese austenitic stainless steel JK2LB is developed by the Japan Atomic Energy Agency as a conduit material for superconducting cable-in-conduit conductors (CICC) for the magnets of international thermonuclear experimental reactor (ITER) [1]. In this paper [2], we measured the JK2LB’s low temperature physical properties which are very important to ITER magnet design but not yet reported.

Experimental
The as received material is heat treated at 650 C for 50 hours to simulate the conditions in the CICC application. The room temperature Young’s modulus is measured by the ultrasonic method. The magnetization, thermal conductivity, specific heat and resistivity at low temperatures are measured by a Quantum Design physical property measurement system. The thermal expansion between 10 K and 300 K is measured by a calibrated extensometer.

Results and Discussion
The Young’s modulus is obtained from the speed of sound measurements to be 191.7±1 GPa at room temperature. The magnetization versus temperature curve (Fig. 1) indicates antiferromagnetism with a Néel temperature \( T_N \approx 240 \) K. This is consistent with a prediction based on the chemical composition of the austenite stainless steel [3]. This is also supported by the resistivity versus \( T \) data which has a slope change at \( \sim 240 \) K (Fig. 2). Fig. 3 shows the thermal expansion versus \( T \). The solid line is calculated value based on the measured specific heat data assuming the Gruneisen parameter \( \gamma = 1.29 \). The thermal expansion between 10 K and 300 K is about 0.22%. The specific heat and thermal conductivity of this material are comparable to that of stainless steel 316 LN.

Conclusions
We found that JK2LB is antiferromagnetic at low temperatures with a Néel temperature of 240 K. The antiferromagnetic phase transition is also evident in the resistivity versus \( T \) curve. Nevertheless, no anomalies are observable in its specific heat and thermal conductivity from 2 to 300 K. The thermal expansion of this steel between 10 and 300 K is about 0.22%.

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References