Self-heating of Bulk High Temperature Superconductors of Finite Height Subjected to a Large Alternating Magnetic Field

P Laurent[1], J-F Fagnard[2], N Hari Babu[3], D A Cardwell[4],
B Vanderheyden[1] and P Vanderbemden[1]

[1]SUPRATECS and Department of Electrical Engineering and Computer Science
B28, Sart-Tilman, B-4000 Liège, Belgium
[2]SUPRATECS, Royal Military Academy of Belgium, Avenue de la Renaissance,
B-1000 Brussels, Belgium
[3]Brunel Centre for Advanced Solidification Technology (BCAST), Brunel University,
West London, UB8 3PH, UK
[4]Bulk Superconductivity Group, Engineering Department,
University of Cambridge, Cambridge, CB2 1PZ, UK
E-mail : Philippe.Vanderbemden@ulg.ac.be

Abstract - In this work we study, both experimentally and numerically, the self-heating of a bulk, large YBCO pellet of aspect ratio (thickness / diameter) ~ 0.4 subjected to a large AC magnetic field. In view of accurate temperature measurements, the sample is placed in a vacuum experimental chamber with a small and reproducible heat transfer coefficient between the superconductor and the cryogenic fluid. The temperature is measured at several locations on the sample surface during the self-heating process. The experimentally determined temperature gradients are found to be very small (< 0.2 K across the radius of the superconductor). The time-dependence of the average temperature *T(t)* is first compared to a theoretical prediction based on the one-dimensional (1-D) Bean model and assuming a uniform temperature in the sample; a satisfactory agreement is found. Next we consider a 2-D magneto-thermal model in order to determine the time-dependent temperature distribution *T(r, z, t)* during the application of the AC field : the losses in the bulk pellet are determined using an algorithm based on the numerical method of Brandt, and this program is combined with a heat diffusion algorithm implemented with a finite-difference method. The model is shown to be able to reproduce the principal features of the temperature evolution of the bulk sample during a self-heating process. In addition, the 2-D model is used to study the effect of a non-uniform distribution of critical current density J_c(r, z) on the losses within the bulk superconductor.

IEEE/CSC & ESAS European Superconductivity News Forum (ESNF), No. 15, January 2010
Published in *Supercond. Sci. Technol*. (SuST) 23 (2010) 124004 (10pp)