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Kinetic Analysis of MgB2 Layer Formation in Advanced Internal Magnesium Infiltration (AIMI) Processed MgB2 wires

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Significantly enhanced critical current density (Jc) for MgB2 superconducting wires can be obtained following the advanced internal Mg infiltration (AIMI) route. But unless suitable precautions are taken, the AIMI-processed MgB2 wires will exhibit incomplete MgB2 layer formation, i.e. reduced superconductor core size and hence suppressed current-carrying capability. Therefore, it is crucial to investigate the mechanism of MgB2 layer formation in AIMI processed wires.
Microstructural characterization of AIMI MgB2 wires before and after the heat treatment reveals that the reaction mechanism changes from a "Mg infiltration-reaction"at the beginning of the heat treatment to a "Mg diffusion-reaction"once a dense MgB2 layer is formed. A drastic drop in the Mg transport rate from infiltration to diffusion causes the termination of the MgB2 core growth. To quantify this process, a two-stage kinetic model is built to describe the MgB2 layer formation and growth. The derived kinetic model indicate that fully reacted AIMI-processed MgB2 wires can be achieved following the optimization of B particle size, B powder packing density, MgB2 reaction activation energy and its response to the additions of dopants. This kinetic model is used to explain the experimental observations in AIMI wires, including the sudden stop of MgB2 layer formation, optimal choice of B precursor type, and the effects of heat treatment temperature as well as C or Dy2O3 dopants on AIMI wires. Finally, suggestions are given for preparing full reacted, well performance AIMI wires according to the above kinetic analysis.

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