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A Comparative Study of Experimental and Computational Modeling for Thickness Dependence of Trapped Field in Machined MgB2 Bulk Superconductors

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MgB2 in bulk form shows great promise as a trapped field magnet (TFM) as an alternative to bulk (RE)BaCuO materials to replace permanent magnets in applications such as desktop high-field magnet systems and rotating machines. In addition to being inexpensive and lightweight, they exhibit a number of additional advantages: a long coherence length, smaller anisotropy, strongly-linked supercurrent flow in untextured polycrystalline samples, and the relative ease of fabrication has enabled a number of different processing techniques to be developed.

In this presentation, we investigate the thickness dependence of the trapped magnetic field in bulk MgB2 superconductors. Two bulk MgB2 samples, 20 mm in diameter and 10 mm in thickness, were fabricated using the powder-in-closed-tube (PICT) technique. The trapped field was then measured after field-cooled magnetisation for thicknesses of 20 mm (both bulks stacked), 10 mm (single bulk), and then 7.5, 5, 4, 3, 2 and 1 mm, for which the sample was machined down to the designated thickness using an automated-wet-polishing technique.

A 2D axisymmetric finite-element model based on the $\boldsymbol{H}$-formulation is used to simulate the experimental results and explain the observed thickness dependence of the trapped field. The numerical results, which assume a Jc(B) dependence based on the measured characteristics of small specimens taken from the bulk before and after machining, suggest that gradual degradation of Jc occurred with machining and hence reducing thickness. When accounting for this, the models and experiments showed excellent agreement. Consistent trapped field measurements on the top and bottom surfaces suggest this degradation occurred globally, rather than local to the machined surface.

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