MT25

KOREA UNIVERSITY

Investigation of Temporal Stability of a Persistent Current Mode Prototype MgB_2 Coil

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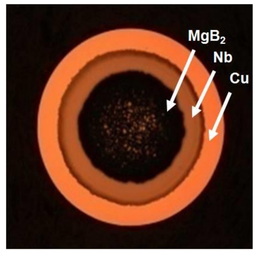
Abstract

A superconducting magnet commonly used in current MRI systems should be operated in the persistent current mode (PCM) to yield a high-resolution level that requires a magnetic field drift of less than 0.01 ppm/h. To acquire the required field homogeneity as a function of time, the availability and even reproducibility of a superconducting joint technique enabling the PCM of the magnet should be guaranteed quantitatively. Currently, a helium-free MgB_2 MRI magnet is being developed by the collaboration between Kiswire Advanced Technology Co. Ltd. (KAT) and Korea University, which is supported by the Materials and Components Technology Development Program of the Korean Evaluation Institute of Industrial Technology (KEIT), Korea. In this study, we report our progress on the development of a PCM prototype coil fabricated using MgB_2 wires manufactured by KAT. The temporal stability of the prototype MgB_2 coil was evaluated through the field decay tests at 4.2 K.

Experimental setup

★ MgB_2 mono-filament wire

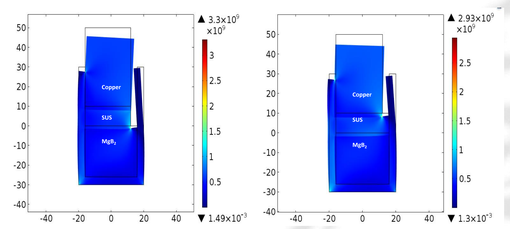


< Photograph of the cross-sectional area of the un-reacted mono-filament MgB_2 >

< Specification of MgB_2 mono-filament wire >

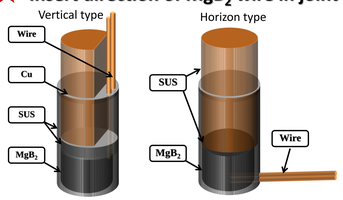
Parameters		Values
Packing density	[g/cm³]	0.31
Filament type		Monofilament
Diameter	[mm]	1.03
Condition		Un-reacted
Non-SC/SC		2.09
Heat treatment temperature	[ºC]	675
Heat treatment time	[hr]	1
I_c @ 4.2 K, 4 T	[A]	283
I_c @ 4.2 K, 5 T	[A]	138
I_c @ 4.2 K, 6 T	[A]	66

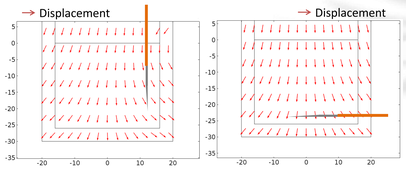
★ Stress analysis



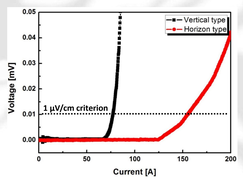
< Stress analysis results: (left) non-circular and (right) circular SUS cap >

★ Insert direction of MgB_2 wire in joint



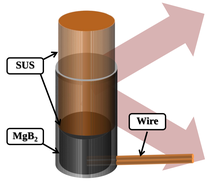


< Distribution of displacement within the mold for MgB_2 joint: (left) vertical type and (right) horizon type >

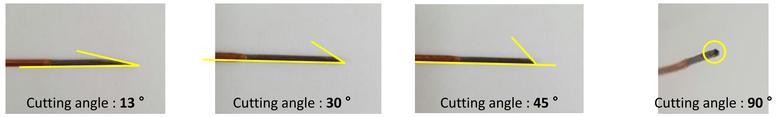


< *V-I* curves of the MgB_2 joint sample with respect to the mold shape >

★ Manufacturing MgB_2 Joint



➢ Cutting angle

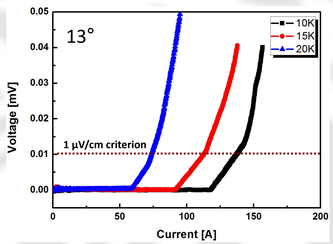


➢ Applied pressure

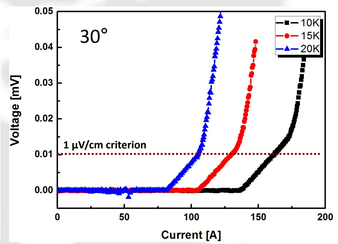
Parameter	Pressing pressure	Cutting angle
2 ton	308 MPa	13 °
5 ton	770 MPa	
9 ton	1386 MPa	

Results & discussion

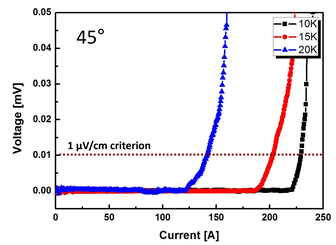
★ Cutting angle



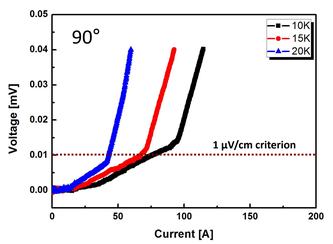
< *V-I* curve of the MgB_2 joint sample with a cutting angle of 13° >



< *V-I* curve of the MgB_2 joint sample with a cutting angle of 30° >

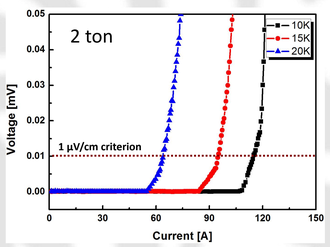


< *V-I* curve of the MgB_2 joint sample with a cutting angle of 45° >

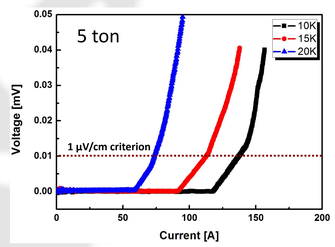


< *V-I* curve of the MgB_2 joint sample with a cutting angle of 90° >

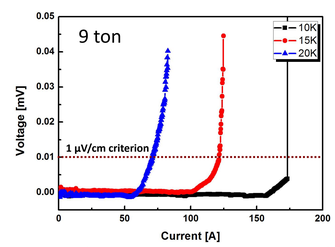
★ Applied pressure



< *V-I* curve of the MgB_2 joint sample with the applied pressure of 2 ton obtained with respect to the temperature>



< *V-I* curve of the MgB_2 joint sample with the applied pressure of 5 ton obtained with respect to the temperature>



< *V-I* curve of the MgB_2 joint sample with the applied pressure of 9 ton obtained with respect to the temperature>

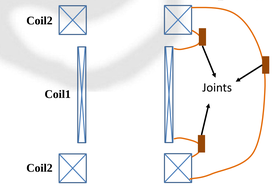
➢ Cutting angle

45 ° >> 30 ° >> 13 °

➢ Applied pressure

5 ton >> 9 ton >> 2 ton

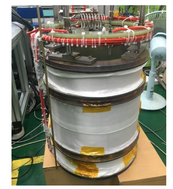
★ A 0.5-T/300-mm MgB_2 magnet



<Schematic drawing of the 0.5-T/300-mm MgB_2 magnet>

<Specifications of the 0.5-T/300-mm MgB_2 magnet>

Parameters		Coil1	Coil2
Inner diameter	[mm]	300	
Outer diameter	[mm]	309.16	335.23
Height	[mm]	199.5	76.6
Turns per layer		199	76
Layers		4	16
Number of coils		1	2
Operating current	[A]	89.3	
Coil constant	[mT/A]	5.6	
Coil inductance	[H]	2.11	



<Photograph of the 0.5-T/300-mm MgB_2 magnet>

★ Future work

- Temporal stability of the 0.5-T/300-mm MgB_2 magnet operated in the persistent current mode will be evaluated.

Laboratory of Superconducting Materials and Applications

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