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Non-destructive investigation of hybrid of ferromagnet /(RE)BCO large grain bulks by flux extraction magnetometry and levitation force

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This work deals with bulk, large grain superconductors used as permanent magnet for rotating machines or levitation applications. It has recently been shown that the magnetic properties of bulk large grain superconductors can be improved easily by attaching a short section of a soft ferromagnetic material (F) to one of the faces of the bulk superconductor (S), thereby producing a hybrid F/S structure [1]. Here we investigate the contactless determination of the magnetic behavior of such structures using a recently constructed bespoke magnetometer based on the flux extraction technique [2]. This device allows magnetic moments as large as 1 Am^2 to be measured at 77 K and accommodates large bulk samples up to 20 mm diameter. This extends significantly the accessible measurement range of "off-the shelf"magnetometers. Unlike techniques based on recording the distribution of flux at the surface of the sample, the measured signal is representative of the superconducting currents flowing across the entire volume of the sample. In the present work we examine the properties of permanently magnetized superconductors and hybrid structures, and measure the irreversible demagnetization of these structures when they are subjected to magnetic field cycles that are not parallel to their magnetization. We also investigate the levitation behavior of hybrid structures subjected to the non-uniform field of a permanent magnet or a combination of permanent magnets used as guideway for levitation applications, and compare the results to those obtained with a bulk superconductor alone.

References:
[1] Egan R. et al., Rev. Sci. Instrum. 86 (2015) 025107
[2] M. P. Philippe et al., Supercond. Sci. Technol. 28 (2015) 095008

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