INVITED

# Quench Properties of Resistive Superconducting Fault Current Limiters Based on YBCO Thin Films

Hye-Rim. Kim*, Hyo-Sang Choi, Sang-do Cha and Ok-Bae Hyun

*Korea Electric Power Research Institute, Taejon, Korea*

We have investigated quench properties of resistive superconducting fault current limiters (SFCL) based on $YBa_2Cu_3O_{7-\delta}$ thin films. Knowledge on quench properties of superconductors are important for the research and development of SFCLs, because quench property determines their performance. The 0.3 μm thick YBCO film grown on a sapphire substrate was coated insitu with a 0.2 μm thick gold layer, and patterned into meander lines by photolithography. Fabricated Au/YBCO meander lines were tested with simulated AC fault currents of various amplitudes and duration. They were immersed in liquid nitrogen during the experiment for effective cooling. Investigation was focused on understanding of quench development in meander lines. Upon fault current surpassing quench current, all sections of the meander line made transitions into the flux flow regime simultaneously with similar flux flow resistivity. Transfer of the generated Joule heat to the surroundings, however, soon changed the distribution. As a result the center area quenched first in uniform films. Quench propagated from the center area mainly through the sapphire substrate until it was completed. The resistivity of the central area was relatively uniform at all voltages, but the resistivity in the edge area was significantly lower than that of center stripes, reflecting the cooling power of the edge area. The range over which cooling had an influence was a few millimeters. Time-dependence of meander line resistance was also investigated. The resistance first increased rapidly and the increase slowed down. It consisted of a slow varying background and an oscillatory component. The initial rapid rise in resistance, which is important for fast current limitation, was due to the superposition of the increasing oscillatory component to the increasing background. The resistance increased linearly with the applied voltage and, at 4 V/cm, the temperature of the gold layer reached 200 K at 3 cycles after the fault. These results could be explained quantitatively with the concept of heat transfer within the film and to the surroundings. Data fit well to a simulation function derived from a heat balance equation with appropriate constraints. The results were applied to the design of SFCL elements of higher power rating. We successfully built 1.2 kV/110 A SFCLs by connecting SFCL elements in parallel and in series. They effectively limited the fault current in 1 millisecond. This work was supported in part by a grant from Center for Applied Superconductivity Technology of the 21st Century Frontier R&D Program funded by the Ministry of Science and Technology in Korea.

keywords : quench, $YBa_2Cu_3O_{7-\delta}$, superconducting, fault current limiter