

# **Simulation of electrical, magnetic and thermal properties of inductive fault current limiters made of YBCO ceramic superconductors**

Dr. István Vajda and Sándor Semperger

*Budapest University of Technology and Economics, Department of Electric Power*

*Engineering, SuperTech Lab, Budapest, Hungary*

**Abstract:** The fault current limiter (FCL) is a device capable of limiting currents in electrical networks during fault conditions. In this device the acting element is a high temperature superconductor (HTS) ring made of ceramic material. The inductive FCL consists of a primary normal metal coil coupled via a ferromagnetic core to a secondary short-circuited superconducting coil assembled in the form of a set of HTS rings or cylinders. In the normal conditions of the protected circuit, the superconducting rings are in the superconducting state. Under fault conditions the secondary superconducting coil becomes resistive. As a result, in normal operation the impedance of the FCL is much less, while in the current limiting mode the impedance is higher than the impedance of the network. A 12 kVA inductive closed core type HTS FCL with melt textured YBCO ring was developed and tested. The current limiting properties of the FCL were investigated experimentally and the results were compared with those of computer modeling. The quench behavior of the YBCO HTS ring has strong influence on the current limiting properties of the FCL. For the description of transient and quasi-stationary processes of the FCL the authors have developed a model and a numerical simulation, which consist of coupled electromagnetic and thermal processes, can handle the influence of the hot-spots generated in the HTS, and the non-linear characteristics of the magnetic core. The model provides the various operational modes of the FCL due to material properties observed in the experiments, and enables the determination of main dimensions of the device including those of the magnetic circuit. Due to the very good agreement between the experimental and calculated results, the model can directly be used for the engineering design of inductive type HTS fault current limiters.