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ORIGINAL PAPER

Magnetic Characterization of MgB_2 Bulk Superconductor for Magnetic Field Mitigation Solutions

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Abstract Magnetic shielding properties of MgB_2 bulk samples synthesized by the SPS (Spark–Plasma–Sintering) technique were characterized in low applied magnetic fields at temperatures ranging from 20 to 37 K. The used growth technique allows one to produce this compound in different shapes and sizes required for shielding applications. In this framework, shielding magnetic-induction field profiles generated by MgB_2-based shield components, shaped as planar thick disks, were measured by means of a suitable Hall probe in-plane array. The magnetic field distribution at different vertical distances above the sample was also obtained by a micrometric motion of the probe ensemble. Magnetic field profiles were then analyzed in the framework of the critical state model and the critical current density, J_c, was evaluated. The J_c magnitude indicates that the material under test is a good candidate for passive magnetic shield manufacturing up to temperatures close to the transition one.

Keywords MgB_2 bulk · Magnetic shielding · Critical current density · Scanning Hall probe technique

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1 Introduction

Due to their ability to expel magnetic flux, superconducting materials represent a remarkable solution for the fabrication of effective magnetic shields in several application sectors, such as medical or military or space fields [1–5].

Low-temperature superconductors were successfully used for passive shields [3, 6], but their use implies elevated operating costs. Encouraging results were also obtained by using high-temperature superconducting cuprates (HTSC) that guarantee a technological improvement in terms of cost and energy saving [7–12]. However, HTSC are brittle in nature and this means mechanical problems during their manufacturing as well as poor system scalability.

Within this scenario, magnesium diboride (MgB_2) represents a good compromise between the need of increasing the operative temperature and of reducing the manufacturing cost. The raw material cost is indeed low and even manufacturing is quite straightforward, due to the affinity between B and Mg that favors an easy reaction to MgB_2. This material can be used also in the polycrystalline state (showing a very small barrier to the current at the grain boundaries [13, 14]) and it presents a higher mechanical strength and a lower density than HTSC materials. On the other hand, the MgB_2 working temperature range (20–30 K) (lower than the corresponding one of a HTSC-based shield) is easy attainable also by single- or double-stage cryogen-free cryocooler. It is worthwhile to note that MgB_2 is reportedly able to shield