IEEE/CSC & ESAS European Superconductivity News Forum (ESNF), No. 7, January 2009
Extended Abstract of Presentation 3F.02 at CCA08, Houston, TX, December 4-6, 2008

Critical Currents and AC Losses in Coated Conductors

T. Kiss, K. Higashikawa, A. Matsekh, K. Imamura, K. Abiru, Y. Honda, and M. Inoue
Dept of EESE, Kyushu University, Fukuoka 819-0395, Japan

S. Miyata, A. Ibi, Y. Yamada, J. Kato, N. Chikumoto, K. Nakao, M. Yoshizumi, T. Izumi, Y. Shiohara
Superconductivity Research Laboratory, ISTEC, Tokyo 135-0062, Japan

***Abstract*— Numerical simulation of AC loss analysis has been carried out based on the critical state model as well as taking into account nonlinear *E-J* characteristics as a function of magnetic field and temperature within the framework of the percolation transition model. Influence of multiple tape stacks, magnetic field dependence and the effect of J_c improvement of magnetization losses in a high field magnet have been discussed based on the numerical analysis. Influence of spatial J_c non-uniformity has also been studied by the magnetic microscopy and its influence on AC losses in multi-filamentary tape has been discussed.**

I. Introduction

Influence of tape stacks on AC losses will become relevant in practical application of coil windings and magnets. Also magnetic field dependence of J_c on AC losses should be taken into account for magnet applications. Based on the comprehensive analysis on transport *E-J* relationship in GdBCO coated conductor, we estimated AC losses by use of numerical analysis. Spatial J_c non-uniformity also becomes critical issues especially in the case of multi-filamentary tapes. We visualize local current flow by solving inverted Biot-Savart's law from magnetic microscopy.

II. Numerical Analysis of AC Losses in Thin Strips

A. Influence of Tape Stacks

Numerical simulation has been carried out assuming constant J_c in 1 cm-wide thin strip. For the case of single layer, calculated losses show good agreement with theoretical expression for both transport loss and magnetization loss. As a next step, we calculated current profile in the case of multiple layers under the same amplitude of alternating magnetic field, B_{AC}=0.01 T. As the number of layer increases, the external field is shielded more effectively, therefore the magnetization loss becomes smaller. The current profile approaches similar to the case of slub if the numbers of stacks increase. Typical examples are shown in Fig. 1.

B. Influence of Magnetic Field Dependent I_c

It has been reported that AC losses deviate from theoretical expression in the region of high magnetic field amplitude because we can not assume constant I_c anymore [1]. Using the percolation transition model, we describe temperature- and

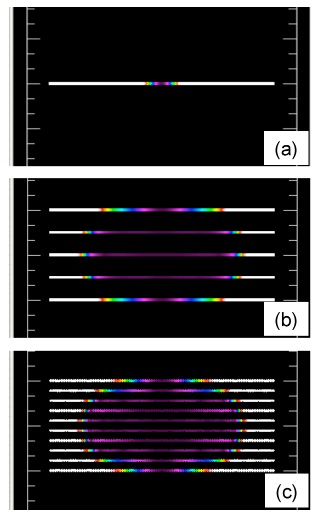

Fig. 1. Current profile in 1 cm-wide thin strips obtained from numerical simulation assuming critical state model. (a) single layer, I_c=100 A, (b) 5 stacks having 1 mm separation with I_c=100 A each, i.e., total I_c=500 A. (c) 10 stacks having 0.5 mm separation with I_c=50 A, namely total I_c =500 A is the same to the case of (b).

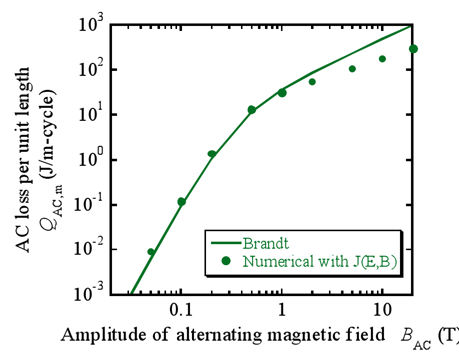

Fig. 2 Magnetization loss obtained by the numerical simulation taking into account magnetic field dependent *E-J* relationship at 4.2 K.

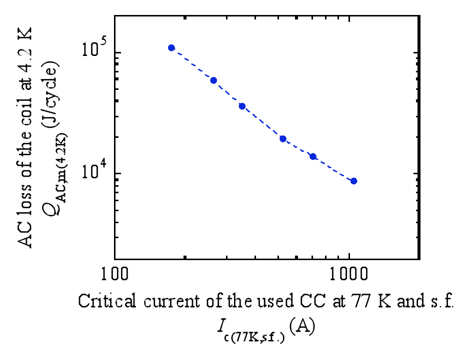

Fig. 3 Magnetization loss estimated in 40 T class magnet as a function of I_c. of tape strand