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Superconducting joints made using internal Mg diffusion (IMD)-processed MgB₂ wires

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Magnesium diboride (MgB₂), which has a critical temperature (T_c) of 39 K, is a candidate for use in liquid-helium free magnetic resonance imaging (MRI). Since the discovery of MgB₂, the performance of MgB₂ wires and the manufacturing technology for long-length conductors have dramatically improved. Moreover, the superconducting properties of MgB₂ wires have improved. Wires subjected to internal magnesium diffusion (IMD) processing show particularly high performance compared to Power-In-Tube processed MgB₂ wires. Our group has been developing high-performance IMD wires with J_c and J_e values greater than 100 kA/cm² and 10 kA/cm², respectively, at 4.2 K and 10 T. MRI magnets usually require persistent-mode operation to obtain high-quality images. Therefore, for wide applicability of MgB₂ in MRI, more work is required on the joining process.

We prepared two unreacted IMD wires having a diameter of 0.8 mm. The edge of each wire was compressed by a press machine to flatten it into a tape shape. After one side of the tape was polished, two tapes were packed into a metal tube and pressed again to form a joint. The IMD wire with the joint was heat-treated at 670°C for 6 h. We performed I_c measurements using the probe method and observed the specimens by scanning electron microscopy (SEM) after the measurements. The maximum I_c values in the wire were depressed 10% compared to those of a normal IMD-processed wire for each investigated magnetic field. However, the I_c values of the joint part at 3 T were equal to the I_c values of normal IMD wire at 10 T, suggesting that this joint was effective for use at magnetic fields weaker than 3 T. SEM observations revealed several B-rich compounds. We will report further improvements of the IMD technique.

Submitters Country

Japan

Primary author: MATSUMOTO, Akiyoshi (NIMS)

Co-author: KUMAKURA, Hiroaki (National Institute for Materials Science)

Presenter: MATSUMOTO, Akiyoshi (NIMS)

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